NAPLES BEACH RESTORATION AND WATER QUALITY IMPROVEMENT PROJECT

30% Design Technical Report

DESCRIPTION	REVISION	BY	CHECKED	DATE
Draft-Final	A	CLP	KME	05/25/2016
Final (Update with Appendix E Water Quality)	B	CLP	KME	09/18/2017

ECE
Erickson Consulting Engineers, Inc.
www.ericksonconsultingengineers.com

Stantec
www.stantec.com

EXECUTIVE SUMMARY

Project Purpose and Need

There have been long-standing concerns from the State's regulatory agencies, City officials and staff, environmental groups, property owners, residents and visitors that the City of Naples beach outfalls adversely impact beach erosion, lateral beach access, sea turtle nesting habitat, water quality and beach aesthetics. In addition, the City has experienced significant flooding of Gulf Shore Blvd during high frequency rainfall events.

Water Quality

Blocked Discharge

Flooding

In 2012, the City adopted Resolution No 12-13028 and amended their stormwater master plan to require the removal of the City's stormwater beach outfalls. These actions were taken to satisfy the Florida Department of Environmental Protection (FDEP) Joint Coastal Permit (JCP) Condition (Permit No. 0222355-001-JC) for the City's beach nourishment projects.

This technical analysis and design development (30%) report was prepared in accordance with the City Council's request to determine the feasibility and preliminary design (30%) for consolidation of the nine publically owned outfalls with a stormwater pump station(s) in a location that would receive all or a portion of the stormwater currently discharging along Naples Beach within Drainage Basin II; and discharge the collected and treated stormwater through an offshore gulf discharge pipeline(s). The City of Naples Beach Restoration and Water Quality Improvement Project (the "Project") Phase I services include all planning, analysis and design (30%) including evaluating consolidation, treatment, pump station siting and offshore diffuser system discharge requirements.

Existing Conditions

The existing outfalls are generally characterized as large PVC pipes (>18 inches in diameter) which extend into the littoral zone and are supported by timber structures. The structures are generally in poor condition, require frequent maintenance and affect lateral use of the beach (walking, jogging, swimming).

High frequency rainfall events result in discharge to the Gulf through the nine outfalls. Periodic beach nourishment and sand placement projects result in a dynamic, fluctuating shoreline which often blocks the outfall pipes' flow due to sand build up in the pipeline, causing upstream flooding of Gulf Shore Boulevard. This blockage results in a reduced level of service ("LOS"), a loss of system functionality, the need for frequent maintenance and causes impaired water quality. This blockage requires the upstream swales and channels to stage (flood) to levels that are sufficient to open the blocked or tidally flooded pipelines for stormwater to discharge to the Gulf. Water quality is then adversely affected from the resulting residence times, nutrient loads and wildlife that may forage in the swales and standing waters. Furthermore, fine sediments accumulate in stagnant water resulting in turbidity plumes during discharge into the shallow waters along the shoreline. Water quality degradation has direct adverse impacts to the community and its environmental resources.

In addition, the City of Naples is considered one of the nation's premier coastal communities. The visual impacts of the outfalls, i.e. pipes and wooden pile mountings, are a considerable detraction from the natural beauty of Naples Beach.

To supplement available data, additional field investigations were conducted as part of this scope of services to collect information necessary to conduct the feasibility study and formulate the preliminary design. Additional field investigations will be required at the 60% design level.

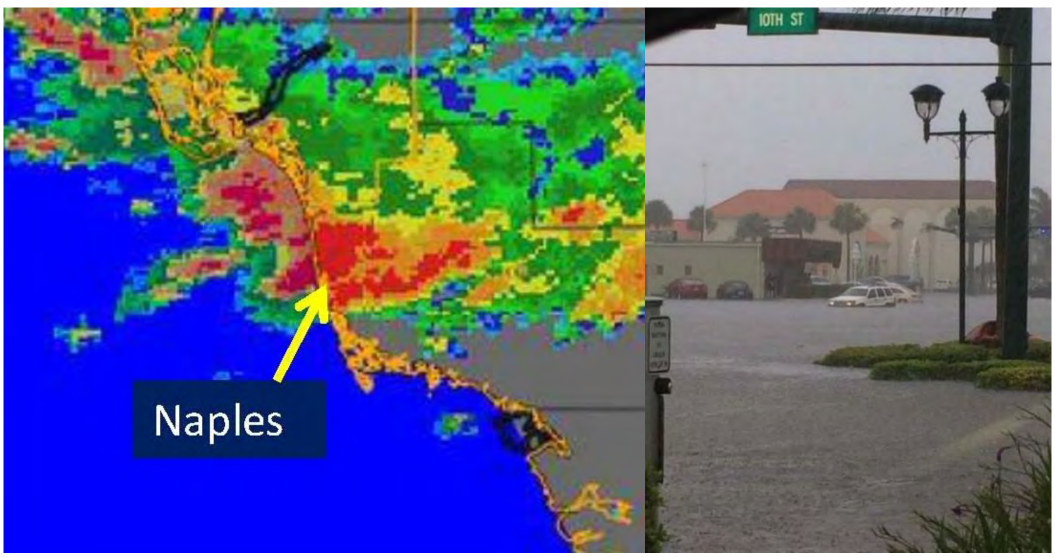
Analysis

Level of Service (LOS) is generally defined as the service capacity of the stormwater sewer system for a specific return period rainfall event based on the assumption that the collection structures and pipeline components of the stormwater sewer system are functioning at full capacity. The existing stormwater sewer is a gravity flow system with beach outfalls that are affected by mid to high tidal phases, storm surge and sand clogging the pipes; each of which compromise or reduce the LOS.

Utilizing the output from the SWMM model and the existing stormwater conveyance system network and elevation data, the simulated LOS provided by each outfall is on the order of a 25-Yr/1-Day event. During the 25-Yr/3-Day rainfall event, the model predicts street flooding of Gulf Shore Blvd between Outfall 2 and Outfall 10 on the order of 1-3.5 ft. The worst flooding is predicted to occur at 7th Ave N (Outfall 4), Alligator Lake (Outfall 6) and at 1st Ave N (Outfall 8).

Based on the actual street flooding observed within Basin II, specifically near Gulf Shore Blvd, it is apparent that the full capacity of the existing system (LOS) is overestimated. The optimum conditions for the existing system are low tidal conditions, absence of waves and storm tides occurring for low frequency rainfall events (> 3 inches). The AECOM SWMM model of Basin II represents a generalization of the existing stormwater conveyance system and attenuation within each sub-basin.

An assessment of rainfall for the prior 13 years was conducted to obtain an overview of rainfall intensities and frequencies in recent years for the City. The analysis identified a total of 40 events where the daily reported rainfall exceeded 2 inches, 6 events where the daily report rainfall exceeded 3 inches and 3 events where the daily report rainfall exceeded 4 inches.



August 4, 2014 Rainfall Over Naples with Flooding in Downtown Naples
(6 Inch Event over 4 Hours)

Water Quality

The water body impacted by the existing outfalls' discharge is the Gulf of Mexico. Water quality parameters that are deemed most significant in assessing potential pollutant impacts include bacteria (fecal coliform and enterococci), nutrients, suspended sediments and heavy metals (mercury). The Gulf of Mexico is a listed, impaired water body for mercury by the FDEP. No increase in discharge volume will occur as a result of the Project; therefore, no increase in these potential pollutants will be introduced in the marine environment. It is anticipated that the removal of debris, such as grass clippings, branches and suspended sediment from the system, and the positive flow from the pump station's forcemain with the new pipe network, will contribute to improvements in overall water quality.

There is no data in the immediate vicinity of the outfalls themselves to provide an accurate representation of the quality of water discharged to the Gulf. To design a suitable treatment system, knowledge of site-specific loadings of specific water quality parameters, including suspended sediment and bacteria, is required. Based on the absence of data, the City and design team developed a sampling program which will provide the basis for designing the water treatment system components and reductions in these potential sources of pollutants to the Gulf.

Design Requirements

The siting and land requirements for consolidating the outfalls to convey flow to a centralized pump station(s) is largely dependent on the existing infrastructure and the level of service provided by the largest outfalls. Three of the nine outfalls carry in excess of 60% of the total outflow to the Gulf. Outfall 2, located at the northernmost limit of the Project Area, represents 19% of the total flow, whereas Outfalls 6 and 8, in the southern portion of the Project Area, represents 31% and 17% of the total flow, respectively. As a result, the consolidation, and therefore pump station location(s), must be in close proximity to these outfalls due to spatial constraints and the geometric requirements of the pipeline to carry the flow.

Three locations were identified as viable to house a pump station and auxiliary equipment (e.g. control panels, generators, treatment, etc) that met the spatial constraints of consolidation. These locations (identified in Section 3.2.1) include:

1. City owned beach access at 6th Avenue North (present location of Outfall 5)
2. City owned beach access at 3rd Avenue North (present location of Outfall 7)
3. Parcel on the west side of Alligator Lake (ID 141517600007)

Due to the existing high flow associated with Outfall 2 (particularly due to the contribution from the Naples Beach and Golf Club), a fourth location in the vicinity of the Naples Beach Hotel and Golf Club would provide additional flexibility if a site can be procured through purchase or perpetual easement.

For routing to/from the pump station location(s), existing utility and construction easements were assessed to identify viable consolidation options and pipeline routes. Options were identified within the Right-of-Ways (ROWs) of Gulf Shore Blvd and potentially along the back-beach between Outfalls 6 and 10.

The Level of Service (LOS), as it applies to the Project, is the design peak flow that the stormwater system can convey and contain prior to backup of the system (i.e., standing water within the street(s)). The LOS is a primary consideration in the system's design as it establishes the system's capacity (pump station, pipeline and stormwater structures sizing) and associated components (e.g. filter systems, etc) and as well as the system's overflow line(s). The Project meets the City's LOS requirements (5-yr/1-hr) and the South Florida Water Management District (SFWMD) requirements (25-yr/3-day). An overflow line is required to provide discharge capacity during extreme low frequency storm events, i.e. conveys flow to the Gulf as a back-up or "overflow" to the primary forcemain system.

Elevations along the Gulf Shore Blvd ROW are low and range from approximately 5.5 ft to 4.2 ft (NAVD 88). The low elevations and width of ROW control the size of the pipeline, and thereby the consolidated flow that can be conveyed.

Alternatives for Stormwater Consolidation, Treatment and Discharge

Once the design requirements were identified, three viable alternatives were identified and the designs further developed for evaluation and ranking. The alternatives were developed to give the City Council a range of alternatives that are practical and meet the prescribed Project goals and objectives which include:

1. Reduce flooding and improve water quality;
2. Eliminate erosion rates from outfall induced scour and improve lateral beach access by removing pipelines;
3. Reduce adverse impacts to the beach and nearshore natural resources (sea turtles and hardbottom);
4. Meet or exceed the existing L*evel of Service* (LOS) to convey flow and improve the stormwater system's resilience for:
    a. 5-yr/1-hr rain event (City of Naples Comprehensive Plan) and
    b. 25-yr/3-day rain event (SFWMD);
5. Convey treated stormwater to a pump station(s) and offshore; and
6. Community education and outreach (project goals & objectives).

Alternative 1: Alternative 1 consolidates the existing stormwater flow associated with Outfalls 3, 4 and 5 (25-Yr) and Outfalls 6, 7 and 8 (25-Yr), and conveys the flow to a single pump station located at 3rd Avenue North with treatment and discharge lines (5-Yr) drilled with a diffuser system placed offshore in the Gulf. An overflow line, located at Outfall 6, will be located below the visible beach and open only during extreme storm events.

The discharge at Outfall 2 associated with the City's collection system will be re-routed and connect to Moorings Bay. However, Outfall 2 will remain with connections, as required, to service the Naples Beach Hotel and Golf Club. Discharge from Outfalls 9 and 10 will be re-routed to the City's Basin III where existing line sizes and system capacity is available (25-Yr storm).

Alternative 1 was developed as the solution which consolidates and eliminates a significant number of outfall structures and maximizes discharge utilizing a single pump station. Alternative 1 consolidates an estimated 77% and 41% of the 5-yr and 25-yr peak discharge, respectively. The limiting factor in the development of Alternative 1 is the total peak flow and the distances for pipeline consolidation to reach a suitable location for a pump station, and the requirement that a portion of the flow is diverted to Moorings Bay and Basin III (Naples Bay).

Alternative 2: Where it is seen that Alternative 1 minimizes costs by using a single pump station, it falls short of a complete removal of the large outfall located on the beach (Outfall 2) and transfers a significant portion of the flow to Moorings Bay and to Basin III, which ultimately discharge freshwater to Naples Bay.

To assess the design requirements for (a) consolidation of the existing stormwater lines from all nine outfalls and (b) two pump stations with capacity to convey the higher flow; the Project Area was evaluated and separated into a north and south system. The available pump station locations and pipeline consolidation requirements were analyzed and the design requirements determined siting at (a) the northern end of the Project Area near Outfall 2 or (b) the central beachfront area near Outfall 6 adjacent to Alligator Lake would result in pipeline distances and sizes that are technically manageable.

The Alternative 2 "North System" consolidates the existing stormwater flow associated with Outfalls 2, 3, 4 and 5 (25-Yr) and conveys the flow to a pump station located at 6th Avenue North with treatment and discharge lines deep drilled to a diffuser system placed offshore in the Gulf.

The Alternative 2 "South System" consolidates the existing stormwater flow associated with existing Outfalls 6, 7, 8, 9 and 10 (25-Yr) and conveys the existing flow to a second pump station located at 3rd Avenue North with treatment and discharge (5-Yr) through directional drilled pipelines offshore. An overflow line, located at Outfall 6, will be located below the visible beach and open only during extreme storm events.

As with Alterative 1, an existing stormwater line remains at Outfall 2 maintaining a connection to service the private Naples Beach Hotel and Golf Club.

Alternative 3: Siting a pump station in the vicinity of the Naples Beach Hotel and Golf Course will allow the Outfall 2 pipes to be eliminated. Evaluation of this option resulted in the design development of Alternative 3.

The Alternative 3 "North System" consolidates the existing stormwater flow associated with existing Outfalls 2, 3, 4 and 5 (25-Yr) conveys the flow to a pump station located in the vicinity of the Naples Beach Hotel and Golf Club with treatment and discharge lines deep drilled to a diffuser system placed offshore in the Gulf. The existing large stormwater line at Outfall 2 will be removed and discharge from the Naples Beach Hotel and Golf Club will be routed to the City's new pipeline consolidation system, pump station and treatment system located in close proximity to the existing Outfall 2.

The Alternative 3 "South System" consolidates the existing stormwater flow associated with existing Outfalls 6, 7, 8, 9 and 10 (25-Yr) and conveys the flow to a pump station located at 3rd Avenue North with treatment and discharge (5-Yr) through a diffuser system using directional drilled deep pipelines offshore. An overflow line will be located at Outfall 6 for extreme storm events. The overflow line will be located below the visible beach and open only during extreme storm events. As a reference, and further described in Section 2, Hurricane Wilma and the similar storm events over the past 14 years (2003- present) would not have resulted in flow that exceed the capacity of this system and result in opening of this overflow line.

Evaluation and Ranking of Alternatives

To evaluate the alternatives, an analysis of the required LOS, available Gulf front/adjacent sites and characteristics, pipeline consolidation/pump station design requirements and nearshore resources/beach features was performed to assess the benefits and sensitivities of each alternative. Representatives from the design team and City Staff (Streets & Stormwater and Natural Resources) assembled to discuss and score each criteria on April 25, 2016 across various technical, economic and social criteria.

"Alternative 3" scored the highest primarily due to (a) greatest percentage of flow consolidated; (b) resulting effectiveness per dollar spent, as well as removal of all outfalls from the visible beach; (c) scalability that would allow the system to be constructed in phases; (d) its highest beneficial environmental and social impacts and (e) consolidation of the existing stormwater lines resulting in the shorter line length and cost.

A graphic comparison and cost comparison of the alternatives follows.

Graphic Comparison of Project Alternatives

Alternative 1: Single Pump Station @ 3rd Ave N

Alternative 2: Two Pump Stations @ 6th Ave N & 3rd Ave N

Alternative 3: Two Pump Stations @ 6th Ave N & 3rd Ave N

Cost Comparison of Project Alternatives

Alternative	Construction Cost	Total Flow % Consolidated to Pump Station		Effectiveness per Dollar Spent ($M)	
		5-yr	25-yr	5-yr	25-yr
1	$13.2M	77%	41%	17.1	32.1
2	$21.0M	96%	69%	21.9	30.5
3	$20.2M	100%	77%	20.2	26.2

Effectiveness per Dollar Spent = Construction Cost / % Flow Treated

Preferred Alternative (30% Design)

Alternative 3 ("Preferred Alternative") is comprised of a "North System" and "South System" as follows:

- **North Drainage and Treatment System** – consolidates the existing stormwater flow associated with Outfalls 2, 3 and 4 (25-Yr) and conveys the flow to a pump station located in the vicinity of the Naples Beach Hotel and Golf Club with treatment and discharge lines deep drilled and a diffuser system placed offshore in the Gulf. All pipeline consolidation is along Gulf Shore Blvd. The north system treats 100% of the 25-yr peak flow through the pump station.

- **South Drainage and Treatment System** - consolidates the existing stormwater flow associated with existing Outfalls 5, 6, 7, 8, 9 and 10 (25-Yr) and conveys the flow to a pump station located at 3rd Avenue North with treatment and discharge (5-Yr) through a diffuser system using directional drilled deep pipelines offshore. The south system treats 77% of the 25-yr peak flow through the pump station. An overflow line will be located at Outfall 6 to convey stormwater during extreme storm events, when peak discharge volumes exceed the maximum rates for the pump stations, by diverting the flow from Alligator Lake. The overflow line will be located below the visible beach and open only during extreme storm events, estimated to occur once in 10-15 years. The potential exists for pipeline consolidation along the back-beach or Gulf Shore Blvd.

The Preferred Alternative offers the most flexibility with regard to construction phasing and future expansion. For example, if the Alternative 3 south system is constructed first, the opportunity will exist in the future to construct the north system for Alternative 3, upon securing funding and procurement of an easement for use of land. Should land use for the Alternative 3 north system prove difficult to acquire, the City will have the option to convert the system to modify the north system to convey flow south to construct either the Alternative 2 ***or*** Alternative 1 project designs.

The Preferred Alternative provides a low impact coastal, environmental and stormwater engineering design and utilizes a unique design that includes a directionally drilled pipeline and a diffuser system, and pump stations with a filtration and UV treatment system to reduce chronic flooding and improve water quality.

Other Considerations

During progression of the Project, meetings were held with stakeholders to receive input during the development and evaluation of the Project alternatives, including the Conservancy and the Water Keepers Alliance as well as the governmental regulatory agencies.

An evaluation of the permits required, and consultation with key regulatory agencies, indicates that the regulatory agencies responsible for the Project permits are supportive of the Project.

Seven potential sources of grant funding were identified. The incorporation of water quality treatment into the Project will result in the greatest potential for funding from the State.

Recommendations and Next Steps

In consultation with the City Staff (Streets & Stormwater and Natural Resources), we recommended the following next steps with the intent of returning to the City Council in the fall of 2016.

1. Continue stakeholder / community coordination
2. Complete the water quality testing program
3. Conduct additional data collection and modeling
4. Complete supplemental engineering

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

ABBREVIATIONS

AECOM	Architecture, Engineering, Construction, Operations and Management, Inc.
ASR	Aquifer Storage & Recovery
BFE	Base Flood Elevation
BMP	Best Management Practices
BOD	Biological Oxygen Demand
CAPEX	Capital Expenditures
CCCL	Coastal Construction Control Line
CCSL	Coastal Construction Setback Line
CFS	Cubic Feet per Second
CFU	Colony Forming Unit
CP&E	Coastal Planning & Engineering
CY	Cubic Yards
DCIA	Directly Connected Impervious Areas
ECE	Erickson Consulting Engineers
ECL	Erosion Control Line
EPA	Environmental Protection Agency
ERP	Environmental Resource Permit
F.A.C.	Florida Administrative Code
FDEP	Florida Department of Environmental Protection
FLUCCS	Florida Land Uses and Cover Classification System
FO	Fiber Optic
FPS	Feet per Second
FPVC	Fuseable PVC
FY	Fiscal Year
GGHS	Golden Gate High School
GIS	Geographical Information System
HDD	Horizontal Directional Drilling
HDS	High Density Sludge
HDS	Hydrodynamic Seperators
HMI	Human Machine Interface
JCP	Joint Coastal Permit
KAPF	Naples Municipal Airport
LOS	Level of Service
MBTA	Migratory Bird Treaty Act
MHW	Mean High Water
MWL	Mean Water Line
NAVD	North American Vertical Datum
NGO	Non-Governmental Organization
NOAA	National Oceanic and Atmospheric Association
NPDES	National Pollutant Discharge Elimination System

O&M	Operations & Maintenance
OH	Overhead
PLC	Programmable Logic Controller
QA/QC	Quality Assurance / Quality Control
ROW	Right of Way
SCADA	Supervisory Control and Data Acquisition
SFWMD	South Florida Water Management District
SHW	Seasonal High Water
SWFWMD	Southwest Florida Water Management District
SWMM	Storm Water Management Model
TDH	Total Dynamic Head
USACE	U.S. Army Corps of Engineers
VFD	Variable Frequency Drive

1 PROJECT OVERVIEW

1.1 Introduction

Erickson Consulting Engineers, Inc. (ECE) was engaged by the City of Naples ("City") to determine the feasibility and preliminary design (30%) for consolidation of the nine publically owned outfalls with a stormwater pump station(s) in a location that would receive all or a portion of the stormwater currently discharging along Naples Beach within Drainage Basin II; and discharge the collected stormwater through an offshore gulf discharge pipeline(s). The City of Naples Beach Restoration and Water Quality Improvement Project (the "Project") Phase I services include all planning, analysis and design (30%) including evaluating consolidation, treatment, pump station siting and offshore diffuser system discharge requirements.

The Technical Report provided herein was prepared in accordance with Task 8 of Purchase Order Number 01501228 of Professional Service Agreement 15-132, between ECE and the City.

1.2 Background

Currently, the City of Naples Drainage Basin II system collects stormwater and discharges through ten (10) beach outfalls located within the intertidal beach "swash" zone. Outfall 1 serves private property and is privately owned, maintained and located at the north end of Naples Beach near Lowdermilk Park; therefore, was excluded from further consideration for the Project. Naples Beach Outfalls 2 through 10 are located between the Naples Beach Hotel and Golf Club and the Naples Pier (FDEP Monuments R-62 and R-69, along some 5,400 ft) as shown in Figure 1-1. These outfalls serve a drainage area of approximately 395 acres.

The City of Naples has undertaken a proactive stormwater management program to implement projects and sustainable programs to improve water quality and flooding. In 2007, the City of Naples updated its Stormwater Master Plan which established numerous goals and objectives and identified over $70-million in projects and programs aimed at managing stormwater as a resource, maximizing the treatment of water prior to discharge and improving flooding.

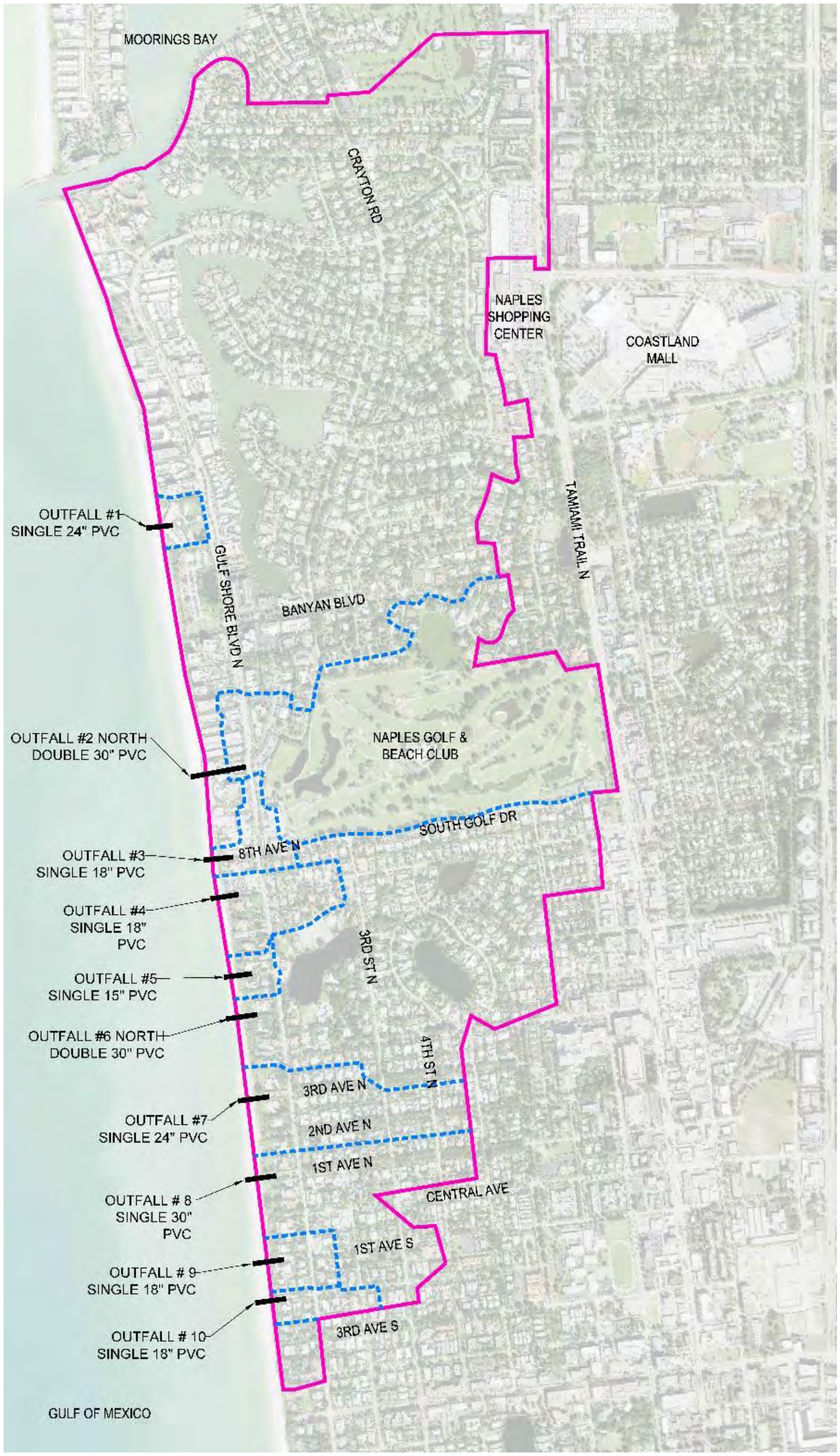


Figure 1-1. Naples Beach Outfall Locations and Sub-Basin Delineations

The City currently funds such improvements utilizing stormwater user fees calculated based on impervious areas of the property and development type. As an incentive, the City offers private property owners the opportunity to implement stormwater improvements (signed off by a licensed design professional) for reduced stormwater fees.

Amended in 2007, the City's Stormwater Ordinance includes requirements for off-site discharge from private properties to the City's stormwater system and regulations on water quality standards (BMPs and pre-treatment through the use of swales, containment berms, rain gardens, etc). Part of the City's ongoing efforts for stormwater management includes educational support through the use of grassed retention swales to collect and attenuate (slow) the conveyance of stormwater runoff entering the City's roadways and right-of-ways. In addition to the benefit of attenuation, the swales serve as a filter for the removal of sediments, nutrients and pollutants to treat water prior to reaching the water table and ground aquifer. Furthermore, the City's Fertilizer Ordinance regulates fertilizers containing nitrogen or phosphorus and provides specific management guidelines for fertilizer application to minimize negative environmental effects fertilizers have in City's waterbodies.

In 2012, the City adopted Resolution No 12-13028 and amended their stormwater master plan to require the removal of the City's stormwater beach outfalls. These actions were taken to satisfy the Florida Department of Environmental Protection (FDEP) JCP Condition (Permit No. 0222355-001-JC) for beach nourishment projects.

The City and Collier County have commissioned work to address the City Resolution regarding the beach stormwater outfalls, including:

- Permitting of Subaqueous Stormwater Outfalls in Florida, a Memorandum (AECOM, September 2003), Commissioned by the City of Naples
- Beach Stormwater Outfalls Alternatives Preliminary Assessment, a Technical Report (AECOM, April 2013), Commissioned by the City of Naples
- Beach Stormwater Outfalls Hydrologic and Hydraulic Modeling for Existing Conditions (AECOM, 2012), Commissioned by the City of Naples
- City Resolution No. 12-13028, A Resolution Amending the City of Naples Stormwater Master Plan to Satisfy the Permit Condition of the Florida Department of Environmental Protection Joint Coastal Permit No. 0222355-001-JC Requiring the Removal of the City's Stormwater Beach Outfalls (2012)
- City of Naples Outfall System Coastal Impact Assessment and Management, a Technical Memorandum (Humiston and Moore, February 2010), Commissioned by Collier County

- Conceptual Stormwater Management Analysis (Gulfshore Engineering, Inc, November 2009), Commissioned by Collier County

The 2013 AECOM report provided an evaluation of potential options for the beach outfalls including:

1. Integration of beach outfalls with planned beach re-nourishment project
2. Integration of beach outfalls with Aquifer Storage and Recovery (ASR) system
3. Consolidation of beach outfall pipes
4. Redirection of beach outfall flow via a pump station to an alternate location
5. Consolidation and extension of beach outfalls deeper and further into the Gulf of Mexico (Subaqueous outfalls)

After a presentation of the report findings, the City Council directed City staff to pursue/implement a project to consolidate the outfalls and discharge to a single ocean outfall via a pump station. This action is also a response to state and federal regulatory permits issued to Sarasota County and the City of Venice for similar Gulf discharge pipelines.

1.3 Project Purpose and Need

There have been long-standing concerns from the State's regulatory agencies, City officials and staff, environmental groups, property owners, residents and visitors that the beach outfalls adversely impact beach erosion, lateral beach access, sea turtle nesting habitat, water quality and beach aesthetics. In addition, the City has experienced significant flooding of Gulf Shore Blvd during high frequency rainfall events.

1.3.1 Beach Erosion and Lateral Beach Access

Discharge of stormwater through the beach outfalls results in localized beach erosion and scour in the vicinity of each outfall. In Naples, nine outfalls are located along approximately 5,400 ft of beach and as such, the erosion losses from the nourished beach are cumulatively approximately 1.5-2 higher than background erosion due to the scour effects of the outfalls. In addition, the outfalls provide an obstruction to which beach users must walk around or otherwise restrict their use of the beach to avoid contact with the outfall structures (Figure 1-2). State regulations now require such outfalls to be located below grade across the beach and littoral zone.

Figure 1-2. Impaired Lateral Access and Shoreline Offset (Scour Induced Erosion) (Outfall 6)

1.3.2 Flooding and Water Quality

High frequency rainfall events result in discharge to the Gulf through the nine (9) City operated and managed outfalls. Periodic beach nourishment and sand placement projects result in a dynamic, fluctuating shoreline which often blocks the outfall pipes' flow, due to sand build up in the pipeline, causing upstream flooding (Figure 1-3). This blockage results in a reduced level of service ("LOS") and a loss of functionality and the need for frequent maintenance. This blockage causes the upstream swales and channels to stage (flood) to levels that are sufficient to open the pipeline and discharge (Figure 1-5). Water quality is then adversely affected from the resulting residence times, nutrient loads and birds/wildlife that forage in the swales and standing waters (Figure 1-6). Furthermore, fine sediments accumulate in stagnant water resulting in turbidity plumes during discharge. Water quality degradation has direct adverse impacts to the community and its environmental resources.

Figure 1-3. Typical Outfall Blockage (Outfall 9)

Figure 1-4. Typical Clearing of Outfall Blockages (Outfall 6)

Figure 1-5. Typical Street Flooding (April 2008)

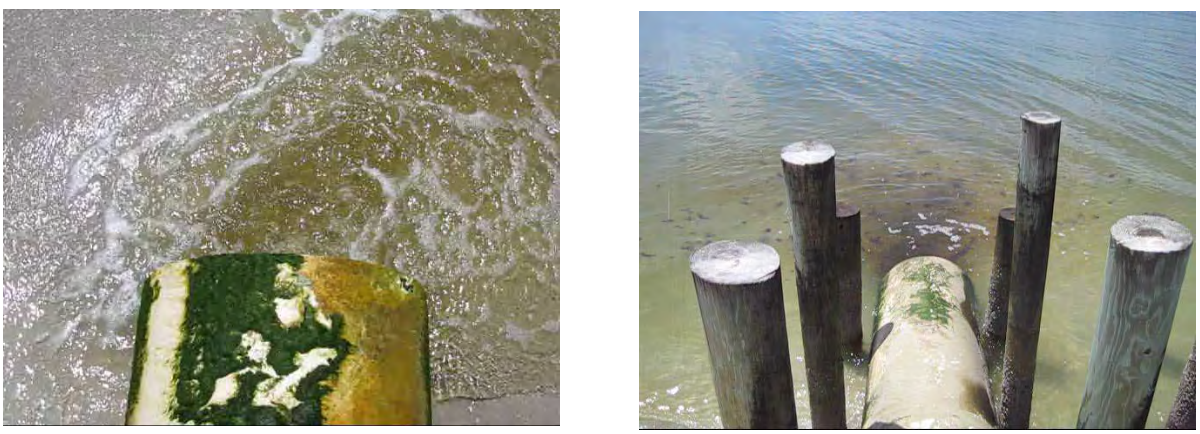


Figure 1-6. Impaired Water Quality

1.3.3 Environmental Impacts

The City's coastal and environmental resources are substantial assets to the community and ecosystem. The presence of and discharge from these beach outfalls adversely impact threatened and endangered species (e.g. sea turtles) as well as hardbottom resources and fisheries. Nesting sea turtles and emerging hatchlings are also potentially affected as they encounter obstacles on the beach which can directly affect nesting and reproductive success. In addition, hardbottom resources and fisheries may be impacted, both in the short-term and long-term, due to degraded water quality.

At present, during spring high tide events or storm surge, tailwater backups and flooding results due to the low elevation of the outfalls which are gravity driven. The City is located in a coastal environment with a low land elevation and substantial development, and as sea level rise increases, the backwater effect will continue to worsen over time. A resilient system will become increasingly important in future years.

1.3.4 *Aesthetics*

The City of Naples is considered one of the nation's premier coastal communities. The visual impacts of the outfalls, i.e. pipes and wooden pile mountings (Figure 1-7), are a significant detraction from the natural beauty of Naples Beach.

Figure 1-7. Typical pipes and wooden pile mountings on the beach

1.4 Project Goals and Objectives

The goals and objectives of the Project are to restore Naples Beach by eliminating the beach outfalls. The Project objectives are:

1. Reduce erosion rates from outfall induced scour and improve lateral beach access by removing pipelines;
2. Reduce flooding and improve water quality;
3. Reduce environmental impacts to the beach and nearshore natural resources;
4. Meet or exceed the existing L*evel of Service* (LOS) to convey flow and improve the stormwater system's resilience for:
    a. 5-yr/1-hr rain event (City of Naples Comprehensive Plan) and
    b. 25-yr/3-day rain event (SFWMD);
5. Convey treated stormwater to a pump station(s) and offshore; and
6. Community education (project goals & objectives).

This Technical Report provides an overview and assessment of existing conditions, design analysis and development of system requirements, evaluation of alternatives for stormwater consolidation, treatment and discharge, and presentation of the 30% design of the recommended alternative. Conclusions and recommendations for next steps are also provided.

2 EXISTING PHYSICAL AND ENVIRONMENTAL CONDITIONS

2.1 Data Collection

Field investigations were conducted to supplement available physical and biological scientific data and information necessary to conduct the feasibility study and formulate the preliminary design. Field investigations conducted by ECE to supplement existing data included:

- GPS of stormwater conveyance system and outfall inverts (October 27 and November 5, 2015)
- Dune vegetation mapping and elevations (March 16, 2016)
- Water quality sampling (in progress)

The data collected by ECE fill in many gaps in the City's stormwater GIS database for Basin II. This data and information was combined with the following key baseline information:

- AECOM SWMM Model (2013)
- Beach profiles (FDEP, 1995-2015)
- FDEP Costal Construction Control Line (CCCL) and Erosion Control Line (ECL)
- Collier County beach nourishment easements
- 2015 Collier County Property Appraiser aerials (georeferenced)
- Collier County hard bottom mapping and habitat assessments (2003, 2008, 2009, 2012, and 2015)
- Stormwater, Utilities, Property GIS Data and 2007 Lidar (City of Naples)
- Utility locations from various providers (water, sewer, reclaim water, power, cable, electric and telephone)
- Historic rainfall, water quality and geotechnical data

The collected and compiled information were merged into base drawings to be utilized throughout the design, permitting and construction phases of the Project. The compiled base maps are in AutoCAD format (2015/16) and are easily converted into GIS shapefiles for future use by the City. A full data compilation reference list is provided as Appendix A. Areas were also identified where additional data collection will be required as the Project progresses through the 60% (permitting) and 90-100% design development phases.

2.2 Tidal Elevations

The tidal station nearest to the Project site is NOAA Station No. 872-5110 which is located at the Naples Pier, approximately 0.8 miles south of the Project site. Reference tidal datums for comparison of MLW, MHW and SHW are provided in Table 2-1. All vertical references are to NAVD 88 (ft) and Tidal Epoch 1983-2001.

Table 2-1. Tidal Datums

Tidal Datum	Elevation - NAVD 88 (ft)
SHW	3.34
MHHW	0.58
MHW	0.33
MSL	-0.64
MTL	-0.67
MLW	-1.68
MLLW	-2.28

2.3 Existing Outfalls

The existing outfalls are generally characterized as large PVC pipes (>15 inches in diameter) which extend into the littoral zone and are supported by timber structures (Figure 2-1). Outfalls 2 and 3 are located adjacent to existing rock groins. The majority of the outfalls are comprised of a single pipe with the exception of outfalls 2 and 6 which are dual pipes.

Figure 2-1. Typical Beach Outfall (Outfall 3 Shown)

Table 2-2 describes each of the City's nine public outfalls and identifies invert elevations. Each outfall pipe terminus discharges in a westerly direction with the exception of Outfall 6 where the pipe terminus discharges north, south and west. Figure 2-2 depicts the unique discharge configuration of Outfall 6.

Figure 2-2. Outfall 6 Termination Configuration

Table 2-2. Beach Outfall Descriptions and Invert Elevations

Outfall #	Location Description	Structure Description	Pipe Size (in)	Invert Elev.[1]	Top of Pipe Elev.[1]
2	Naples Beach Hotel & Golf Club	Dual PVC pipes with timber supports and rock groin for structural stabilization on the north side of the pipe.	30	-1.5	1.0
				-1.5	1.0
3	8th Ave N	Single PVC pipe with timber supports and rock groin for structural stabilization on the south side of the pipe.	18	-1.6	-0.1
4	7th Ave N	Single PVC pipe with timber supports.	18	-1.8	-0.3
5	6th Ave N	Single PVC pipe with timber supports.	15	-1.4	-0.2
6	Near Alligator Lake	Dual PVC pipes with timber supports, configured to discharge north and south with multiple discharge ports.	32	-0.6	0.9
				-1.8	
				-2.3	
				-2.1	0.6
				-1.0	
7	3rd Ave N	Single PVC pipe with timber supports.	24	-1.9	
8	1st Ave N	Single PVC pipe with timber supports. Outfall 8 has been extended seaward (between Nov 2015 and March 2016).	30	-2.7	
9	1st Ave S	Single PVC pipe with timber supports.	18	-1.4	
10	2nd Ave S	Single PVC pipe with timber supports.	18	-1.5	

Notes: 1. Elevation referenced to ft, NAVD 88.

Per City ordinance, adopted in 2007, stormwater construction standards were implemented within the City limits to address water quality and quantity standards for new residential and commercial construction prior to discharge to the municipal stormwater system. Such improvements include:

- Establishment, re-establishment or maintenance of swales within the abutting City street right-of-way.
- Prohibition of stormwater discharge into a platted alley unless a drainage conveyance system exists with sufficient surplus capacity to handle the quantity of runoff proposed for discharge to the alley.
- Roof gutters are required as an erosion control technique that also follows the philosophy of reducing DCIA.
- Streets, driveways and sidewalks shall be designed to minimize potential for increasing the runoff from private property to the City's stormwater system.
- The property owner shall maintain the stormwater system in accordance with the stormwater plan certified at the time of issuance of the certification of occupancy.
- Where an existing property's elevation will not grade back into the required stormwater master system, the City will require, at a minimum, some form of pretreatment before discharge to a canal, lake, bay or other water body. Innovative BMPs are employed to accomplish the treatment including, but not limited to, interceptor swales, containment berms, raingardens and interconnection into the seawall rock drain system.

Stormwater runoff from the basin contributing to each outfall is generally conveyed toward the west with connections along Gulf Shore Blvd via a stormwater sewer system. Connection points along Gulf Shore Blvd collect rainfall runoff, conveying the flow west to each outfall along beach access street ends. The exception to this conveyance scenario is Outfall 6 which receives discharge flow directly from Alligator Lake. Alligator Lake is connected to two upstream lakes which include North Lake and South Lake. North Lake and South Lake are interconnected by a series of weirs and pipelines to Alligator Lake. The upstream stormwater collection system for North Lake includes peak discharges of 10 cfs during the 10-Yr/24-Hr rainfall event and 18 cfs during the 25-Yr/72-Hr rainfall event from the Naples Beach Hotel and Golf Club property. No direct stormwater flow from Gulf Shore Blvd convey to Outfall 6.

Appendix A contains photos and profiles of each of the existing outfalls.

2.4 Rainfall

2.4.1 Assessment of Historic Rainfall Data

Rainfall data was compiled and summarized for two stations; one located at the Naples Municipal Airport (approx. 2 miles from the Project site) and the other located at Golden Gate High School (approx. 7 miles from the Project site). The rainfall station locations relative to the Project site are shown in Figure 2-3 below. Rainfall data from these stations were analyzed for the Project to obtain an overview of rainfall intensities and frequencies using recent years for the City:

<u>Naples Municipal Airport (KAPF)</u> – Data was analyzed from January 1, 2000 through February 29, 2016 (available from January 1, 1945). The 2000 to 2016 period was deemed to best represent current conditions. Data from this gauge was primarily used for analysis due to its proximity to the Project site. The reliability and overall quality of the data is good based upon a review of reported data relative to known storm events. Data between 2000 and 2002 was excluded from the final analysis as erroneous data as significant gaps occurred during these years.

<u>Golden Gate High School (GGHS)</u> – Data from January 1, 2000 through December 31, 2014 period was analyzed (available from January 1, 1942). The 2000 to 2016 period was deemed to best represent current conditions. This gauge appears to have been out of service during Hurricane Wilma (Oct 2005) as it only reported approximately 0.6 inches of rainfall during the storm. From discussions with City Staff, Hurricane Wilma exceeded 5 inches of rainfall; therefore, data from this gauge was excluded from the analysis for that period.

In the analysis, special attention was given to periods of known significant storm events. The following known significant storm events occurred within the Naples area over the period analyzed (2003 to 2015):

- On September 29, 2003 a stalled cold front over central Florida and a tropical disturbance in the southwest Caribbean resulted in significant rainfall across Collier County. By evening, the rainfall ended but it took until late day September 30, 2003 for streets and yards to dry.
  (http://www.srh.noaa.gov/mfl/?n=wet_collier_county)
- On August 13, 2004, Hurricane Charlie made landfall approximately 50 miles north of Naples.
  (http://naplesinsider.com/naplesarea/hurricaneinformation.htm)
- On October 25, 2005, the annual maximum rainfall event occurred when Hurricane Wilma directly impacted Naples. The Golden Gate High School gauge did not report significant rainfall during that period and was assumed to be off line. (http://naplesinsider.com/naplesarea/hurricaneinformation.htm)

- On August 18, 2008, Tropical Storm Fay made landfall near Naples.
- On August 4, 2014, a band of heavy rain hit Naples resulting in several inches of rain within a short period of time (approx. 4 hours). (http://www.weather.gov/miami)
- Hurricanes or tropical storms that directly impacted the Naples area occurred in 2004, 2005 and 2008. (http://naplesinsider.com/naplesarea/hurricaneinformation.htm)

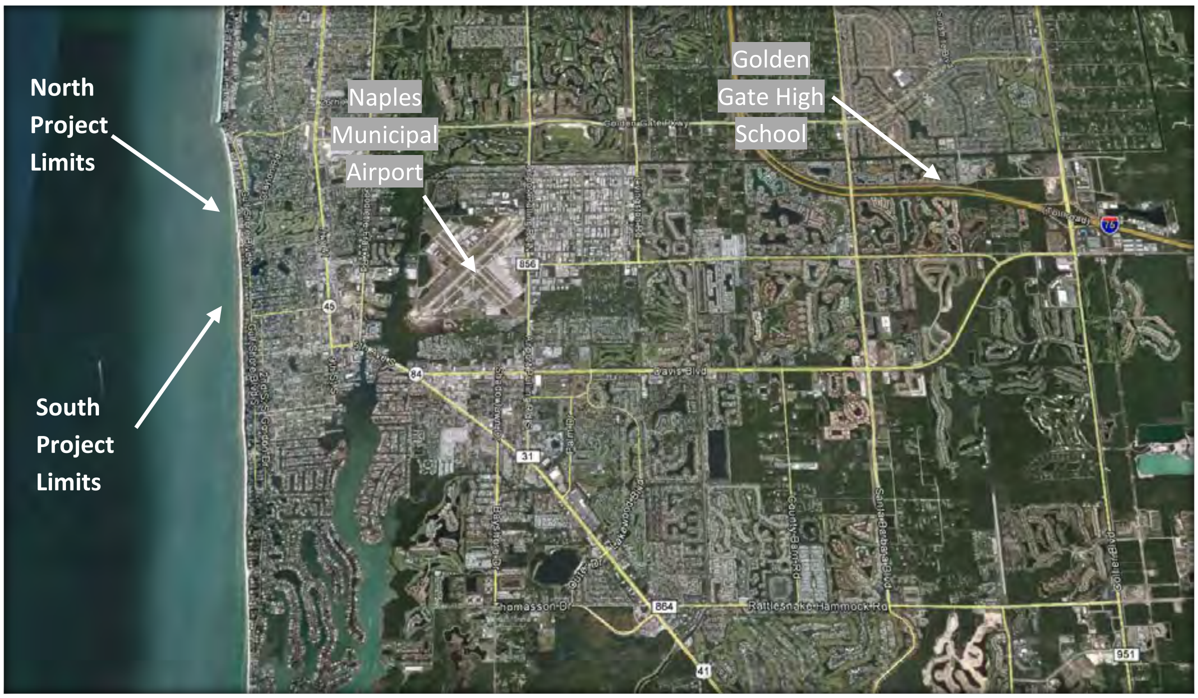


Figure 2-3. Rainfall Stations Relative to Project Site

Rainfall data was analyzed to identify events that exceeded specific rainfall thresholds. The table below identifies the total days of rainfall for each year as well as the number of days throughout the year that daily rainfall totals exceeded 0.5 in, 1 in, 2 in, 3 in and 4 in for the Naples Municipal Airport gauge. Table 2-3 summarizes the total days of exceedance each year for the established thresholds for the Naples Municipal Airport Rainfall Gauge as it is the closest to the Project site and the exceedance data for the two referenced stations are similar (Figure 2-3). For daily measurements where rainfall exceeded 2 inches on consecutive days, the data was analyzed to determine the combined total rainfall impacts. For example, if rainfall began at 8pm and continued through the next day, the values were summed and flagged for further analysis.

As seen in Table 2-3, between 2003 and 2015 (a period of 13 years) there have been a total of 40 events where the daily reported rainfall exceeded 2 inches, 6 events where the daily report rainfall exceeded 3 inches and 3 events where the daily report rainfall exceeded 4 inches.

Table 2-3. Days with Rainfall Exceeding 0.5 Inches
(Naples Municipal Airport Rainfall Gauge)

Year	Total Days Exceeded					Total # Days
	0.5 in	1 in	2 in	3 in	4 in	
2003	42	20	7	3	1	148
2004	25	12	2	0	0	125
2005	35	18	9	1	1	142
2006	30	20	4	0	0	93
2007	18	9	2	0	0	96
2008	33	15	3	0	0	103
2009	25	6	0	0	0	96
2010	34	11	3	0	0	96
2011	24	13	2	0	0	96
2012	25	12	1	0	0	99
2013	31	14	4	1	0	109
2014	33	9	1	1	1	104
2015	22	6	2	0	0	105
TOTAL	**377**	**165**	**40**	**6**	**3**	**1,412**
AVG	**29**	**13**	**3**	**0**	**0**	**109**
OCCURENCE	**26.6%**	**11.6%**	**2.8%**	**0.4%**	**0.2%**	**100%**

Figure 2-4 depicts the percent non-exceedance which was analyzed for all rainfall greater than 0.1 inch for both referenced stations. As seen in Figure 2-4, percent non-exceedance for the Golden Gate High School Gauge and the Naples Municipal Airport Gauge are similar.

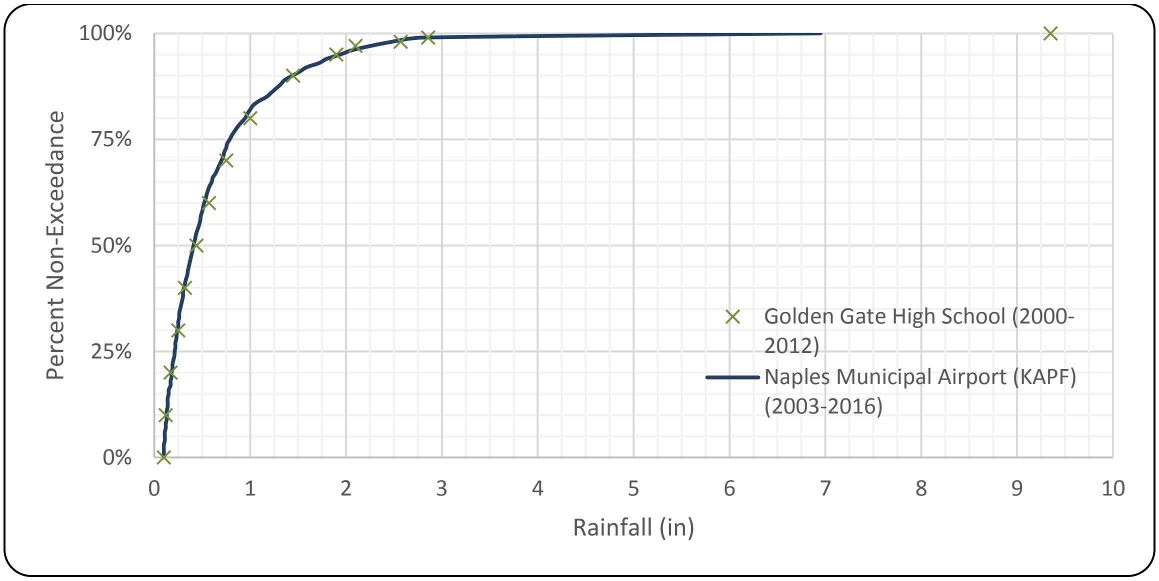


Figure 2-4. Percent Non-Exceedance for Naples Rainfall Events (Greater than 0.1 in)

Table 2-4 provides a comparison of rainfall at these two stations over the same period (2003 to 2014). A review of the total annual rainfall at each of these locations, as presented in Table 2-4, shows that east Naples receives some 28% more rainfall than west Naples. Each year the east Naples station (Golden Gate High School) received greater rainfall totals than the west Naples station (Naples Municipal Airport), with the exception of 2006 where the total annual rainfall for each gauge were within an 1 inch. Figure 2-5 and Figure 2-6 provide examples of high frequency rainfall events that occurred in 2014 and 2015.

Table 2-4. Comparison of Golden Gate High School (GGHS) Gauge Data and the Naples Municipal Airport (KAPF) Gauge Data

Year	Reporting Gauge	No. Days of Rainfall	Total Annual Rainfall (in)	Annual Mean Daily Rainfall (in)	Annual Max Daily Rainfall (in)
2003	GGHS	128	74.6	0.2	6.5
	KAPF	148	65.9	0.2	6.9
2004	GGHS	149	55.7	0.2	2.9
	KAPF	125	35.1	0.1	2.6
2005	GGHS	137	66.1	0.2	2.9
	KAPF	142	63.6	0.2	6.1
2006	GGHS	113	46.2	0.1	2.8
	KAPF	93	47.2	0.1	2.6
2007	GGHS	113	40.5	0.1	2.9
	KAPF	96	31.7	0.1	2.9

Table 2.4. Comparison of Golden Gate High School (GGHS) Gauge Data and the Naples Municipal Airport (KAPF) Gauge Data (Continued)

Year	Reporting Gauge	No. Days of Rainfall	Total Annual Rainfall (in)	Annual Mean Daily Rainfall (in)	Annual Max Daily Rainfall (in)
2008	GGHS	123	60.3	0.2	3.9
	KAPF	103	45.8	0.2	2.9
2009	GGHS	118	56.8	0.2	1.8
	KAPF	96	33.9	0.1	1.9
2010	GGHS	112	57.1	0.2	2.8
	KAPF	96	44.6	0.1	2.6
2011	GGHS	114	55.8	0.2	9.4
	KAPF	96	38.1	0.1	2.7
2012	GGHS	136	52.7	0.1	2.8
	KAPF	99	35.8	0.1	2.2
2013	GGHS	121	64.5	0.2	3.1
	KAPF	109	48.9	0.2	3.4
2014	GGHS	115	60.4	0.2	4.8
	KAPF	104	50.3	0.2	6.7
Average Annual	**GGHS**	**123**	**57.6**		
	KAPF	**109**	**45.1**		

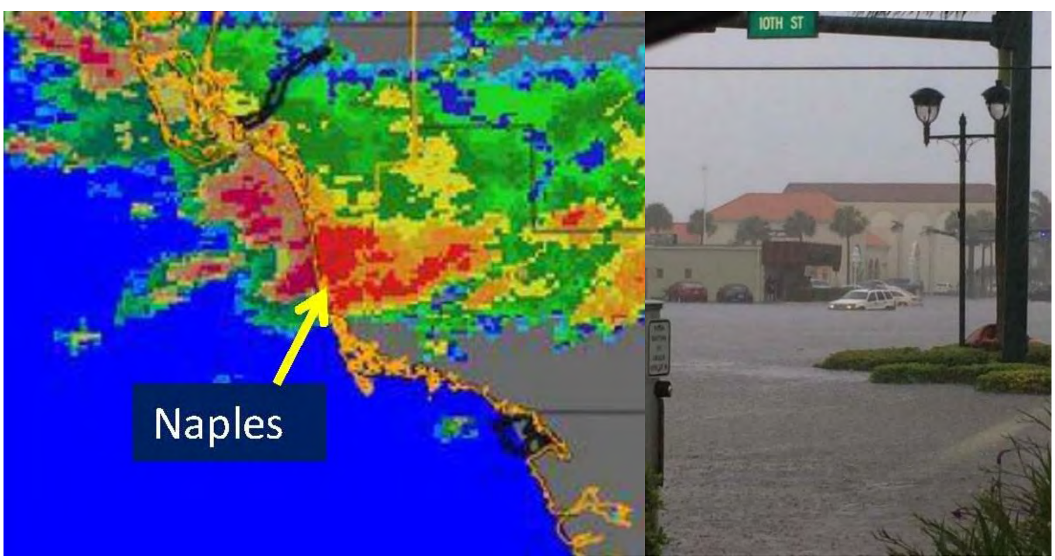


Figure 2-5. August 4, 2014 Rainfall Over Naples with Flooding in Downtown Naples (6 Inch Event over 4 Hours)

Figure 2-6. Street Flooding Near 2nd Ave N (North of Outfall 8) in Sept. 2015
(Approx 3 Inch Event Over 2 Days)

Approximately 13 events occurred between January 2003 and February 2016 where the total rainfall (spanning consecutive days) exceeded 4 inches. The table in Appendix B summarizes these events based on the Naples Municipal Airport Station.

2.4.2 Rainfall Intensities by Return Period

Rainfall intensities by return period, as given by the South Florida Water Management District (SFWMD), are provided in Table 2-5 (SFWMD, 2014). For comparison of historic data to the return period events, there were 13 days exceeding 4 inches between January 2003 and February 2016. Appendix B provides a detailed description of these events and references.

Table 2-5. Rainfall Intensities by Return Period

Return Period	Rainfall (Inches)
5-Yr/1-Hr	3.0
5-Yr/1-Day	5.5
25-Yr/3-Day	11.5
100-Yr/3-Day	15.0

2.5 Naples Beach Hotel and Golf Course Proposed Improvements

The Naples Beach Hotel and Golf Club has applications pending with the SFWMD and the City for modification to the existing stormwater management system to accommodate redesign golf course layouts and other site development. The modifications would result in a reduction of the discharge volumes and flow rates to Outfall 2 as documented in a report commissioned by the Club entitled “Stormwater Management Report for Naples Beach Hotel Golf Course”

(Grady Minor, 2015). The existing and reduced flow rate for the varying rainfall events is given in Table 2-6.

2.6 Level of Service (LOS) and Flow Rates

A stormwater model was previously developed for the nine City-operated beach outfalls located within the City's drainage basin II (AECOM, 2012). Based on this prior work, an analysis of the peak discharge through each of the simulated outfalls in Basin II that convey stormwater to the beach outfalls was performed as summarized in Table 2-6. For reference, Figure 1-1 identifies each outfall and the associated sub-basin.

Level of Service (LOS) is generally defined as the service capacity of the stormwater sewer system for a specific return period rainfall event based on the assumption that the collection structures and pipeline components of the stormwater sewer system are functioning at full service capacity. The existing stormwater sewer is a gravity flow system with beach outfalls that are affected by mid to high tidal phases, storm surge and sand clogging the pipes; each of which compromise or reduce the LOS.

Table 2-6. Outfall Discharge Comparison

Outfall #	Outfall Location Description	Peak Discharge (cfs)			
		5-Yr/ 1-Hr Event	5-Yr/ 1-Day Event	25-Yr/ 3-Day Event	100-Yr/ 3-Day Event
2	Naples Beach Hotel	36.8 (19.9)	26.2 (14.2)	84.1 (45.5)	89.7 (48.5)
3	8th Avenue North	9.6	8.5	12.9	13.8
4	7th Avenue North	9.8	8.0	12.4	13.3
5	6th Avenue North	5.6	5.1	8.2	8.8
6	Alligator Lake Outfall	37.0 (34.2)	37.0 (34.2)	82.3 (76.1)	87.7 (81.1)
7	3rd Avenue North	19.4	16.4	24.1	26.0
8	1st Avenue North	31.7	28.1	42.6	45.4
9	1st Avenue South	8.2	8.0	11.2	11.9
10	2nd Avenue South	9.6	8.1	11.8	12.6
Totals		168 (148)	145 (131)	290 (245)	309 (261)

Note: Peak flow rates shown in parenthesis include the reduction associated with the Naples Beach Hotel & Golf Club proposed improvements (Grady Minor, 2015)

Utilizing the output from the SWMM model, the existing stormwater conveyance system network and elevation data provided by the City, the theoretical LOS provided by each outfall is on the order of a 25-Yr/1-Day event. During the 25-Yr/3-Day rainfall event, the model predicts street flooding of Gulf Shore Blvd between Outfall 2 and Outfall 10 on the order of 1-3.5 ft. The worst flooding is predicted to occur at 7th Ave N (Outfall 4), Alligator Lake (Outfall 6) and at 1st Ave N (Outfall 8).

Based on the actual street flooding observed within Basin II, specifically near Gulf Shore Blvd, it is apparent that the full capacity of the existing system (LOS) is overestimated. The optimum conditions for the existing system are low tidal conditions, absence of waves and storm tides occurring for low frequency rainfall events (> 3 inches). The AECOM SWMM model of Basin II represents a generalization of the existing stormwater conveyance system and attenuation within each sub-basin.

To determine the actual LOS, a detailed model of the Basin II outfalls, stormwater conveyance network and sub-basin attenuation is required. It is recommended that new stormwater simulations are conducted to provide supplemental engineering information needed to complete the 60% design phase of this Project for the proposed pipe consolidation and pump station and discharge pipeline system described in Sections 4 and 5. The exiting LOS is a key design factor in determining the parameters required to improve current site conditions.

2.7 Jurisdictional Lines and Easements

Identification of the locations, conditions and uses/restrictions for the government jurisdictional lines and easements within the Project Area was required to site and design the Project. Jurisdictional lines relevant to the Project are provided in Table 2-7.

Table 2-7. Jurisdictional Lines

CCCL	Coastal Construction Control Line	State of Florida	That portion of the beach-dune system subject to fluctuations based on a 100-year storm event, development seaward of this line requires a construction permit from the State.
ECL	Erosion Control Line	State of Florida	Property boundary between State submerged lands and upland ownership, established prior to the first beach nourishment project in 1996.
CCSL	Coastal Construction Setback Line	City of Naples	The "Original CCCL" established in 1978, development seaward of this line requires a variance from the City.
	30-Yr Erosion Projection Line	State of Florida	Projection of shoreline recession over a period of 30 years

Beach nourishment easements granted by private beachfront property owners to Collier County exist between R-63 (south of Outfall 2) and R-70 (South of Outfall 10). Each beach nourishment easement is defined as the land which lies on the sandy beach seaward of the vegetation line on the subject property. These temporary easements, which expire between 2024 and 2028 depending on location, entitle Collier County and their assignors the right to utilize the easements for maintaining the beach.

The City of Naples has a "Gulf Street" right of way which may be of value for segments of work along the beach landward of the ECL and seaward of the dune line.

Submerged lands easement for a pipeline corridors associated with the Collier County Beach Restoration Project also exist within the Project Area, which allows crossing of the pipeline in between the hardbottom, between 8th Ave North (Outfall 3) and the Naples Beach Hotel and Golf Club (Outfall 2).

Locations of the jurisdictional lines and easements are provided graphically in Appendix C.

2.8 Beach Nourishment Program

The outfalls are located within the Collier County Beach Nourishment Project boundaries and are within a FDEP classified critically eroded shoreline (Division of Water Resources Management, 2015). A total of approximately 1.45 MCY of sand has been placed on "Naples Beach", the beach segment located within the City limits bounded between FDEP R-monuments R-58 and R-79, since the first major nourishment in 1995/96 (Table 2-8). Large-scale sand placements occurring in 1995/96 and 2006 spanned the entire length of Naples Beach. Periodic, small-scale nourishments have also occurred since 1995/96; either beneficial use or emergency sand placements in critically eroding areas.

In January 2015, Collier County applied to FDEP for a 15-year Joint Coastal Permit (JCP), to conduct small, single reach, truck haul projects occurring routinely over the next three to six years to maintain a 100 ft wide beach width (120 to 140 ft berm constructed) (CB&I, 2015). In addition, hydraulic dredging of Doctor's Pass with sand directly placed at the North end of Naples Beach occurs periodically. As part of their 2015 beach nourishment application, the County adjusted the beach templates vertically by +0.3 ft in berm elevation to account for sea level rise. The project is cost-shared by the State with approximately $1.5M appropriated to beach re-nourishment in FY2015-16.

Table 2-8. Summary of Sand Placements Events

Year	Pay Volume (CY)	Location	Length (FT)	Description
1995-1996	759,150	R58-R78	20,064	37.8 CY/FT using offshore sediment
1998	15,516	R67 & R70		Truck haul
2000	7,420	R69, R72		Truck haul
2001	39,800	R63		Inlet bypassing by truck haul
2002	45,047	R60		Truck haul
Jan 2006	53,630	Unknown		Doctor's Pass Dredging
Jan to May 2006	347,381	R58-R79	21,120	16.4 CY/FT nourishment using offshore sediment
Nov to Dec 2013	27,321	Doctor's Pass to R-60	2,966	Truck haul (9.2 CY/FT)
Nov to Dec 2013	25,411	R61 to R65	3,709	Truck haul (6.9 CY/FT)
Nov to Dec 2013	13,118	R69 to R73	3,199	Truck haul (4.1 CY/FT)
Nov to Dec 2014	25,000	R59+300 - R63+300	4,192	Truck haul (6.0 CY/FT)
Nov to Dec 2014	5,000	R67+300 - R69+500	200	Truck haul (2.7 CY/FT)

Note: Highlighted rows represent large-scale, hydraulic sand placement events occurring on Naples Beach (R-58 to R-79).

2.9 Physical Characteristics of the Beach-Dune System

The Project shoreline frontage directly affected by Outfalls 2 through 10 is 5,400 ft. To evaluate beach profile variability, an analysis was performed to estimate the shoreline recession rates and beach volume changes along the subject shoreline (250 ft north of Outfall 1 and 800 ft south of Outfall 10 – 1.6 miles of shoreline in total) as well as the depth of closure. A linear regression analysis was performed for the FDEP historic shoreline data between 1996 and 2013 (Appendix D). In addition, the volumetric changes at the profiles in the vicinity of the outfalls as well as the shape and depth of closure of the profiles were assessed.

The following data in Table 2-9 was available for the analysis of the existing physical characteristics of the beach-dune system.

Table 2-9. Available Data for Beach-Dune Physical Analysis

Dates	Source	Type of Data
1970s-2015	FDEP	MHWL Position
1996-2009	FDEP	Beach Profiles
2003, 2007, 2009, 2014	CP&E	Post Construction Monitoring Reports
2015	CB&I	JCP Application
2004-2010, 2012, 2014, 2016	Google Earth	Aerial Photos
10 & 11/2015, 3/2016	ECE	Site Photos

Coastal processes that will affect the design and permitting of the Project include beach profile variability, depth of closure and beach profile response to low frequency storm events.

2.9.1 Outfall Induced Beach Scour and Erosion Losses

The volume changes within approximately 3,000 ft north and south of the Project Area (FDEP R-58A to R-79) are provided in Table 2-10 for the period of 2006 to 2013. These years were selected based on beach nourishment events to develop an annual sand loss excluding the effects of sand placement. The cumulative volume changes within the area of direct influence of the outfalls is estimated at 92,200 CY over this timespan.

The outfalls are located along approximately 5,400 ft of beach and as such, the erosion losses from the nourished beach are cumulatively approximated at 1.5-2 higher than background erosion due to the scour effects of the outfalls. With the cost of sand conservatively estimated at $35/CY in place for a truck haul project, this equates to a loss of roughly $1.6M in sand over seven years (2006-2013).

In addition, the outfalls frequently require the manual removal of sand from the outfall to facilitate discharge to the Gulf. This is due to (1) tidal movement of sand into the outfalls and (2) insufficient water level (and therefore insufficient driving head) to flush the system. The cost of this maintenance routinely exceeds $100,000 per year.

Table 2-10. Volume Changes from 2006 to 2013

	Monument	Intervening Distance	June 2006 to April 2013		
			Volume above -15 ft NAVD 88		Cumulative Volume
		FT	CY/FT	CY	CY
Inlet Zone	R-58		-36.4		
		981		-25,844	-25,844
	R-59		-16.2		
		1,086		-10,699	-36,543
	R-60		-3.5		
Outfalls 2-10 (Area of Direct Impact)		1,077		-5,772	-5,772
	R-61		-7.3		
		1,020		-11,714	-17,486
	R-62		-15.7		
		1,009		-20,218	-37,704
	R-63		-24.4		
		926		-16,568	-54,273
	R-64		-11.4		
		783		-2,463	-56,736
	T-65		5.1		
		825		-1,215	-57,951
	R-66		-8.1		
		801		-6,420	-64,371
	T-67		-8.0		
		809		-5,273	-69,644
	R-68		-5.1		
		812		-3,986	-73,630
	T-69		-4.7		
		798		-3,577	-77,207
	R-70		-4.2		
		803		-5,933	-83,139
	R-71		-10.6		
		804		-9,051	-92,191
	R-72		-12.0		
	Sub-Totals:	**10,465**	**-8.8**		**-92,191**
South of Outfalls		811		750	750
	R-73		13.8		
		815		7,453	8,203
	R-74		4.5		
	Total:	**14,159**	**-8.5**		**-120,530**

NOTE: Sand placement has not been included in this analysis.

2.9.2 *Depth of Closure*

The "depth of closure" is defined as the most landward depth seaward of which there is no significant change in bottom elevation and no significant sediment movement between the nearshore and offshore. In other words, this is the depth at which sediment is not expected to affect (i.e. cover or uncover) the offshore outfall system. Beach profile comparison plots for the time period between 1996 and 2015 (encompassing multiple nourishment events) were compiled to assess the depth of closure within the Project Area (Appendix D).

An analysis of beach profiles was conducted to determine the depth of closure for the Project Area. Prior studies have estimated an average depth of closure for Naples Beach (R58-79) of -10.9 ft (NAVD 88), with a range of -9.5 ft to -13.0 ft (NAVD 88) (CPE, 2004). ECE conducted an independent examination of historic profiles in the vicinity of the outfalls and identified the average depth of closure at -13.4 ft (NAVD 88) (Table 2-11), and therefore, the location beyond which sediment movement is deemed to be insignificant is approximately the -13.4 ft (NAVD 88) depth contour.

Table 2-11. Estimated Depth of Closure Based Upon Beach Profile Surveys (2003-2015)

Outfall	Monument	Estimated Depth of Closure (FT NAVD 88)
	T62	-13.5
2 & 3		
	R63	-13.5
4		
	R64	-13.7
5		
	T65	-14.7
6		
	R66	-15.0
7		
	R67	-13.1
8		
	R68	-10.0
9 & 10		
	R-69	-14.2
Average (Weighted)		-13.4

2.10 Biological Characteristics of the Beach-Dune and Nearshore

Types of areas occurring within the Project Area include urban residential (single and multi-family) built-up areas, coastal scrub and swimming beach based upon the Florida Land Uses and Cover Classification System (FLUCCS). Littoral (intertidal) and sublittoral communities are also included within the Project Area. The littoral zone is defined as the nearshore zone along the beachfront, including the low tide to high tide area and is characterized by coastal dune vegetation, sandy beach and tidal zone. The marine habitat within the Project Area is inhabited by nesting sea turtles, nesting and foraging shorebirds/seabirds, manatees, hard bottom communities and fisheries. These habitats are described in detail in the following sections.

The urban built up area surrounding these outfalls is comprised of the development east of the primary dune and swimming beach. The development includes single-family homes and condominiums as well as deeded beach access easements.

2.10.1 Protected and Threatened Species (Shorebirds/Seabirds & Sea Turtles)

Several species of shorebirds\seabirds are prevalent on Naples beaches but do not typically nest in the Project Area due to recreational use. Shorebird nesting season spans from March through September.

Several species of shorebirds may forage and rest within the proposed Project site (Table 2-12). Of these species, all are protected from take and harassment by the Migratory Bird Treaty Act (MBTA 1918). There is no critical habitat for Piping Plover within the Project Area.

Table 2-12. Potential Feeding and Resting Shorebirds

Species Common Name	Scientific Name
Black-Bellied Plover	*(Pluvialis squatarola)*
Brown Pelican	*(Pelecanus occidentalis)*
Double-Crested Cormorant	*(Phalacrocorax auritus)*
Gull	*(Laridae, spp.)*
Least Tern	*(Charadrius wilsonia)*
Piping Plover	*(Charadrius melodus)*
Red Knot	*(Calidris canutus)*
Royal Tern	*(Sterna maxima)*
Sanderling	*(Calidris alba)*
Sandwich Terns	*(Sterna sandvicensis)*
Snowy Egret	*(Egretta thula)*
White Ibis	*(Eudocimus albus)*
Willet	*(Catoptrophorus semipalmatus)*

A list of sea turtle species which may nest on Naples Beach is provided in Table 2-13. The loggerhead sea turtle is the primary turtle nesting species on Naples Beaches; however, the Project Area is not classified as critical loggerhead habitat. While other species occasionally nest on Naples Beaches, loggerhead sea turtles represent 99% of the nests in Collier County.

Table 2-13. Potential Sea Turtle Species

Species Common Name	Scientific Name	USWF/NMF Status
Loggerhead Sea Turtle	*(Caretta caretta)*	Threatened
Green Sea Turtle	*(Chelonia mydas)*	Endangered
Leatherback Sea Turtle	*(Dermochelys coriacea)*	Endangered
Hawksbill Sea Turtle	*(Eretmochelys imbricata)*	Endangered
Kemp's Ridley Sea Turtle	*(Lepidochelys kempii)*	Endangered

2.10.2 Hardbottom and Fisheries

Within the Project Area, hardbottom is located offshore of R62/63 (Naples Beach Hotel and Golf Club) and R64/65 (6^{th} Avenue North). The evaluation of the overall ecological diversity and relief of the hardbottom within the Project Area was based on prior studies associated with the Collier County Beach Nourishment Project. These prior studies are described briefly below.

In 2003, Coastal Planning & Engineering, Inc. (CP&E) conducted a pre-construction survey for 4 Segments along the Collier County coastline: Vanderbilt Beach, Pelican Bay, Park Shore and Naples. The purpose of this report was to characterize and evaluate the biodiversity of the nearshore hardbottom resources located within the zone of influence of the Naples Beach Re-Nourishment Segment (CPE, 2003). This report concluded that the condition (biodiversity) of the Naples Segment hardbottom (along with the Park Shore Segment) contained the lowest vertical relief, the least amount of macroalgae, the highest average frequency of 100% sand cover, and also contained the least amounts of corals (hard, soft and colonies). The data collected by CP&E for the Naples Segment, resulted in their determination that the hardbottom was a chronically disturbed habitat. Thus indicating that the hardbottom was ephemeral due to the low relief.

The 2006 Collier County Beach Re-Nourishment Project authorized 1.09 acres of impacts to nearshore hardbottom. To offset these impacts, the Collier County provided mitigation in the form of a 1.09 acre artificial reef (3.5-4.5 foot diameter limestone boulders) located approximately 900 ft from R-66 (offshore between Outfalls 6 and 7). The reef was constructed in 2007 and after two years of post-construction monitoring was deemed a success (CPE, 2009).

The most recent hardbottom survey was conducted in August-September 2015 as a post-construction event to the 2013/14 Collier County Beach Nourishment Project and the Doctors Pass Maintenance Dredging Project.

The outer edges of the hardbottom within the Project Area are provided on the Project Drawings (Appendix G). The hardbottom is ephemeral in nature with the 2008/09 surveys documenting the largest area of exposed hardbottom resources. The hardbottom has continually been characterized as low vertical relief hardbottom with no notable coral heads (Figure 2-7).

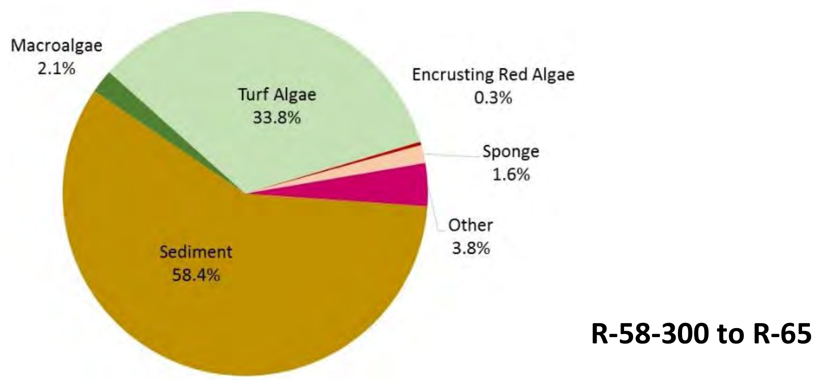


Figure 2-7. Average Benthic Cover along Naples Beach (2015)

Fisheries occurring inshore on Naples beaches include rod and reel fishing on a commercial and recreational level. Notable fish include striped mullet (*Mugil cephalus*), spotted seatrout (*Cynoscion nebulosus*), pompano (*Trachinotus carolinus*), grouper (*Mycteroperca* and *Epinephelus sp*), red snapper (*Lutianus campechanus*), tarpon (*Megalops atlanticus*), snook (*Centropomus undecimalis*), red drum (*Sciaenops ocellatus*) and mangrove snapper (*Lutianus griseus*). Notable shellfish include pink shrimp (*Panaeus duorarum*), blue crab (*Callinectes sapidus*) and stone crab (*Menippe mercenaria*).

Within the Project Area there is frequent pounding and scouring of the shoreline resulting from wave and tidal action. The benthic community consists of several species of snails, starfish, urchins, anemone and whelks. In addition, several species of invertebrates such as, snails, crabs and shrimp, inhabit the benthic community. Small bait fish congregate in the nearshore waters of the tidal zone. These small congregations of bait fish attract larger shallow water predators. This provides important fish congregations for commercial and recreational fisherman.

2.10.3 Dunes and Coastal Vegetation

Beaches of Naples are gently sloping with a relatively low berm and a nominally +5 ft elevation dune. Notable grasses include sea oats (*Unioloa paniculata*), panic grass (*Panicum amarum*) and muhly grass (*Muhlenbergia filipes*). Notable trees and shrubs include seagrape (*Coccoloba uvifera*), beach naupaka (*Scaevola taccada*), cabbage palm (*Sabal palmetto*), saw palmetto (*Serenoa repens*), coconut palms (*cocos nucifera*) and sporadic pockets of inkberry (*Scaevola ivifolia).*

These terrestrial habitats provide suitable nesting, foraging and shelter for a variety of wildlife species including sea turtles and shorebirds.

2.11 Water Quality

The water body impacted by the existing outfalls' discharge is the Gulf of Mexico. Water quality parameters that are deemed most significant in assessing potential pollutant impacts include bacteria (fecal coliform and enterococci), nutrients, suspended sediments and heavy metals (mercury). The Gulf of Mexico is a listed, impaired water body for mercury by the FDEP and EPA. No added discharge volume will occur as a result of the Project; therefore, no increase in these potential pollutants will be introduced in the marine environment. It is anticipated that the removal of debris, such as grass clippings, branches and suspended sediment from the system, and the positive flow from the pump station's forcemain with the new pipe network, will contribute to improvements in overall water quality.

2.11.1 Historic Sampling

The State of Florida Department of Health (DOH) periodically tests shoreline water quality (bacteria) at two locations adjacent to the Project Area: (1) Lowdermilk Beach Park, (approximately 0.3 miles north of Outfall 2); and (2) Naples Pier (approximately 0.8 miles south of Outfall 10). Historically, few swim advisories have been issued for Naples Beach.

The City also conducts routine monitoring of their upland stormwater lakes. This monitoring program includes sampling of North Lake (Location #8), South Lake (Location #9) and Alligator Lake (Location #10) which serve as stormwater holding and attenuation for beach Outfall 6. The samples collected are tested for various constituents including bacteria, nutrients, suspended sediment and copper. The City's sampling routinely indicates the presence of bacteria but at levels above state limits.

As there was no data in the immediate vicinity of the beach outfalls, a monitoring plan to establish baseline conditions for key parameters was developed to provide an accurate representation of the quality of water discharged to the Gulf. To design a suitable treatment system, knowledge of site-specific loadings of specific water quality parameters, including suspended sediment and bacteria, is required. The City's engineering team developed a sampling program which provides the basis to design the water treatment system components and reductions in these potential sources of pollutants to the Gulf.

2.11.2 Sampling Program

The goal of the water quality sampling program is to identify and quantify the types and concentrations of pollutants that presently discharge through the City's beach outfall pipes (2-10). Treatment to reduce levels of pollutants from the City's stormwater runoff will be identified and evaluated during the 60% design and permitting phases of the Project.

The objectives of the water quality sampling protocol include:

1. Siting the sampling locations for overall geographic location to estimate and quantify the sub-basin contribution and concentrations for outfalls characterized by high discharge rates;
2. Timing the sampling to capture the "worst case conditions" for an approximate 0.5 inch or greater rainfall event;
3. Following established standard methods for sampling and testing to measure pollutants of concern and gather related key baseline and physical information;
4. Utilizing adaptive management to assess the sampling and testing results to incorporate feedback loops that may result in siting and protocol changes; and
5. Gaining an understanding of variability and levels of water quality impacts to the Gulf associated with stormwater at these outfalls and opportunities to reduce levels of pollutants.

Sampling will be conducted at the outfall locations identified in Table 2-14 and Figure 2-8.

Table 2-14. Water Quality Sampling Locations

Outfall #	Location	Characteristics
2	R-63, north of 8th Avenue North at the Naples Beach Hotel & Golf Club	High discharge rate, golf course drainage/influence, geographic location
4	R-64, 7th Avenue North	Geographic and spatial contribution from sub-basin 4
6	R-65, Between 4th & 6th Avenue North and west of South Lake Drive	High discharge rates, geographic location and spatial contribution from sub-basin 6

Table 2-14. Water Quality Sampling Locations (Continued)

Outfall #	Location	Characteristics
7	Between R-66 & R-67, 3rd Avenue North	Geographic location and spatial contribution from sub-basin 7
8	R-67, 1st Avenue North	High discharge rate and spatial contribution from sub-basin 8
10	R-69, 2nd Avenue South	Geographic location (Project's south limit)

Figure 2-8. Water Quality Sampling Locations

The sampling methods were developed to maximize the following conditions that contribute to higher pollutant loads, and thus strive to meet the following criteria:

- Minimal to no rainfall in the area for 7 days for 2 events;
- A rainfall event of at least 0.5” occurring in an 8 hour period; and
- Safe conditions for sampling (e.g. daylight, no lightning strikes nearby, low waves)

Additional considerations include the preference to conduct the sampling during an onshore wind from the north to avoid upwelling and collection of samples at an outgoing to low tide condition where a positive discharge occurs and a plume is visible.

The water samples are collected at each of the identified outfalls immediately after a rain event when the outfalls are discharging near peak velocity. Sampling occurred at the seaward terminus of the outfall. Further, at Outfalls 2, 6 and 7 (highest flow rates), additional sampling downstream was deemed important to determine the magnitude of loading reduction occurring over time. The goal was to capture the initial or highest discharge or worst case conditions for 2 of the 4 sample events that would result in high levels of pollutants near shore and not allow for significant diffusion/dispersion. Additional sampling was decided to include locations ranging from 50 ft and 100 ft from outfall discharge lines for the final sample event (June 2017). Appendix E provides a description of the sampling program methods, procedures and test results.

2.11.3 Testing and Findings

The water quality results of the sampling and testing conducted May 4, 2016, June 7, 2016, July 21, 2016 and June 2017 are provided in Appendix E. Based upon multiple rainfall conditions and sampling attempts, it was determined that the tidal conditions and rainfall intensity of a minimum of 1 inch in a 3-4 hour period was required for sufficient water level stage to create positive flows through the outfalls. Several conditions adversely affect discharge and flows to the Gulf including insufficient pipe slope and upstream pipe inverts at the elevation of high to mid tidal levels combined with the effect of sea level rise. As a result, significant upstream flooding presently occurs following rainfall intensity of 0.5 inches along GSB and Central Avenue which extends north and south from this intersection.

Sampling the outfall discharge occurred during a falling tide near or about mean low tidal condition and rainfall events which exceeded 1 inch in a 1-2 hour period. Sample locations were increased to include sampling immediately downsteam (50 ft and 100 ft) of the outfall discharge and included salinity levels to assess the impacts of near-field mixing on bacteria levels which exceeded state standards when collected from within the immediate discharge from the outfall pipe.

Specifically, on May 4 2016 the site received significant rainfall after a period of more than a month without rain with six (6) outfalls samples taken of the direct discharge. In addition, the weir at Alligator Lake was sampled. Bacteria results for Enterococci and Fecal Coliform showed all outfalls exceeded state limits, while Outfall 6 bacteria levels for Enterococci were 19000 compared to 300 for the upstream weir at Alligator Lake. In 2017, water samples were taken on June 6, 2017 following an 8 month period of minimal rainfall where very high levels of bacteria were measured at all outfalls and the Alligator Lake sites were salinities varied between fully saline Gulf waters (35- 38 ppt) and freshwater (2-5 ppt). Overall, bacteria levels were significantly reduced at locations where stormwater mixing and dilution occurred as evidenced by the salinity level of the samples taken at locations approximately 50 ft and 100 ft down current from the discharge.

During the summer months' and seasonal wet season of 2016, several attempts to sample following a high rainfall event (> 1 in/hour); however, due to tidal stages at the Gulf (often a mid to high tide condition), there was insufficient positive flow to collect stormwater discharge samples at the outfalls, or sufficient staging and optimal conditions occurred when conditions did not allow for sampling such as lightening and waves associated with passing convective storms or after daylight hours. It was observed that after the initial flush at the start of the summer wet season, bacteria level are significantly reduced to near or below state limits for all outfall locations.

Nitrogen is a measure of nutrient loading (nitrites, nitrates and and total nitrogen) and was assessed for the upstream and outfalls. In addition the City requested an overall assessment of copper levels where samples and conditions warranted testing. It was observed that copper levels are low and below the state limit of 3.7 ug/l for all samples tested in 2016 and 2017. For these reasons, reduced sample testing for these parameters was deemded warranted and new added testing was deemed more valuable for (a) bacteria at sites down current of each of the outfall discharge locations and (b) total suspended solids (TSS) in the stormwater runoff that could require supplemental treatment. Levels of TSS found were often higher than the actual stormwater as the samples included a fraction of the "beach" sediment due to the turbulence generated from the discharge. As a result, additional samples were taken upstream in the pipe when feasible and at Alligator Lake (AL) near the South Lake (SL) discharge pipes and the AL weir structure. This data and information will be related to turbidity (NTUs) for the assessment of pre-treatment and alternative systems in the 60% design phase.

3 ANALYSIS AND DESIGN REQUIREMENTS

The design requirements and identification of alternatives for the City's Basin II stormwater system were developed for the Project focusing on the primary system components and alternatives to best achieve the Project's goals and objectives. The primary system components and design considerations for analysis to support the design development phase include:

1. pipeline consolidation and routing (pipeline size, length and collection points);
2. pump station(s) and auxiliary structures (e.g. control panels, generators, treatment, etc); and
3. offshore discharge system (directionally drilled pipeline and outfall diffuser structure).

Evaluation of data collected, compiled and analyzed to develop options for design of the consolidation and pipeline network, pump station, treatment systems and offshore discharge system included:

- Existing stormwater line location, drainage sub-basin and pipe sizes
- Existing roads and utility infrastructure (power, communications, water, w/water)
- Level of Service (LOS) to convey required 5 Yr and 25 Yr return period stormwater flow
- City owned land (availability, ownership and land use) and adjacent development
- Site acreage and footprint requirements for the pump station and ancillary equipment (backup generator, filtering, UV, etc)
- Lakes, ponds, swales and opportunities for storage
- Overflow pipeline locations, existing infrastructure/culverts/pipelines and connection options for pipeline consolidation networks
- Environmental resource(s) and locations
- Types of potential social impacts (negative and positive)
- Technologies for treatment including sediment and debris removal, bacteria treatment and nutrient uptake
- Project Costs vs System Performance/Percent Treatment

Design requirements of the system components are developed in the following sections based on the primary considerations identified above, and their interrelation.

3.1 Consolidation of Existing Outfalls

The components of pipeline consolidation include the collection and conveyance system to carry the design flow to a centralized location(s). Consolidation requires consideration of siting, land availability and use, utility infrastructure locations and conflicts, pipeline distance and system capacity (flow). These design considerations, options and system requirements are assessed in the following sections.

3.1.1 Siting Considerations

The siting and land requirements for consolidating the outfalls to convey flow to a centralized pump station(s) is largely dependent on the existing infrastructure and the level of service provided by the largest outfalls. Three of the nine outfalls carry in excess of 60% of the total outflow to the Gulf. Outfall 2, located at the northernmost limit of the Project Area, represents 19% of the total flow, whereas Outfalls 6 and 8, in the southern portion of the Project Area, represent 31% and 17% of the total flow, respectively. As a result, the consolidation, and therefore pump station location(s), must be in close proximity to these outfalls due to spatial constraints and the geometric requirements of the pipeline to carry the flow.

Three locations were identified as viable to house a pump station and auxiliary equipment (e.g. control panels, generators, treatment, etc) that met the spatial constraints of consolidation. These locations (identified in Section 3.2.1) include:

4. City owned beach access at 6th Avenue North (present location of Outfall 5)
5. City owned beach access at 3rd Avenue North (present location of Outfall 7)
6. Parcel on the west side of Alligator Lake (ID 141517600007)

Due to the existing high flow associated with Outfall 2 (particularly due to the contribution from the Naples Beach and Golf Club), a fourth location in the vicinity of the Golf Club would provide additional flexibility if a site can be procured through purchase or perpetual easement.

For routing to/from the pump station location(s), existing utility and construction easements were assessed to identify viable consolidation options and pipeline routes. Applicable easements and Rights-of-Way (ROW) include:

1. Gulf Shore Blvd ROW and the City owned beach accesses at 6th Avenue North and 3rd Avenue North.
2. “Gulf Street” ROW for pipeline consolidation along the beach-dune landward of the ECL and seaward of the dune line. The ECL represents line of state versus private ownership (seaward property line).
3. Temporary beach nourishment easements granted by private beachfront property owners to Collier County that entitle Collier County, and their assignors, the right to utilize the easements for maintaining the beach.

Typically, a pipeline consolidation of this type would be routed within the ROW along the adjacent roadway, in this case Gulf Shore Blvd. The east and west ROWs are currently utilized by several utility service providers, thereby limiting the size (width) of the pipeline and thus controlling the volume of water that can convey to a centralized collection point (i.e. pump station). The typical width available for stormwater pipeline(s) is described in Figure 3-1. Underground fiber optic (F.O.) and overhead (O.H.) power utilities do not run continuous along the full length of the Project.

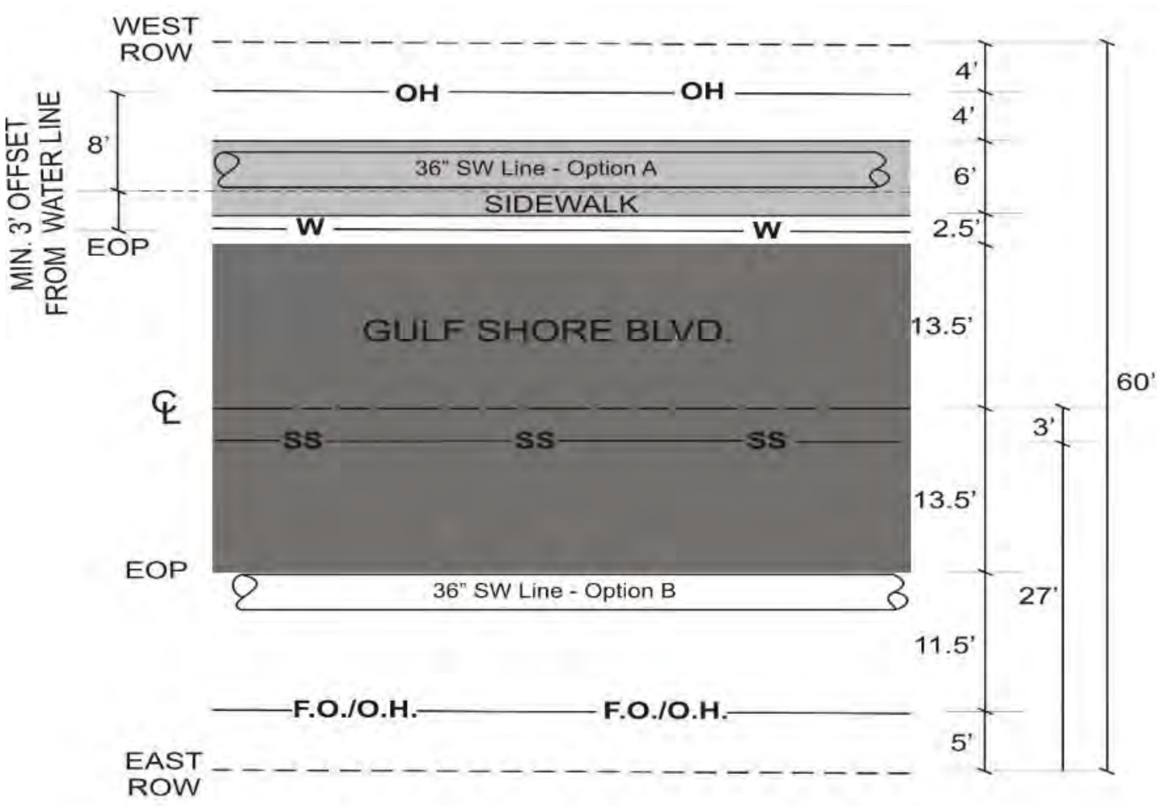


Figure 3-1. ROW Easement and Location Options for New Stormwater Line

The beach construction easements held by Collier County and/or the Gulf Street ROW can be used as a supplemental means to site the pipeline on the back-beach, seaward of the ECL and landward of the dune line, as opposed to Gulf Shore Blvd. If the pipeline is sited west (seaward) of the ECL, the consolidation will occur on State Lands. Typical pipeline consolidation along the back-beach/dune is as shown in Figure 3-2.

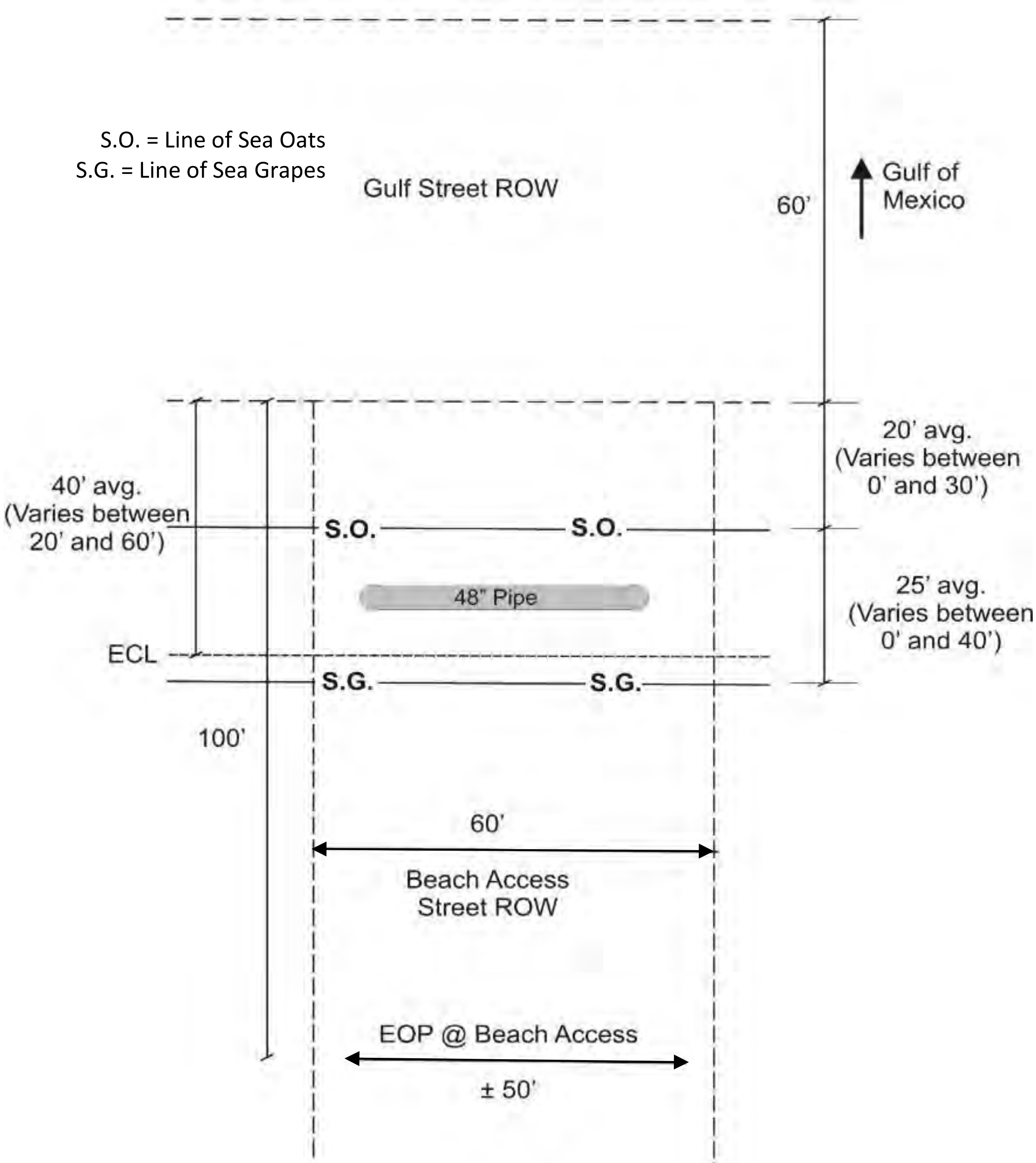


Figure 3-2. Typical Pipeline Consolidation along Back-Beach/Dune

3.1.2 Existing Site Conditions

An assessment of the existing conditions along Gulf Shore Blvd, the beach access ROWs and the back-beach/dune was conducted within the framework of pipeline consolidation requirements and design.

<u>Pipeline Consolidation along Gulf Shore Blvd</u>

Elevations along the Gulf Shore Blvd ROW are low and range from approximately 5.5 ft to 4.2 ft (NAVD 88). Gulf Shore Blvd has a mild crown, with elevations generally 0.2 ft above the

ROW, and conveys runoff to inlets located along the edge of pavement within the ROW. These inlets are located primarily at the intersection of Gulf Shore Blvd and the beach accesses associated with the nine beach outfalls (Figure 3-3). The collected runoff from these discharge lines flow directly to the Gulf of Mexico via the beach outfalls.

Figure 3-3. Typical Storm Sewer Manhole in Foreground with Curb Inlet in Background

The stormwater infrastructure is continually inundated with ground water and tidal surge due to the low elevation of the roadway and the underground pipeline conveyances. Standing water was observed in all storm sewer structures during design team site visits. Standing water in the system is most likely tidal surge due to the low elevation of the system. Tidal surge inundation is readily observed daily at the Alligator Lake outfall structure which is directly connected to Outfall 6. During high tide, water flows east through the structure and into Alligator Lake (Figure 3-4 and Figure 3-5). In addition to the low elevation of the system, the standing water can also be attributed to potential problems such as insufficient pipe slope and/or outfall blockage.

Existing pipe sizes within the Gulf Shore Blvd and beach access ROWs typically range between 15 in to 25 in, with the exception of box culverts at Outfall 2 (3 ft by 4 ft) and Outfall 6 (2 ft by 6 ft). As previously noted, Outfalls 2 and 6 represent the largest discharges within the Project Area.

Figure 3-4. Alligator Lake Control Structure

Figure 3-5. Alligator Lake Control Structure Weir

The existing infrastructure within the Gulf Shore Blvd and beach access ROWs include (Figure 3-6, Figure 3-7 and Figure 3-8):

- Potable Water (City of Naples) – typically located along the west side of the Gulf Shore Blvd ROW.
- Reclaim Water (City of Naples) – limited to the area immediately surrounding Central Ave at the south end of the Project Area between Outfalls 8 & 9. The reclaim water lines cross Gulf Shore Blvd at two locations north and south of Central Ave.
- Sanitary Sewer (City of Naples) – the main trunk line is located along the center of Gulf Shore Blvd with collection lines extending along the beach access ROWs.
- Storm Sewer (City of Naples) – collection points are typically at intersections with lines conveying west along the beach access ROWs to each of the beach outfalls. At specific locations where the storm sewer system conveys parallel to Gulf Shore Blvd, the line is typically located along the east ROW of Gulf Shore Blvd. However, between 2nd Ave N and 3rd Ave N the line is located along the center of Gulf Shore Blvd, adjacent to the main sanitary sewer trunk line. The line is located on along the west ROW of Gulf Shore Blvd between 3rd Ave N and 4th Ave N and then again between 8th Ave N and Oleander Dr.
- Cable (CenturyLink – internet, phone, TV) – typically located along the east side of the Gulf Shore Blvd ROW with various Gulf Shore Blvd service connection crossings. Cable lines are underground.
- Power (FPL) – typically located along the west side of the Gulf Shore Blvd ROW. The power lines are typically overhead with some underground portions, specifically between North Lake Drive and 7th Ave N.

The existing water line consists of asbestos cement pipes. Construction near or around the existing water distribution system will necessitate full replacement of the impacted water lines. Replacement of these lines is planned by the City as a future infrastructure improvement project, which provides an opportunity to complete both projects concurrently and consequently, to reduce construction dollars and impacts to surrounding neighborhoods and traffic control that would result from individual projects.

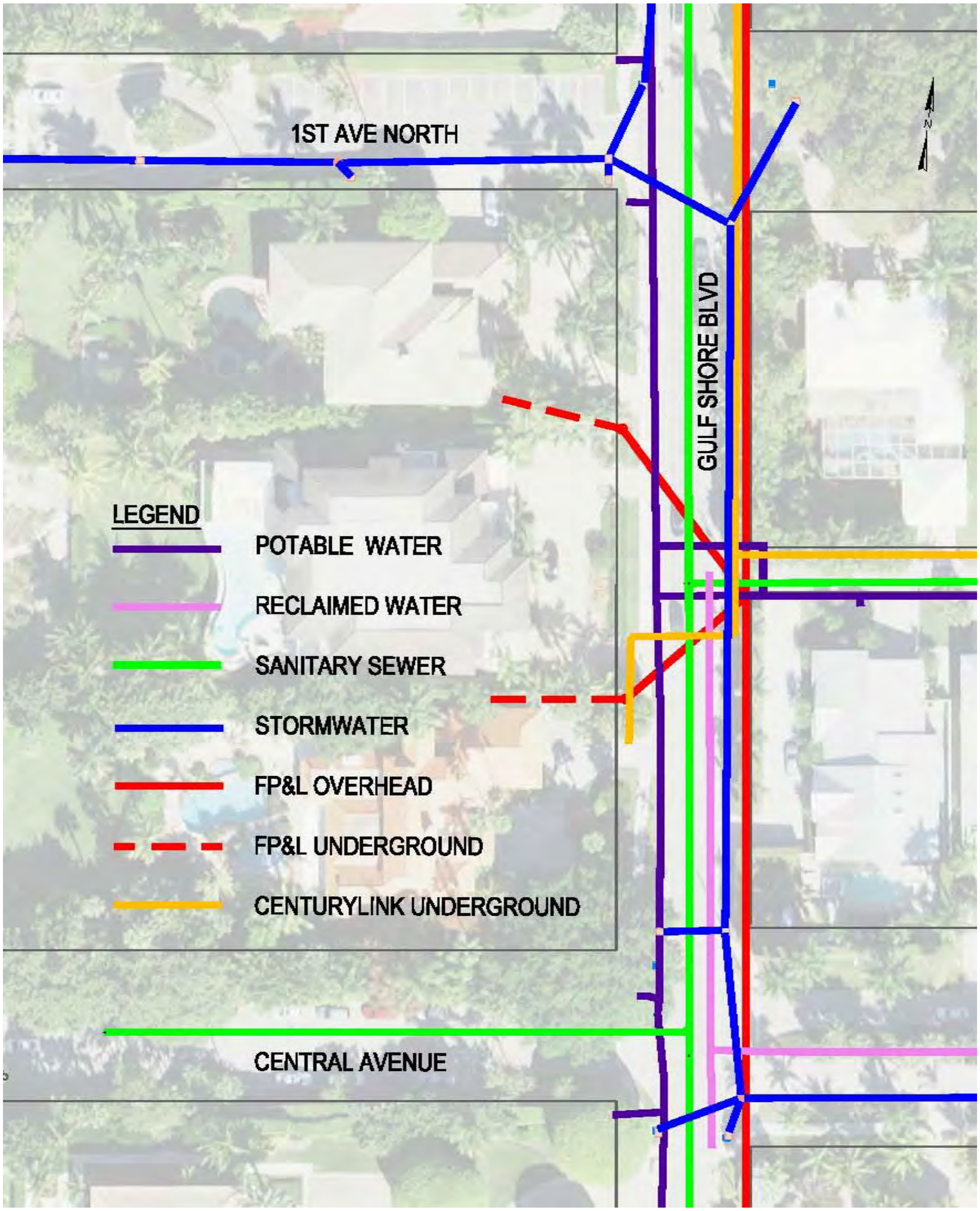


Figure 3-6. Typical Utility Configuration Along Gulf Shore Blvd

Figure 3-7. Typical Intersection with Utilities – Storm Drain with Adjacent Fiber Optic Cable Manholes

Figure 3-8. Typical Intersection with Utilities – Storm Drain in Foreground with Water Line in Background

Pipeline Consolidation along Back-Beach/Dune

Dune elevations are on the order of +5 to +6 ft (NAVD 88), with the seaward berm elevations at +4 to +5 ft (NAVD 88). At present, beach widths vary from 85 to 100 ft. The Project is located within the limits of the Collier County Beach Nourishment Project, an established, funded program to maintain beach widths on the order of 100 ft with a 6-yr re-nourishment interval.

A coastal engineer and a marine scientist were mobilized to the site to conduct a 1-day field assessment of the dune characteristics and vegetation on March 16, 2016. The dune system south of 6th Avenue North is generally characterized as coastal shrubs (seagrape and beach naupaka) fronted by grasses (sea oats, railroad vine, etc) (Figure 3-9).

North of 6th Avenue North, the coastal shoreline is characterized by the presence of coastal structures (i.e. revetments and seawalls) with little to no dune feature (Figure 3-9).

Figure 3-9. General Dune Vegetation Configuration along Naples Beach

The feasibility of pipeline consolidation along the back-beach was assessed. North of 6th Avenue North, pipeline consolidation along the dune was immediately excluded due to spatial restrictions and the presence of coastal structures.

The potential for pipeline consolidation along the back-beach South of 6th Avenue North was deemed technically feasible. The benefits of pipeline consolidation and routing along the back-beach principally include the avoidance of utility conflicts. Secondary benefits include a reduction in construction costs and presumably shorter design and permitting timeline to commence construction. The FDEP will likely condition the CCCL permit to require relocation of the stormwater pipe within a certain timeframe which can be permitted and completed at the time the potable watermain is replaced.

3.1.3 Design Level(s) of Service

Level of Service (LOS), as it applies to the Project, is the design peak flow that the stormwater system can convey and contain prior to backup of the system (i.e., standing water within the street(s)). The LOS is a primary consideration in the system's design as it establishes the system's capacity (pump station, pipeline and stormwater structures sizing) and associated components (e.g. filter systems, etc) and as well as the system's overflow line(s). The overflow line is required to provide discharge capacity during extreme low frequency storm events (i.e. conveys flows to the Gulf as a back-up or "overflow" to the primary forcemain system).

Peak flow rates by storm event, based on the AECOM SWMM model, were introduced in Section 2.6. The design LOS peak discharge is based upon the 5-yr/1-hr event as stipulated in the City's current stormwater ordinance. The 5-yr/24-hr and the 25-yr/3-day event are the LOS required by the SFWMD. Table 3-1 identifies the LOS requirements for the Project's design.

Table 3-1. Level of Service Requirements

Outfall #	Outfall Location Description	Peak Discharge (cfs)		
		5-Yr/1-Hr Event	5-Yr/1-Day Event	25-Yr/3-Day Event
2	Naples Beach Hotel & Golf Club	36.8 (19.9)	26.2 (14.2)	84.1 (45.5)
3	8th Avenue North	9.6	8.5	2.9
4	7th Avenue North	9.8	8.0	12.4
5	6th Avenue North	5.6	5.1	8.2
6	Alligator Lake Outfall	37.0 (34.2)	37.0 (34.2)	82.3 (76.1)
7	3rd Avenue North	19.4	16.4	24.1
8	1st Avenue North	31.7	28.1	42.6
9	1st Avenue South	8.2	8.0	11.2
10	2nd Avenue South	9.6	8.1	11.8
	TOTALS	**168 (148)**	**145 (131)**	**290 (245)**

Notes: *Peak flow rates shown in parenthesis indicate the predicted peak discharge reduction as a result of the Naples Beach Hotel & Golf Club improvements in progress (Grady Minor, 2015).*

3.1.4 System Design Requirements and Components

The design components for pipeline consolidation include a hydraulic and conveyance capacity (LOS), pipeline sizing and an overflow system. These design considerations, options and system requirements are assessed in the following sections.

<u>Pipeline Consolidation and Conveyance Capacity</u>

The requirements for pipeline consolidation are directly dependent upon the cumulative sum of the flows it must carry. Table 3-2 provides a typical consolidation plan to satisfy the Level of Service requirements for the Project. In this scenario, the consolidation plan cumulatively collects and conveys a total of 228 cfs for Outfalls 2-10 (or 96% of the total 25-yr flow for the Project).

Table 3-2. Conceptual Collection System Flow for Pipeline Consolidation

Conveyance Direction	Outfall	Outfall Description	Peak Flow for the 5-Yr/1-Day Event (cfs)	Collection System Flow (Peak cfs)	Cumulative Collection System Flow (Peak cfs)
To Outfall 2	2	Naples Beach Hotel and Golf Club (City)	17.1		
To Pump Station	2	Naples Beach Hotel and Golf Club (City)	28.4	28.4	28.4
	3	8th Avenue North	12.9	12.9	41.3
	4	7th Avenue North	12.4	12.4	53.6
		Sub-Total (2-4)	*53.6*	*53.6*	
Pump Station 1					61.9
To Pump Stn	5	6th Avenue North	8.2	8.2	8.2
		Sub-Total (5)	*8.2*	*8.2*	
To Pump Station	6	Near Alligator Lake	76.1	76.1	76.1
	7	3rd Avenue North	24.1	24.1	100.2
		Sub-Total (6-7)	*100.2*	*100.2*	
Pump Station 2					165.7
To Pump Station	8	2nd Avenue North	42.6	42.6	65.6
	9	1st Avenue South	11.2	11.2	23.0
	10	2nd Avenue South	11.8	11.8	11.8
		Sub-Total (8-10)	*65.6*	*65.6*	
TOTAL CONSOLIDATED			**227.6**	**227.6**	**227.6**
TOTAL PEAK RUNOFF (Outfalls 2-10)			**244.7**		

*Individual values may not sum to totals due to rounding

The Project's LOS requirements include the 5-yr and 25-yr rainfall events. The magnitude of the components (the number and sizes of the pump stations and pipelines) required, and the associated cost, are oftentimes not warranted to treat low frequency rainfall events (i.e. 25-yr) when options exist for diversion to a larger water body (Bay, Gulf, etc). Due to economies of scale, an overflow system is a viable option to handle flows associated with these infrequent events. A typical use of an overflow system combined with pump station(s) for outfalls consolidation is described in Table 3-3.

Table 3-3. Conceptual Discharge Plan for Pipeline Consolidation

Description	**Cumulative Collection System Flow**	**Pump Station Flow Discharged to Gulf**	**System Overflow Flow Discharged to Gulf**
	(Peak cfs)		
Pump Station 1	61.9	61.9	0.0
Pump Station 2	165.7	94.8	71.0
TOTAL	**227.6**	**156.6**	**71.0**

*Individual values may not sum to totals due to rounding

Once the cumulative flows for consolidation were known, as well as the site layout restrictions and elevations for pipeline routing, sizing of the pipelines was developed (Table 3-4).

Table 3-4. Conceptual Pipeline Sizing for Consolidation

Conveyance Direction	**Outfall Collection**	**Segment Description**	**Peak Flow for the 25-Yr/3-Day Event (cfs)**	**Pipe Diameter (in)**	**Number of Pipes**	**Approx Length of Pipe (ft)**	**Max Peak Flow for Pipe System (cfs)**
Up-stream	2 to 3	Beach Club - Gulf Shore Blvd to 8th Ave N - Gulf Shore Blvd	28.4	36	1	850	29.0
↓	3 to 4	8th Ave N - Gulf Shore Blvd to 7th Ave N - Gulf Shore Blvd	41.3	36	1	360	42.2
Down-stream	4 to 5	7th Ave N - Gulf Shore Blvd to 6th Ave N - Gulf Shore Blvd	53.7	42	1	780	54.0
PUMP STATION		**6th Ave N (current location of Outfall 5)**	**61.9**	**48**	**1**	**150**	**66.4**

*Individual values may not sum to totals due to rounding

System Overflow Siting and Design Requirements

The Project's design includes the use of an overflow structure to manage low frequency rainfall events associated with return period events exceeding a 5-yr/1-day event, i.e. 5.5 inch 24 hour storm and including extreme storms such as a 25-yr return event. Consolidation, conveyance and offshore discharge of a flow of this magnitude require a very large pump station(s); the cost and impracticality of which may not outweigh the benefit where lower cost solutions are available.

The design requirements for the overflow system are dependent on available locations and required pipeline size(s). It is most practical and most cost effective to utilize and modify an existing outfall for the system overflow based upon both regulatory and land use sensitivities. Two existing outfalls of sufficient capacity for this purpose presently exist within the City's existing beachfront stormwater infrastructure at Outfall 2 and Outfall 6. Outfall 2, at the northern extent of the Project Area, is a large capacity discharge however, this outfall was excluded due to the total pipeline distance and flow that require a pipeline(s) of a size and dimension that is impractical to route along Gulf Shore Blvd.

Outfall 6 is centrally located within the Project Area and provides the optimal location based upon the cumulative consolidated flows conveyed from the south and the north segments of the Project Area. In addition, the pipe size and routing was deemed optimal and thus selected for modification and use as the primary overflow structure. The overflow line will utilize both gravity flow through a traditional beach outfall with forcemain to "open" the buried lines under the visible beach and thus will otherwise remain buried landward of the shoreline.

3.2 Pump Station(s) Requirements

The Project will utilize one or more pumping stations. These pumping stations allow the conveyance of greater flows and volumes than would be possible under normal gravity flow, thereby optimizing installed pipe capacities. The hydraulic head created by the pump stations also allow for positive conveyance of stormwater runoff during high tide. This is a critical advantage for low-lying coastal communities subject to tidal influence.

3.2.1 Siting

The construction of a pump station requires the availability of a site that is adequately sized to accommodate the various components of the station. The pump station sites must be located in proximity to the proposed outfall, and to the pipe conveyance system used in the consolidation of the various outfalls, as described above. The availability of suitable public lands within the Project Area, meeting the size and the outfall proximity requirements, is limited. The City may also consider the purchase of a vacant parcel to suit the Project. Figure 3-10 illustrates all City owned and vacant parcels within Basin II.

City Owned Parcels

Within Basin II there are five City-owned Parcels. Lowdermilk Park consists of three adjoining parcels (Parcel #s 06230040009, 06287320002, 06287400003). There are also two City-owned parcels located on the east and west side of Alligator Lake Parcel (Parcel #s 14151760007, 14151800006). The west side parcel of Alligator Lake was not considered for consolidation of the outfalls as these locations did not meet the siting and land requirements.

The parcel located on the on the east side of Gulf Shore Blvd, adjacent to Alligator Lake (Parcel # 14151800006), was originally recommended by AECOM (Beach Outfall Management Evaluation, April 2013) as a potential site for a stormwater pumping station. This site is located near Outfall 5. This site is close to Outfalls 5, 6 and 7, and is currently used as a small park. This park site, although public, will need zoning action to allow its use for a pump station.

Right-of Way

The right-of-way of Gulf Shore Boulevard includes the north-south road which runs parallel to the beach, and the various beach access ROWs which intersect it. These publically-owned beach accesses were identified as potential locations for pump station siting. It was determined that the City should consider the feasibility of City owned beach access right-of-ways for pump station sites. The beach access ROWs, were evaluated, and two potential sites were identified:

- 3rd Avenue North (by Outfall 7)
- 6th Avenue North (by Outfall 5)

Non- City Owned Parcels

The option to acquire private property was studied, but due to high property valuation in the area, this option was determined to be unfeasible. However, a suitable site may be available within the Naples Beach Hotel and Golf Club. The property owner is currently planning major improvements/redevelopment, and the City has been in discussions with the owner to provide a pump station site as needed.

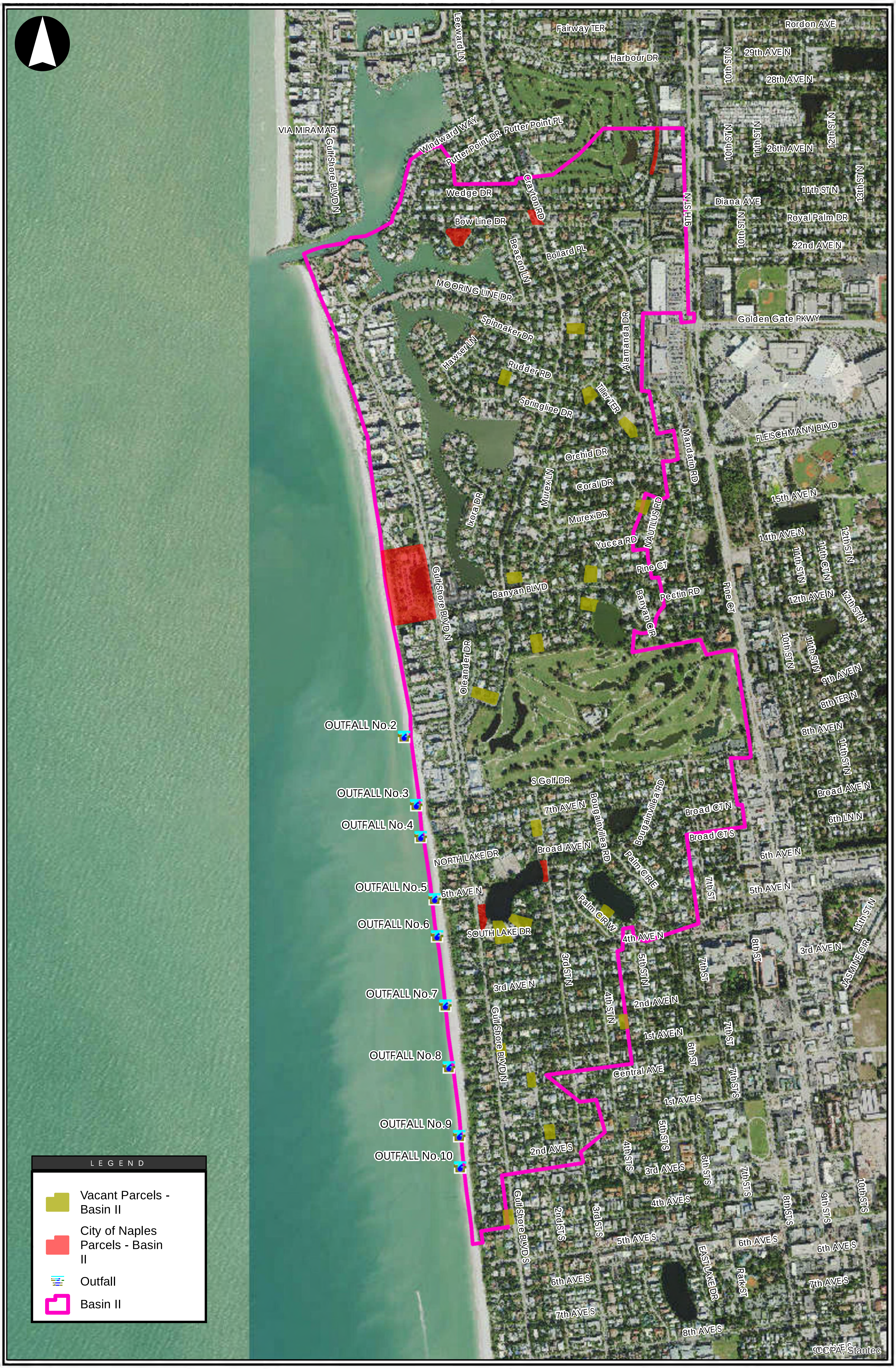


FIG. 3-10

Erickson Consulting Engineers, Inc.

ECE

7201 Delainey Court
Sarasota, FL 32420
(941) 373-6460

Stantec

Stantec

3200 Bailey Lane
Suite 200
Naples, FL 34105
(239) 263-6403

Naples Beach Restoration &
Water Quality Improvement Project

BASIN II CITY OWNED & VACANT PARCELS

3.2.2 *Existing Site Conditions*

The following three sites were evaluated to determine feasibility of the construction and operation of a stormwater pumping station and ancillary equipment (generators, etc):

- Gulf Shore Blvd adjacent to Alligator Lake (Parcel # 14151800006)
- 3rd Avenue North (by Outfall 7)
- 6th Avenue North (by Outfall 5)

<u>Gulf Shore Boulevard by Alligator Lake</u>

As part of the pump station siting feasibility study, an assessment of the City owned property adjacent to Alligator Lake (Parcel # 14151760007) was conducted. Currently, this parcel is operated as a public lakeside park (Figure 3-11).

The following was observed during site assessment:

- Several different persons were observed walking, jogging and riding bicycles along Gulf Shore Blvd.
- The parcel has an on-site water fountain, a garbage can as well as park bench, indicating that this location is used by stakeholders in the area.
- No persons were noted to be specifically using the site at this time.
- The landscaping features (palm trees and other plantings) are well maintained.

Figure 3-11. City-Owned Parcel Adjacent to Alligator Lake
(Parcel # 14151760007)

The site appears to have been cleared of native vegetation in the past and planted with trees and sod. There is a potential for the American alligator and protected wading birds to inhabit or utilize the lake, however no state or federal listed species were observed utilizing or inhabiting the site at the time of the assessment. Additionally there were no protected species listed by the U.S. Fish and Wildlife Service (FWS) or Florida Fish and Wildlife Conservation Commission (FWC).

This parcel is within the City's R1-10 Residential zoning district. The minimum yard setbacks for the zoning district are:

- Front: 30 ft from right of way
- Side: 7 ½ ft for the first 15 ft of vertical height from the greater of:
  - FEMA first habitable floor height requirement
  - 18 inches above the state department of environmental protection requirement for the 1st habitable floor structural support
  - 18 inches above the elevation of the average crown of the adjacent roads
  - The average natural grade
- Rear: 25 ft

The permitted uses in this district do not allow for a public utility facility such as a pump station. For the pump station to be built on this parcel, rezoning would be required. The site would need to be rezoned as PS Public Service District. The new potential site constraints for PS Public Service District at this site would be as follows:

- Minimum Yard Setbacks:
  - Front: 20 ft from right of way
  - Side: 10 ft
  - Rear: 25 ft
- Maximum height: 30 ft

The existing site grade elevation is generally at 4.9 ft (NAVD 88). The Base Flood Elevation (BFE) for the parcel is 11 ft (NAVD 88). However, according to the Florida Building Code requirements, the minimum height for the electrical components are to be located 2 ft above the BFE. As such, all electrical equipment must be located, at a minimum, at an elevation of 13 ft (NAVD 88) which is approximately 8 ft above existing grade.

To rezone a property for a stormwater pump station, the City may complete a petition and submit it to the City Manager with the required fee and supportive materials, as required. If the City Manager determines the rezone petition to be in order, property owners located within 500 ft of the property involved in the petition must be notified of the date, time, place and reason for the public hearing. At the public hearing, the planning advisory board shall hear from the petitioner or the petitioner's designated representative and all other interested parties who may appear and request to be heard.

The planning advisory board ultimately submits its recommendation for approval or denial, or approval with conditions, in writing, together with the minutes of the hearing, to the City Council. After considering the recommendation of the planning advisory board, the City Council may approve or deny the petition, or approve the petition with conditions.

<u>3rd Avenue North</u>

3rd Ave North is a City owned beach access ROW, west of Gulf Shore Blvd (Figure 3-12). As part of the pump station siting feasibility study, an assessment of this site was conducted. The following was observed:

- 3rd Avenue North serves a one of the City's public beach access corridors from the Gulf Shore Blvd to the beach front.
- 3rd Avenue North features fourteen (14) coin-operated parking spaces distributed evenly on both sides of this access road. Five of these parking spaces were occupied at the time of the visit.
- Several people were observed walking, jogging and bike riding along Gulf Shore Blvd.
- The surrounding landscaping was well maintained, including grass, bushes and palm trees.
- 3rd Avenue North is bordered by one single family residence to the north and another single family residence to the south, both with driveway access from Gulf Shore Boulevard.
- There is a small pedestrian access to the south single family residence, at the western end of 3rd Avenue North.

Figure 3-12. 3rd Avenue North, Facing West

The 3rd Avenue North Beach Access Site consists of paved, asphalt road, ROW, metered and un-metered public beach parking spaces and driveways associated with the adjacent residential properties. The southern and northern property boundaries are bordered by walls, sod and planted landscape vegetation associated with the adjacent residential properties. The western-most portion of the site contains coastal scrub vegetation. The dune vegetation consists of sea oats (*Uniola paniculata*), railroad vine (*Ipomea pes-carpe*), sea ox-eye daisy (*Borrichia frutescens*), and seagrape.

There is a potential for protected sea turtles and protected shorebirds to nest or utilize portions of the coastal scrub habitat. Temporary or permanent impacts to the coastal scrub would likely require coordination with the FWC and FWS to avoid impacts to nesting marine sea turtles and nesting shorebirds/wading birds.

The existing site grade elevation is generally at 6.3 ft (NAVD 88). The BFE for this site 12 ft (NAVD 88). However, according to the Florida Building Code requirements, the minimum height for the electrical components is +2 ft above BFE, so all electrical equipment must at a minimum elevation of +14 ft (NAVD 88) which is approximately 8 ft above existing grade.

<u>6th Avenue North</u>

6th Avenue North is a City owned beach access ROW, west of Gulf Shore Blvd (Figure 3-13). As part of the pump station siting feasibility study, an assessment of this site was conducted. The following was observed:

- 6th Ave North is one of the City's public beach access corridors from Gulf Shore Blvd to the beachfront.
- The beach access at 6th Avenue North features beach parking as well as five (5) residential driveways to four (4) single family residential homes.
- The driveways consist of brick pavers.
- Nine (9) coin-operated parking spaces exist, all on the southern side of 6th Ave. Only one such parking space was occupied at the time of the visit.
- Several people were observed walking, jogging and bike riding along Gulf Shore Blvd.
- The right-of-way and traffic islands within the ROW are well maintained (e.g. landscaping including palm trees).

Figure 3-13. 6th Avenue North, Facing West

The 6th Avenue North Beach Access site exhibits similar conditions as the 3rd Avenue North Beach Access site; consisting of a paved, asphalt road, ROW, metered and un-metered public beach parking spaces, and driveways associated with the adjacent residential properties. The southern and northern property boundaries are bordered by walls, sod and planted landscape vegetation associated with adjacent residential properties. The western-most portion of the site contains coastal scrub vegetation including paver stones, a wooden dune walkover and sitting bench. The dune vegetation consists of sea oats (*Uniola paniculata*), railroad vine (*Ipomea pes-carpe*), sea ox-eye daisy (*Borrichia frutescens*), and seagrape.

Temporary or permanent impacts to the coastal scrub portions of the 3rd Avenue North Beach Access would likely require coordination with the FWC and FWS to avoid impacts to nesting marine sea turtles and nesting shorebirds/wading birds.

The existing site grade elevation is generally at 6.3 ft (NAVD 88). The BFE for this site 12 ft (NAVD 88). However, according to the Florida Building Code requirements, the minimum height for the electrical components is +2 above the BFE, so all electrical equipment must at a minimum elevation of +14 ft (NAVD 88) which is approximately 8 ft above existing grade.

<u>Summary</u>

In summary, three locations were identified as viable to house a pump station and auxiliary equipment (e.g. control panels, generators, water quality treatment, etc). These locations include:

1. City owned beach access at 6th Avenue North (present location of Outfall 5)
2. City owned beach access at 3rd Avenue North (present location of Outfall 7)
3. Parcel on the west side of Alligator Lake (ID 141517600007)

A fourth location, in the vicinity of the Naples Beach Hotel and Golf Club, would provide additional flexibility if a site can be procured through purchase or perpetual easement.

3.2.3 System Design

The design components for the pump station(s) include a hydraulic analysis, individual pump station components and the site layout and development of the pump station location. These design considerations, options and system requirements is assessed in the following sections.

Hydraulic Analysis

The hydraulic requirement for each proposed pump station is determined based on the preliminary discharge locations (pump station sites) and peak flow rate to each station (Level of Service). The maximum discharge main considered for this application is 24-inches in diameter. Therefore, the headloss can be calculated for the following alternatives for each pump station to properly size the hydraulic needs of each alternative:

- single 24-inch discharge main;
- two parallel 24-inch force mains; and
- three parallel 24-inch force mains.

These headloss calculations were based on the Hazen Williams equations with a C-factor of 140. Preliminary minor losses are added for the duck-bill style outfall structures at the seabed along with the velocity head. Finally, the anticipated static lift is added (from the wet well level to the Gulf of Mexico) to obtain the required total dynamic head (TDH) for each potential site.

The number of 24-inch diameter force mains required for each pump station scenario was then determined. The critera for this selection was to keep the TDH within the 30 to 40 ft range, as this head range could be reasonably accommodated by available pump technologies.

Despite the high uncertainty of climate change and sea level rise, it is important that the City develop infrastructure to have the resiliency needed to function adequately in the face of change. The opportunity exists with projects such as this one, where infrastructure is being modified or improved, to build this adaptation and resiliency into the normal infrastructure renewal cycle.

This concept of "mainstreaming" adaptation by focusing on the most urgent effect of climate change and sea level rise allows resiliency to happen at very little adaption cost. In the case of this Project, pump station design considerations such as a slightly raised sea level discharge elevation would be the advisable. To address this issue, South Florida communities typically use design sea levels above annual King Tides as their design datum. In the case of these pump stations, a minimum design sea level rise of 6-inches is recommended for pump sizing.

Pump Station Components

Because homes are in close proximity to the three potential pump station sites, the layout and design of the pump stations must be sensitive and responsive to visual, aesthetic and noise concerns. The required design is low-profile with as little above-ground elements as possible. Submersible all-electric pumps are viable at the given design flows, and are recommended. They will be installed underground, and since not engine-driven and in an enclosed chamber, noise associated with pump operation is virtually non-existent.

The only equipment located above ground with such stations, are the electrical panel, transformer, controls and emergency power systems. Heavy landscaping and other aesthetic treatments can effectively buffer these elements and will harmonize with the residential surroundings.

The pump station will consist of the following components:

1. Below grade wet well
2. Submersible axial flow pumps
3. Below grade valve vault
4. Pump station controls
5. Electrical system

The following provides an introductory discussion on each pump station component.

Submersible Mixed Flow pumps

Based on the anticipated hydraulic requirements at each station, submersible vertical axial flow pumps are recommended for the proposed stormwater pump stations. Submersible, mixed flow pumps are suitable for stormwater pump applications that typically have high flow rates and low to medium discharge head conditions. Vertical mixed flow pumps consist of an impeller inside of a casing pipe. The submersible motor is positioned on top of the casing pipe, and the entire pump and impeller assembly are submerged.

The number of pumps required for each site and the associated pump diameters were considered. Each station will be sized to pump the peak design flow with one pump out of service. Additionally, a jockey pump is included at each pump station to convey lower flows.

Below grade wet well

A trench style wet well design, in accordance with the Hydraulic Institute Standards, is best suited for these sites (Figure 3-14). A trench style pump station has a simple layout, efficient hydraulics, compact footprint and a configuration where, except for electrical components, the station elements are all contained in an underground structure, making it the preferred configuration for these stations. The intake structure will be designed to allow for optimal pump performance that minimizes the following hydraulic phenomenon that negatively impact pump station operation:

- Vortices
- Non uniform velocities
- Entrained air bubbles

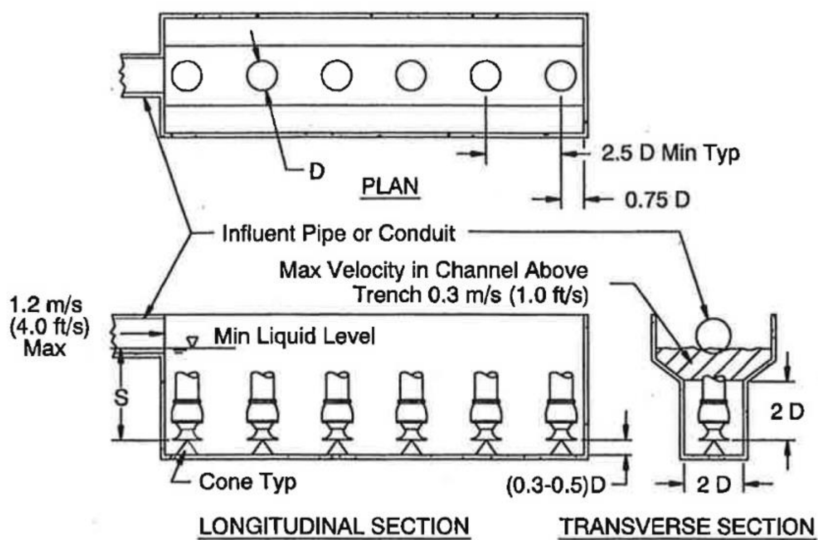


Figure 3-14. Typical Trench Style Wet Well
(Source: Hydraulic Institute: Pump Intake Design Manual)

Below grade valve vault

Each pump discharge will have a lever weighted check valve and a manually operated isolating butterfly valve located below grade in a valve vault alongside the wet well with adequate space for all required fittings, valves, and piping. A bypass connection pipe is also recommended from the wet well to the discharge force main manifold with an added butterfly valve at the wet well side. A typical pump station schematic is provided in Figure 3-15.

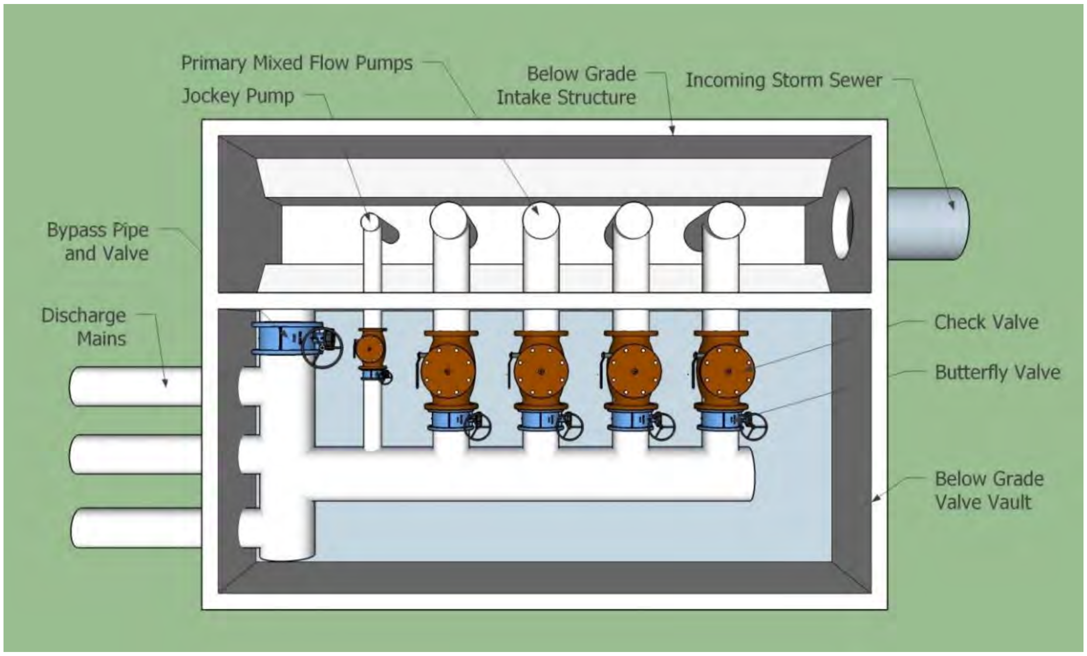


Figure 3-15. Typical Pump Station Schematic

Pump Station Controls

The general approach for controlling the pumps at the proposed stormwater pump station(s) is based on flow matching. The number of active pumps and their associated pump speed is controlled so that the stormwater inflow rate is matched by the total discharge rate. The inlet structure liquid elevation will be monitored by a level transducer. There will be a system of backup float switches to control the pumping in the event of a transducer liquid elevation monitoring faiurel. The pump station includes two controllers (primary and secondary) for the variable frequency drive pumps.

For the primary controller, the level transducer and programmable logic controller (PLC) forms the basis of the primary control logic. The PLC system shall perform all logic operations necessary to sequence and alternate the electric pumps to achieve proportional level control and ensure equal run times for all pumps. The hydrostatic level transmitter is used as the primary control variable. Pumps are controlled at virtual set-points established within the PLC and SCADA HMI. The pre-set primary control points will be evaluated during the 60% level design and in-depth modeling of the liquid elevation of the stormwater collection system will be required. The PLC shall interface with wet well level instruments and the VFD's through discrete and analog module interfaces. The PLC coordinates the operation of the pumps, monitors status of the complete station operation and provides the SCADA interface. In normal operation the PLC shall schedule the pumps operation to keep the wet well level within the desired parameters. Primary level control is based on the hydrostatic level probe (4-20 mA) signal. The pump stop/start control will be based on set point values visible on the HMI graphic screen. These set point values may be changed by the operator on the associated HMI graphic screen. For each VFD in the system, the PLC program shall control the RUN command and specify the operating mode (LEAD, LAG) for each pump. The software internal to the PLC shall coordinate the VFD to allow a lower priority pump to move up in the priority string in the event that the next higher pump fails. The drives are hardwired for control via an analog connection and monitored through an ethernet connection.

The secondary controller will consist of floats. Hardwired relay logic forms the basis of this control. The secondary controller is initiated from a high level relay that is set to levels slightly higher than the primary setpoints and would therefore normally not be called to operate if primary controls are functioning properly. The high level relay initiates secondary control and posts an alarm. All pumps are called to run at a fixed speed. The pre-set primary control points will be evaluated during 60% level design and in-depth modeling of the liquid elevation of the stormwater collection system will be required.

The jockey pump is a single speed pump, and will operate when the inflow to the station is modest. A detailed pump control strategy will be developed when the Project enters the 60% level design. The jockey pump control schema will require in-depth modeling of the liquid elevation of the stormwater collection system.

Electrical System

The electrical systems are comprised of:

1. Control Panels with Variable Frequency Drives
2. Power Transformer
3. Backup emergency generator

Due to the size of the pumps, all pumps will be equipped with variable frequency drives and soft starts which will be housed in control panels. The panels will also require redundant air condition systems to cool the panels. The control panels must be located in close proximity to the station itself, and elevated above BFE. As previously mentioned, the electrical system components must be located 2 ft above the FEMA BFE. These elements can be installed on raised access platforms, as shown in Figure 3-16 below of a recently completed installation for a stormwater pump station on Miami Beach. The transformer can be located slightly above the road crown, but essentially at grade.

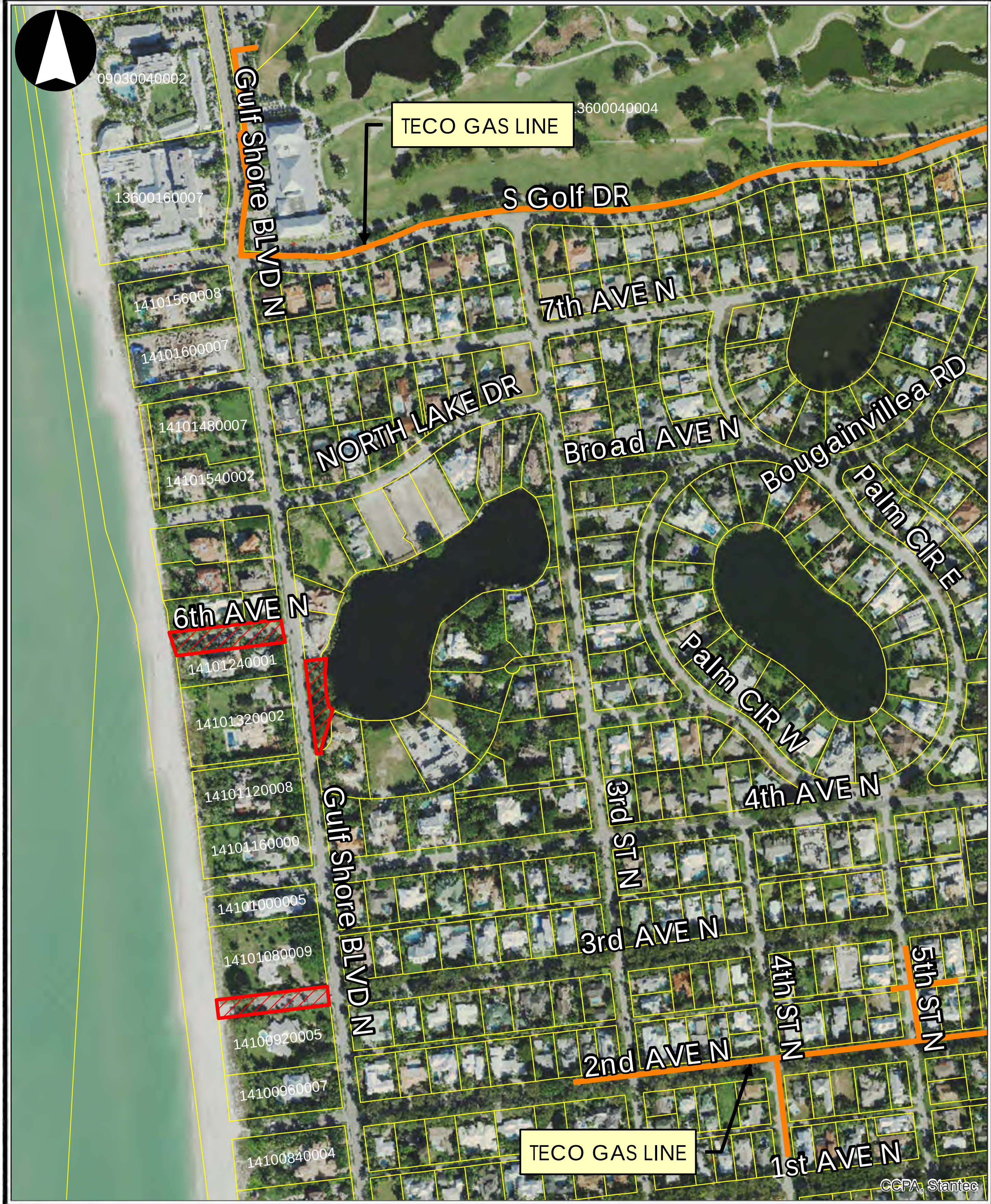
Figure 3-16. Electrical Components Installed on Raised Access Platforms

The backup power generator can be located in close proximity to the pump station, or can be located at a distance of up to 600 ft away from the pump station, depending on whether site can accommodate the generator, or if the site constraints and impacts are such that the generator is best located in a remote configuration.

Both diesel and natural gas were considered for emergency generator fuel. Diesel powered generators are widely used within the City of Naples, and are the only choice when natural gas is not available. Stantec contacted Teco Partners to determine availability and location of natural gas lines in the general vicinity of the Project Area. Figure 3-17 provides the general location of the existing natural gas lines (in orange) as provided by TECO. TECO is in the process of expanding their gas line coverage along Gulf Shore Blvd, from 4th Avenue South to 2nd Avenue South (Outfall 10) (Figure 3-18). The option exists to extend a natural gas line southward along Gulf Shore Boulevard to the Alligator Lake site. A brief discussion on the pros and cons associated with the use of diesel and natural gas diesel generators is provided below in Table 3-5. Upon consideration of all pros and cons, it was decided that natural gas would be the best overall fuel choice for this Project. This decision was mainly based on limitations associated with the Alligator Lake site, as this site would be the most likely choice for the proposed generator(s).

Table 3-5. Pros and Cons of Natural Gas and Diesel Generators

Natural Gas Generator		Diesel Generator	
Pros:	Cons:	Pros:	Cons:
Easy to permit	Gas line must be brought to site	Relatively low capital cost	Noisy operation
Less odor during operation	Relatively high capital cost	Shorter lead time	Higher elevation due to belly tank
Cheaper fuel cost	Longer lead time	No digging in streets for gas line	Harder to permit
No fuel storage required			Odor during operation
Overall lower equipment profile due to lack of belly-tank			Fuel storage must be managed
Relatively quiet operation			



ECE
Erickson Consulting Engineers
7201 Delainey Court
Sarasota, FL 34240
(941) 373-6460

Stantec
Stantec
3200 Bailey Lane Suite 200
Naples, FL 34105
(239) 263-6403

Naples Beach Restoration & Water Quality Improvement Project

TECO GAS AVAILABILITY

FIG. 3-17

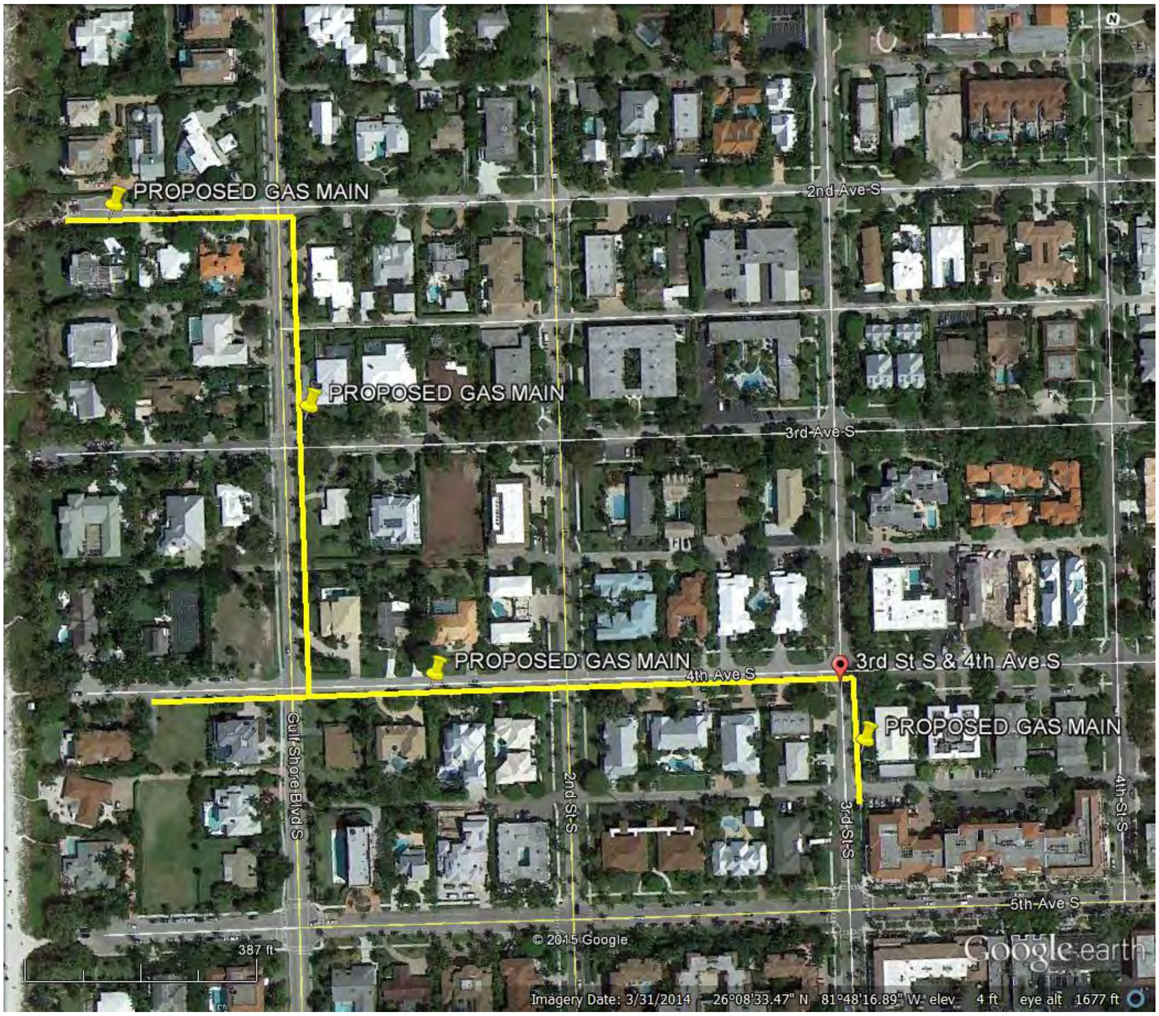


Figure 3-18. 2015 TECO Gas Line Expansion Near Outfall 10

Site Layout/Development

Various configurations were studied at the three potential pump station locations to determine if the sites were feasible options. All three sites were determined to be too highly congested and negatively impacted for a full pump station installation, including the generator. Hydraulically, the two beach access sites work best for the station locations, as such, those are the preferred site for all station elements except for the backup generator. The generator was found to be most suitably located at the Alligator Lake park site, and from that location can serve pump stations at both beach access sites (3rd Ave North and 6th Ave North).

3.2.4 Surrounding Neighborhoods and Potential Impacts (Components and Requirements)

The following is a discussion regarding the potential impacts of a proposed pump station(s). It is a general discussion and is not specific to the location of the particular pump station site. Recommendations for additional measures to be taken during the pump station design to mitigate and minimize adverse impacts to the surrounding area are provided.

Noise

In general, noise associated with pump station operation is a result of mechanical equipment and alarms which indicate either a high level within the wet well or a mechanical/ electrical failure. The proposed pump station includes pumps that are located below grade within a wet well and submerged in liquid. In normal operation, little or no noise is to be anticipated from the pump operation, as the pumps are submerged in water, below grade, and in a sound attenuating concrete structure. High noise levels associated with submersible pumps is usually an indication of a potential mechanical failure such as a defective seal. A properly installed pump with no mechanical problems should have very little sound associated with pumping.

The emergency generator will also create a noise during operation. The generator will operate when there is a power failure. Additionally, the generator will operate weekly for 15 minutes to ensure the system is in working order. Measures to minimize noise impacts include the distance of the generator from adjacent properties and sound enclosures. For example, the generator can be installed in a sound attenuated enclosure rated for 68 dB(A) or less at a distance of 30 ft from the source. The actual sound/noise level that an adjacent property may experience would be less.

Final design efforts will include a noise and vibration analysis to document the ambient conditions currently experienced at each site. The analysis should evaluate the proposed equipment and recommend measures to minimize noise associated with the pump station equipment and operation.

Lighting

The goal of any lighting system is to have adequate amount of light where and when it is needed to work safely and effectively. Lighting also serves as a security precaution. Typical staffed operations associated with pump stations occur during the day. Staff operation at night would occur in the event of:

- An alarm
- Failure of pump station
- Large scale maintenance or improvement project

A pump station of the size and nature considered for this Project would typically have a pole mounted, automated halide lamp adjacent to the wet well and control panel. They are typically designed and shielded in such a manner that all adjacent properties and roadways are protected from direct or reflective glare. Additionally, the light fixtures are designed to provide a full cutoff at the property line. Due the stations proximity to residential properties and the beach, additional considerations may be required when designing the lighting system for the proposed pump station so as not to adversely impact the residential neighbors or nesting sea turtles. It is recommended that the design include an evaluation of lighting technologies and options to minimize adverse lighting impacts.

<u>Traffic</u>

Any new pump station will generate routine traffic. All trips to the station are event generated. The following lists the types of events that result in site visits from City staff and their contractors.

- Pumps require preventative maintenance annually (at a minimum). A crane will be required to remove the pump for inspections. This takes 1-2 days to access all pumps.
- Cleaning of the wet well is performed monthly.
- Generators are tested weekly
- If landscaping is a part of the pump station site, landscaping is done weekly during the summer, and less frequent at other times.
- Operators will perform a daily inspection during the first year of operation, and that may be reduced to weekly.

These activities will most likely occur during non-peak periods and will not impact normal AM/PM traffic operations on adjacent roadways.

<u>Visual Impacts</u>

All pump stations will be designed to minimize visual impacts to surrounding properties. The proposed pump stations and appurtenant equipment will be housed below grade. The electrical control panel, power transformer and backup generator will be installed at the required BFE, as previously discussed. Screening and buffering requirements such as fencing, landscaping, and other means of visual barriers can be incorporated into each site. It is also common practice to enclose pump stations and appurtenant equipment, including control panels and backup generators, in a building. For the City owned and ROW sites, there is limited land available to enclose the entire station within a building and was not considered a feasible option. If the City were to acquire additional property or easements, incorporating a building with architectural features to resemble the community would be an option to consider.

The generators are recommended to be located at the Alligator Lake site. It is recommended that this site be enclosed by a fence or wall to protect the equipment as well as provide a visual barrier. The constructed wall height and architectural features, if any, will be evaluated and will include input from the public. The community perspective will be important in developing the screening and buffering requirements for each site. It is recommended that the adjacent property owners, as well as the community, be included in the development of visual barriers for the pump station site.

Beach Access

Both 3rd Avenue North and 6th Avenue North provide parking and public beach access. The pump stations must be sited to allow City operations staff can access the pump stations to clean as well as to remove a pump if necessary. This may limit the available parking at each beach access site. Pedestrian beach access may be maintained. The exact site layout will rely heavily on coordination with adjacent property owners, City operations and the public and must consider beach parking and access.

3.3 Water Quality Treatment Systems

This Project does not propose to increase or reduce the volume of stormwater discharged to the Gulf of Mexico; however, there is an opportunity to improve the water quality of the discharged stormwater, resulting in an overall environmental benefit for the Gulf and the local Naples Beach. Based on available water quality sampling and testing information, the existing system discharge results in a measurable adverse impact to the Gulf of Mexico. Water quality parameters that impact the Gulf include suspended sediments, bacteria (fecal coliform and enterococci), nutrients and heavy metals.

Suspended Solids

Total Suspended Solids (TSS) are a common constituent in stormwater runoff. Sources of TSS vary based on land use within watersheds, but typically arise from particulate matter eroded from impervious surfaces or deposited on surfaces as a result of human activity and atmospheric deposition. Yard swales provide filtration and removal while road collection inlets directly transport surficial particles to the stormwater system. An increase in TSS typically leads to an increase in turbidity in receiving waters, which can impact growth of marine habitats. Sedimentation can also occur should the suspended solids settle to the bottom of the waterway. Transport of harmful pollutants such as heavy metals is a secondary impact of TSS. Treatment of stormwater to reduce TSS is typically accomplished using physical methods, and includes, but is not limited to, wet detention ponds, swales, catch basin inserts, inline hydrodynamic/vortex separators and sand filters.

Bacteria

Bacteria is a common constituent in stormwater runoff and can serve as a potential health threat depending on the levels at the downstream receiving waters and outfall locations (i.e. recreational activities or for sourcing foods such as shellfish that are monitored for compliance with state limits). Bacteria occurs naturally in soils that are carried in stormwater runoff and grow in any location with standing water. Delineation of harmful bacteria versus naturally occurring bacteria is the key in determining negative impacts and treatment criteria. Bacteriological testing of stormwater is typically performed, identifying indicator organisms such as fecal coliform which can indicate if harmful pathogens are present. Commonly used BMPS have varying levels of ability in treating bacteria, and therefore active treatment such as chlorination, UV light and ozone are utilized when highly effective removal is required and treatment is feasible.

Nutrients

Nutrients are a common constituent in stormwater runoff, with nitrogen and phosphorus as the principal nutrients of concern. The primary sources for nutrient loading in stormwater runoff are heavily influenced by land use and come from landscaping byproducts (such as fertilizer and plant debris), atmospheric deposition and septic system contamination. Excess nutrient loading causes eutrophication and leads to significant impairments in receiving waters. Nutrient loading can result in algae blooms, which can eventually lead to hypoxia and fish kills. Many BMP's target reducing nutrient loading using passive techniques, including dry and wet detention ponds, rain gardens and vegetated swales.

Heavy Metals

Heavy metals are a common constituent in urban runoff, with copper, lead and zinc being the most prevalent. The most common source for these pollutants is from automobiles and industrial areas, though atmospheric deposition can be a primary source in some areas. Heavy metals cause toxicity in aquatic organisms in receiving waters, impacting the local ecosystem. Heavy metals are typically found as particulates, or are transported by sediments in urban runoff. As such, treatment methods for removing TSS are also functional in removing heavy metals.

Additional sampling is being performed to better understand the impacts that the existing outfall pipes have at their point of discharge. The results of the water quality sampling will become the basis for identifying water quality improvement objectives and the associated treatment technologies to achieve those objectives.

A brief and conceptual discussion on various treatment technologies that could be incorporated into the overall Project is provided herein. The final selection of treatment processes will consider treatment objectives, footprint requirements and available land, maintenance frequency and ease, treatment removal efficiency, capital costs and other requirements.

The land requirement is the most critical factor for selecting treatment technologies and was therefore used to eliminate all treatment technologies that would have a large footprint such as ponds, wetlands and sand filters. Treatment technologies that would change the stormwater basin were also eliminated from evaluation such as swale installations and bio-retention installations.

The following three technologies are discussed conceptually as potential treatment alternatives:

<u>Hydrodynamic Separators (HDS)</u>
These sub-grade structures have cylindrical shapes, and use a vortex flow pattern to create particle-liquid drag forces to promote dynamic and quiescent settling of solids. These structures often have an additional internal chamber that separate trash, oil and grease. These structures will require regular maintenance in the form of cleaning and emptying. This is typically done by a vactor truck removing the accumulated sediments from the bottom vault. Figure 3-19 shows a hydrodynamic separator with arrow indicating the flow pattern.

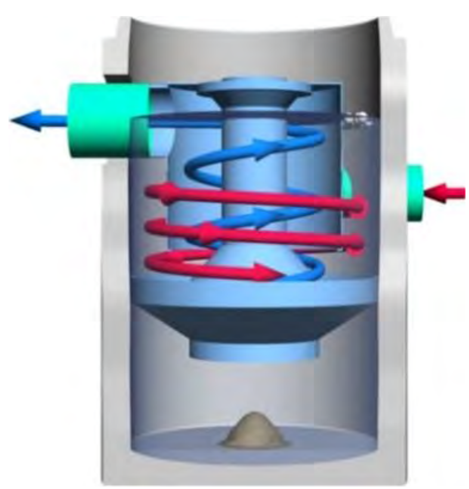


Figure 3-19. Typical Hydrodynamic Separators
(Source: http://www.rocla.com.au/Downstream-Defender.php)

Media Filters

Stormwater media filter treatment systems use rechargeable, self-cleaning, media-filled cartridges to filter the water. These filter cartridges are often arranged in an array within a sub-grade vault. These arrangements can either be based on an up-flow or a down-flow configuration. The filter media is customized to absorb and retain most pollutants within the stormwater runoff including total suspended solids, hydrocarbons, nutrients, metals, and other common pollutants. The suspended solids removal is typically higher for media filters than for hydrodynamic separators. On the downside, these filters require higher maintenance and a larger footprint. Additionally, if the filters are below grade, access must adhere to confined space requirements. Figure 3-20 shows a typical media filter arrangement.

Figure 3-20. Typical Media Filter
(Source: http://www.rainwatermanagement.ca/products/stormfilter-media-filtration/)

UV-treatment

UV-treatment has recently begun to enter the field of stormwater treatment in conjunction with pump stations. This treatment technology is only effective for the deactivation of bacteria. No other water quality constituent is affected by this treatment mythology. UV-treatment can be a standalone treatment or compliment a hydrodynamic separator or the media filter treatment. The outcome of the water quality sampling effort will suggest what type of treatment will be required. A UV system may be electrical power intensive. Figure 3-21 shows a typical inline UV unit.

Figure 3-21. Typical Inline UV Reactor Unit

Table 3-6 and Table 3-7 show the pollutant removal potential associated with each treatment technology and some key parameters associated with each approach.

Table 3-6. Pollutants Removed by Type of Treatment Technology

Pollutant	HDS	Media Filters	UV Reactors
Suspended Sediments	x	x	
Heavy Metals	x*	x	
Nutrients		x	
Bacteria		x	x
Oil & Grease	x	x	
Trash	x	x	
BOD		x	
Turbidity		x	

** When bonded to sediments*

Table 3-7. Characteristics of Water Quality Treatment Technologies

Treatment Type	Loading Rates	Removed Particle Size	TSS Rem. %	Trash Removal	Offline / Online	Maint. Freq.	Ease of Maint.
HDS	Low to High	Coarse Silt and Sand	50-80	Yes	Both	Medium	Easy
Media Filters	Low to High	Fine Silt and Sand	>80	Yes	Offline	Medium	Moderate
UV-Reactor	Low to High				Both	Low	Easy

Clay < 2 microns, Silt 2 - 63 microns, Sand > 63 microns

3.4 Offshore Pipeline Discharge and Diffuser System

3.4.1 Siting

The design requirements for the siting and layout of the offshore discharge line and diffuser system were developed based on consideration of the pump station locations, location and characteristics of nearshore hardbottom, depth of closure and profile shape, existing easements and construction methods.

Based on the consolidation requirements and opportunities described in the preceding section, the gulf discharge pipelines and pump stations are proposed to be located in one or more of three locations: (1) vicinity of Naples Beach Hotel and Golf Club, (2) 3rd Avenue North and (3) 6th Avenue North. To avoid environmental impacts, the gulf discharge pipeline will be directionally drilled from a point landward of the dune for all locations.

To avoid the periodic covering and scouring of the diffuser structure, the pipeline outfall must be located seaward of the depth of closure, previously established as -13.5 ft (NAVD 88) (Section 2). In addition, the outfall structure must be located in sufficient depths so as not to become an obstruction to boaters and to maximize vertical mixing of freshwater and seawater. As such, the pipelines were designed to surface between the 14 ft and 16 ft (NAVD 88) depth contours.

A significant factor in determining the location of the diffuser system(s) is the offset from natural resources and the requirements for the mixing zone. The mixing zone is defined as the region in which the dilution of discharged "freshwater" from the stormwater discharge point is mixed and diffuses with the "ocean" waters to reach naturally occurring salinity levels. Full freshwater dilution is achieved within the mixing zone.

In addition to surfacing a sufficient distance from hardbottom, the offshore diffuser structure must be sited outside of any existing submerged lands leases and uses. At present, Collier County utilizes a pipeline corridor which comes ashore between R-63 and R-64 (8th Avenue North and Naples Beach Hotel and Golf Club). As such, the offshore discharge structure should avoid the footprint of this corridor.

Hard, consolidated and relatively impermeable subsurface material provides the optimum conditions to support the bore hole diameter and contain drilling fluids (i.e., avoid frac out). As such, the probable drilling depth would be 50 to 70 ft below the seabed, and follow a path at which the pipe drill will surface from the seabed at the optimum subsurface depth which was previously determined to be between -14 ft to -16 ft (NAVD 88) (Figure 3-22).

Figure 3-22. Preliminary Offshore Pipeline and Diffuser System Profile

3.4.2 Existing Site Conditions

Hardbottom is present offshore of all three pump station locations identified, but is not continuous. Opportunities exist to align and surface the pipeline offshore by deep drilling under the seabed seaward of these nearshore areas of hardbottom. To provide a sufficient mixing zone (freshwater diffused and mixed with the ambient seawater), a buffer of 250-400 ft was established as a design requirement for the siting and layout of the offshore diffuser structure away from hardbottom resources. The minimum depth for the diffuser pipe is proposed at 14-16 ft of depth, and is based on the "depth of closure" for this beach-shoreline area. This depth is based on a historical analysis of beach profile changes and represents the depth where sediment movement is negligible, and where seabottom remains the same over time.

Subsurface soil conditions, pipeline size and pipeline characteristics will determine the final drill hole size and depth of drill. Core borings taken in the area provide background information to support the assumptions for the use of HDD. In general terms, consolidated limestone subsurface strata provide the optimum conditions to support the bore hole diameter. Project specific deep geotechnical borings are recommended during the 60% design phase, within the vicinity of the selected HDD location(s), to a depth of approximately 80 to 90 ft below the ground surface to identify subsurface strata and material hardness.

3.4.3 System Design

Design requirements for the offshore diffuser structure include the pipeline type and size, flow rate and diffuser size, pipe slope for emergence, mechanical joints, resilience for operations and maintenance and anchoring.

During preliminary design calculations, it was determined that two 24 in (inner diameter) discharge pipelines would be necessary to convey the required discharges offshore. Pipeline selection must also consider the ability of the material to withstand the forces and stresses associated with pulling the pipeline through the borehole for placement. Table 3-8 identifies a pipeline that is expected to be sufficient in terms of pipe size and safe pulling force to utilize for this Project.

Table 3-8. Conceptual Offshore Discharge Pipeline Material Selection

Pipe Description	OD (in)	ID (in)	Safe Pull Force (lbs)	Min. Wall Thickness (in)	Min. ID (in)	Estimated Line Length (ft)
24” Fusible PVC™	25.80	23.61	224,800	1.03	24	1,200-1,800

The peak discharge flow rate through the pipeline and the required mixing velocity was evaluated to size the diffuser system. Mixing velocity (fps) determines the diameter of each diffuser and the number of diffusers required to disperse the peak discharge flow rate (cfs). Table 3-9 identifies the typical diffuser options to meet a mixing velocity of 8 fps.

Table 3-9. Conceptual Diffuser Design for 60 cfs Pump Station

Peak Flow	Option	Diffuser Diameter (in)	Total Number Diffusers[1]	Total Number Diffusers/Line[2]
North	1	6	40	20
	2	8	20	10

Notes: 1. The *options above provide the diffuser configuration required to meet a discharge mixing velocity of 8 fps. 2. Two discharge pipelines for each option with are assumed.*

The selection of diffuser size is based on optimizing the cost versus number of diffusers to convey the peak flow. This is based on economies of scale whereas a larger diffuser may result in a slight increase in cost, the number of differs required will increase exponentially. The length of the diffuser system is determined by the number of diffusers required. In turn, the longer the diffuser section, the greater number of helical anchors required to stabilize the pipeline.

At the location of pipeline emergence, an angled mechanical joint is recommended to transition from the HDD placed pipeline with an upward, angled orientation to the pipeline diffuser section that is parallel to the seabed. A second, straight mechanical joint is then placed within approximately 5-10 ft of the HDD emergence point to provide a diffuser system disconnect point for future (15-20 yr) diffuser system replacement. Pipeline buoyancy, pipeline position support and anticipated loads on the diffuser system will dictate the anchoring system requirements. A conceptual diffuser system design is provided in Figure 3-23.

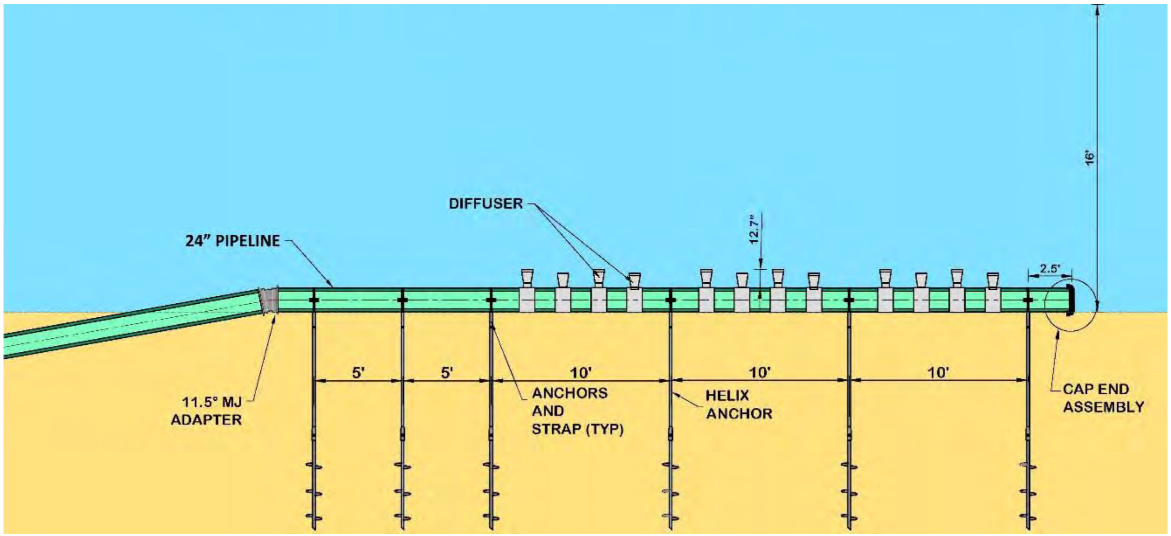


Figure 3-23. Conceptual Diffuser System

Pipeline buoyancy is calculated based on the pipeline material, the buoyancy of the discharged water and the displacement of the pipeline. These factors affect the loads that the anchor must counteract. Additional forces that must be considered include boat anchors and other similar types of potential impacts and loads that could affect the discharge pipeline system. The integrity of the overall diffuser system is maintained by design of the diffuser components to breakaway, as the diffusers are significantly less expensive to replace than the entire diffuser system. Further, the system will remain fully functional with the loss of individual diffusers.

3.5 Identification of Alternatives and Summary of Level of Service

Evaluation and development of the system's components in terms of alternative configurations was required to achieve the optimum design at the optimum cost and construction conditions. Three alternative configurations of the primary stormwater improvement system were developed for evaluation and further consideration (Table 3-10).

Table 3-10. Alternative Configurations of Stormwater Improvement System

Alternative	Pump Station Location	Total Flow Consolidated to Pump Station 5-yr / 25-yr	Re-Routed to Moorings Bay & Naples Bay	Outfalls to Remain
1	3rd Avenue N	77% / 41%	Outfall 2 (City Contribution)	Outfall 2 (Private Contribution)
2	6th Avenue N ("North System") **and** 3rd Avenue N ("South System)	96%/64%	-	Outfall 2 (Private Contribution)
3	Vicinity of Naples Beach Hotel & Golf Club ("North System") **and** 3rd Avenue N ("South System)	100%/71%	-	-

Note: The Naples Beach Hotel and Golf Club is located near Outfall 2; 6th Avenue North is located at the present location of Outfall 5; and 3rd Avenue North is located at the present location of Outfall 7.

4 ALTERNATIVE(S) FOR STORMWATER CONSOLIDATION, TREATMENT AND DISCHARGE

4.1 Identification of Alternatives

Three (3) alternative Stormwater Improvement Systems were identified and the preliminary designs were developed to evaluate rank based on the technical design requirements, economic, environmental and social effects for each Alternative as described below.

4.1.1 Alternative 1

Alternative 1 consolidates the existing stormwater flow associated with Outfalls 3, 4 and 5 (25-Yr) and Outfalls 6, 7 and 8 (25-Yr), and conveys the flow to a single pump station located at 3rd Avenue North with treatment and discharge lines (5-Yr) drilled offshore into the Gulf with a diffuser system. An overflow line, located at Outfall 6, will be placed below the visible beach and will open only during extreme storm events.

The current discharge at Outfall 2 associated with the City's collection system will be re-routed and connect to Moorings Bay. However, Outfall 2 will remain with connections to service the Naples Beach Hotel and Golf Club. Discharge from Outfalls 9 and 10 will be re-routed to the City's Basin III where existing line sizes and system capacity is available (25-Yr storm). Refer to the Alternative 1 Schematic Design Drawing (Figure 4-1).

Alternative 1 was developed as the solution which consolidates and eliminates a significant number of outfall structures and maximizes discharge utilizing a single pump station. Alternative 1 consolidates an estimated 77% and 41% of the 5-yr and 25-yr peak discharge, respectively. A summary of the benefits and challenges of Alternative 1 are described in Table 4-1. The limiting factor in the development of Alternative 1 is the total peak flow and the distances for pipeline consolidation to reach a suitable location for a pump station as well as the requirement that a portion of the flow is diverted to Moorings Bay and Basin III (Naples Bay).

Figure 4-1. Alternative 1: Conceptual Flow Schematic

Table 4-1. Benefits and Challenges of Alternative 1

Benefits/Opportunities	Challenges
Single Pump Station Site and Eliminates 6 of 9 Outfalls	Shifts stormwater to Moorings Bay (7%) and Basin III (12%)
Reduced Overall Project Costs	Outfall 2 pipes remain to convey Golf Club Discharge (4%)
Reduced Impacts to Nearshore Seabed (reduced pipeline lengths)	Outfall 6 pipes remain to convey 25-Yr Overflow (w/ seaward 100 ft removed)
Utilizes Beach Site (3rd Ave North) an existing truck access	Pipeline consolidation follows west ROW at Gulf Shore, requires replacement of potable water line and siting 2 pipelines between 6th Ave North and 3rd Ave North
Outfall 6 pipes reconfigured to be buried in backshore	

4.1.2 Alternative 2

Where it is seen that Alternative 1 minimizes costs by using a single pump station, it falls short of a complete removal of the large outfall located on the beach (Outfall 2) and transfers a significant portion of the flow to Moorings Bay and to Basin III which ultimately discharges to Naples Bay.

To assess the design requirements for (a) consolidation of the existing stormwater lines from all nine outfalls and (b) two pump stations with capacity to convey the higher flow, the Project Area was evaluated and separated into a north and south system. The available pump station locations and pipeline consolidation requirements were analyzed and the design requirements determined siting which would result in pipeline distances and sizes that are technically manageable. These options are evaluated in the design development of Alternatives 2 and 3 as described below.

The pipeline consolidation system's main trunk line is segmented and the flow separated based on an evaluation of the:

- magnitude of flow and distance of consolidation (Table 4-2);
- need to avoid deeply placed, or large pipeline that would result in a structure conflict at the existing box culvert associated with Outfall 6; and
- the location and characteristics of the landward beach berm and dune that may allow less costly routing to consolidate the pipeline along the back-beach for outfalls situated south of Outfall 6, whereas it is impractical north of Outfall 6 due to existing shoreline conditions (i.e. revetments and seawalls).

Table 4-2. Level of Service Requirements for North and South Systems

Outfall #	Outfall Location Description	Peak Discharge (cfs)	
		5-Yr/1-Hr Event	25-Yr/3-Day Event
2-5	North System	62 (45)	118 (79)
6-10	South System	106 (103)	172 (166)
	TOTALS	**168 (148)**	**290 (245)**

Notes: *Peak flow rates shown in parenthesis indicate the peak discharge reduction at Naples Beach Hotel & Golf Club and predicted reduced flow for recently approved improvements to the Golf Course (Grady Minor, 2015).*

The Alternative 2 "North System" consolidates the existing stormwater flow associated with Outfalls 2, 3, 4 and 5 (25-Yr) and conveys the flow to a pump station located at 6th Avenue North with treatment and discharge lines deep drilled and a diffuser system placed offshore in the Gulf.

The Alternative 2 "South System" consolidates the existing stormwater flow associated with existing Outfalls 6, 7, 8, 9 and 10 (25-Yr) and conveys the existing flow to a second pump station located at 3rd Avenue North with treatment and discharge (5-Yr) through directional drilled pipelines offshore. An overflow line, located at Outfall 6, will be located below the visible beach and open only during extreme storm events.

As with Alterative 1, an existing stormwater line remains at Outfall 2 maintaining a connection to service the private Naples Beach Hotel and Golf Club. Refer to the Alternative 2 Schematic Design Drawing (Figure 4-2). The benefits and challenges of Alternative 2 are described in Table 4-3.

Figure 4-2. Alternative 2: Conceptual Flow Schematic

Table 4-3. Benefits and Challenges of Alternative 2

Benefits/Opportunities	Challenges
Two pump station sites readily linked to Outfall 6 (Overflow) and eliminates 8 of 9 outfalls	Higher overall Project Costs
Consolidates all outfall discharge sites in Basin II, eliminates freshwater to Bay	Higher buffer to avoid impacts to nearshore seabed (6th Ave N site proximity to hardbottom is higher)
Utilizes beach accesses (3rd Ave North and 6th Ave North) that are truck accessible, city owned land and minimizes impact to public use/access	Adjacent to estate homes and residential land
Pipeline consolidation along the back-beach would eliminate 1,800 ft of ROW construction along Gulf Shore Blvd (2nd Ave S to 3rd Ave N)	

Siting a pump station in the vicinity of the Naples Beach Hotel and Golf Course will allow the Outfall 2 pipes to be eliminated. Evaluation of this option resulted in the design development of Alternative 3.

4.1.3 Alternative 3

The Alternative 3 "North System" consolidates the existing stormwater flow associated with existing Outfalls 2, 3, 4 and 5 (25-Yr) conveys the flow to a pump station located in the vicinity of the Naples Beach Hotel and Golf Club with treatment and discharge lines deep drilled to a diffuser system placed offshore in the Gulf. The existing large stormwater line at Outfall 2 will be removed and discharge from the Naples Beach Hotel and Golf Club will be routed to the City's new pipeline consolidation system, pump station and treatment system located in close proximity to the existing Outfall 2.

The Alternative 3 "South System" is identical to the stormwater improvement system described above in Alternative 2. This Alternative consolidates the existing stormwater flow associated with existing Outfalls 6, 7, 8, 9 and 10 (25-Yr) and conveys the flow to a pump station located at 3rd Avenue North with treatment and discharge (5-Yr) through a diffuser system using directional drilled deep pipelines offshore. An overflow line will be located at Outfall 6 for extreme storm events. The overflow line will be located below the visible beach and open only during extreme storm events. As a reference, and further described in Section 2, Hurricane Wilma and the similar storm events over the past 14 years (2003- present) would not have resulted in flow that exceeded the capacity of this system resulting in the opening of this overflow line. Refer to the Alternative 3 Schematic Design Drawing (Figure 4-3). The benefits and challenges of Alternative 3 are described in Table 4-4.

Table 4-4. Benefits and Challenges of Alternative 3

Benefits/Opportunities	Challenges
Two pump station sites with North Site landward of CCCL and eliminates all 9 outfalls	Higher overall Project costs
Reduced flow to Outfall 6 overflow, Outfall 6 outfall reconfigured and buried in backshore	City requires an easement for use of land
Consolidates all outfall discharge sites in Basin II, eliminates freshwater to Bay	
Reduced impacts to nearshore seabed and existing Infrastructure	
Utilizes one beach access site (3rd Ave North) which is a truck access, city owned land and minimizes impacts public use/access	
Pipeline consolidation along the back-beach would eliminate 1,800 ft of ROW construction along Gulf Shore (2nd Ave S to 3rd Ave N)	
Both Outfall 2 pipes are eliminated Golf Club Discharge (includes 25-Yr storm conveyance and treatment)	

The preliminary design of the conceptual components of for the alternatives are described in Section 4.2 and 4.3 that follow.

Figure 4-3. Alternative 3: Conceptual Flow Schematic

4.2 Preliminary Design of Alternatives for Evaluation

4.2.1 Alternative 1

<u>LOS and Pipeline Consolidation Design</u>

As described in Section 4.1 above, Alternative 1 will consolidate the existing stormwater flow associated with Outfalls 3, 4 and 5 (from North) and Outfalls 6, 7 and 8 (from South), and conveys the flow to a single pump station located at 3rd Avenue North. Analysis of the pipe size, configuration, elevations and type was based on the Manning's equation to evaluate consolidation design options for the feeder line and the main trunk line, assuming the peak flow rates given in Table 4-5. The required peak discharge (LOS) of 176.3 cfs is based on the cumulative flow from a 25-Yr return period rainfall event.

Table 4-5. Peak Flow Collection System Design for a 25-Yr LOS (Alternative 1)

Alternative 1								
Conveyance Direction	Outfall	Outfall Description	Quantity: Peak Flow for the 5-Yr/1-Day Event (cfs)	Quantity: Peak Flow for the 25-Yr/3-Day Event (cfs)	Collection System Flow (Peak cfs)	Cumulative Collection System Flow (Peak cfs)	Pump Station Flow Discharged to Gulf (Peak cfs)	System Overflow Flow Discharged to Gulf (Peak cfs)
To Ex. Outfall 2	2	Naples Beach Hotel and Golf Club	5.7	17.1				
		TOTAL - TO EX OUTFALL 2	**5.7**	**17.1**				
To Moorings Bay	2	Naples Beach Hotel and Golf Club (City)	8.5	28.4	28.4			
		TOTAL - To Moorings Bay	**8.5**	**28.4**				
To Pump Station	3	8th Avenue North	8.5	12.9	12.9	12.9		
	4	7th Avenue North	8.0	12.4	12.4	25.3		
	5	6th Avenue North	5.1	8.2	8.2	33.5		
	6	Near Alligator Lake	34.2	76.1	76.1	109.6		
		Sub-Total (3-6)	*55.8*	*109.6*	*109.6*			
Pump Station						176.3	100.3	76.0
To Pump Station	7	3rd Avenue North	16.4	24.1	24.1	66.7		
	8	2nd Avenue North	28.1	42.6	42.6	42.6		
		Sub-Total (7-8)	*44.5*	*66.7*	*66.7*			
		TOTAL - ALT 1	**100.3**	**176.3**	**176.3**	**176.3**	**100.3**	**76.0**
To Basin I	9	1st Avenue South	8.0	11.2	11.2			
	10	2nd Avenue South	8.1	11.8	11.8			
		TOTAL - To Basin I	**16.1**	**23.0**	**23.0**			
TOTAL PEAK RUNOFF (Outfalls 2-10)			**130.5**	**244.7**				

Note: all values are peak flow rates (cfs)

The primary site conditions that affect the pipeline design were the low elevation of Gulf Shore Blvd and the adjacent ROW as well as the cumulative capacity required to convey the peak flow for a 25-Yr event. A schematic of the consolidation plan is shown in Figure 4-4, where the pipeline is consolidated between 6th Ave North and the pump station. Table 4-6 describes the key design elements of the consolidation plan. The ROW grade elevations at the north end of the main trunk line ranged from 4.8 to 5.0 ft decreasing to 4.2 to 4.5 ft near 6th Ave North. The diameter of the main trunk line increases to 36 inches, maintaining a single line between 8th Ave North and 3rd Ave North where the line crosses the Outfall 6 box culvert.

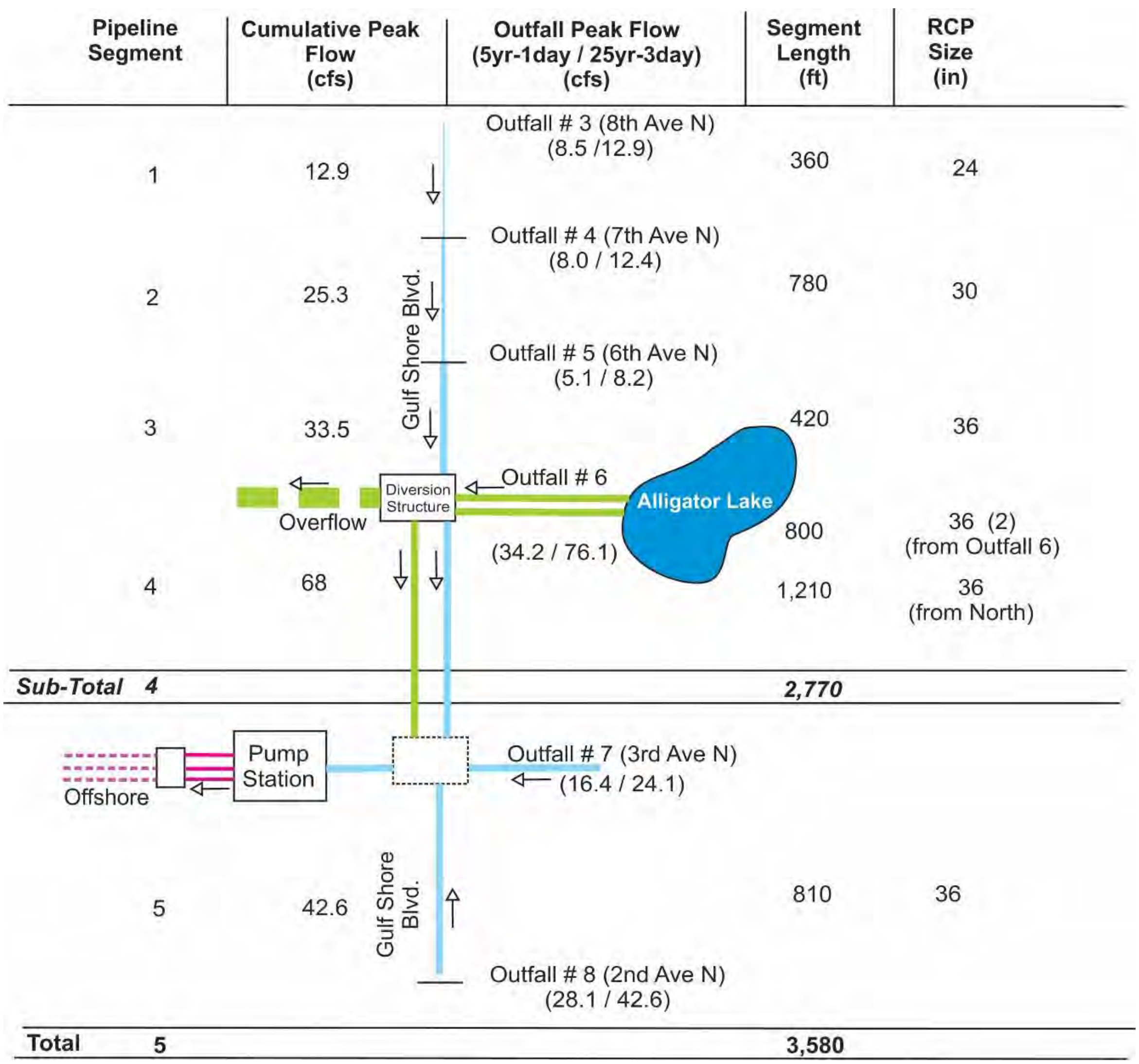


Figure 4-4. Schematic Pipeline Consolidation Plan (Alternative 1)

Table 4-6. Main Trunk Line Design Elements Consolidation Plan (Alternative 1)

Alternative 1							
Conveyance Direction	**Outfall Collection**	**Segment Description**	**Peak Flow 25-Yr/3-Day Event[1] (cfs)**	**Pipe Diameter (in)**	**Number of Pipes**	**Approx Length of Pipe (ft)**	**Maximum Peak Flow for Pipe System[4] (cfs)**
	3 to 4	8th Ave N - Gulf Shore Blvd to 7th Ave N - Gulf Shore Blvd	12.9	24	1	360	13.5
	4 to 5	7th Ave N - Gulf Shore Blvd to 6th Ave N - Gulf Shore Blvd	25.3	30	1	780	25.6
	5 to 7	6th Ave N - Gulf Shore Blvd to 3rd Ave N - Gulf Shore Blvd	33.5	36	1	1,210	33.5
	6 to 7	Alligator Lake Control Structure to 3rd Ave N - Gulf Shore Blvd	76.1 34.2 (5-Yr/ 1-Day)	36	1	800	38.9
PUMP STATION		**3rd Ave N (current location of Outfall 7)**	**100.3 To Pump Station** **76.0 To Over-Flow** **176.3 Total**	**42**	**1**	**100**	**106.6**
	8 to 7	1st Ave N - Gulf Shore Blvd to 3rd Ave N - Gulf Shore Blvd	42.6	36	1	810.0	43.0

At the intersection of the box culvert and the trunk line, invert elevations of the trunk line would be carried under the existing box culvert. As previously discussed, the existing box culvert shall remain as a system overflow to discharge the 25-Yr rainfall event. A new 36 inch line (or similar) from the box culvert would be added to carry the flow from Alligator Lake to the trunk line. It is estimated that the base invert for the box culvert is nominally -0.5 ft based on the existing seaward pipe invert elevation of Outfall 6 and an assumed uniform slope upstream to Gulf Shore Blvd.

A new diversion box structure will be constructed to divert flow during extreme low frequency storm events, which exceed the capacity of the pump station, to the system overflow. It was deemed most cost effective to divert flow and eliminate the requirement for multiple lines and a diversion structure near the pump station. Phase 2 engineering will evaluate the optimal design for this intersect, the diversion structure, and the grades/final elevations of the overflow line along the existing Outfall 6 easement. The Outfall 6 overflow line direct for Gulf discharge will be located below the visible beach and will open by hydraulic force during extreme rainfall events. An evaluation of prior beach conditions and minimum widths over the last 25 years and the present dune and vegetation locations and profile conditions provided the preliminary design basis for siting and design of the new structure as seen in Figure 4-5. A structure is required to attenuate the flow velocities and consolidate the four lines entering the 3rd Ave North pump station (Figure 4-4).

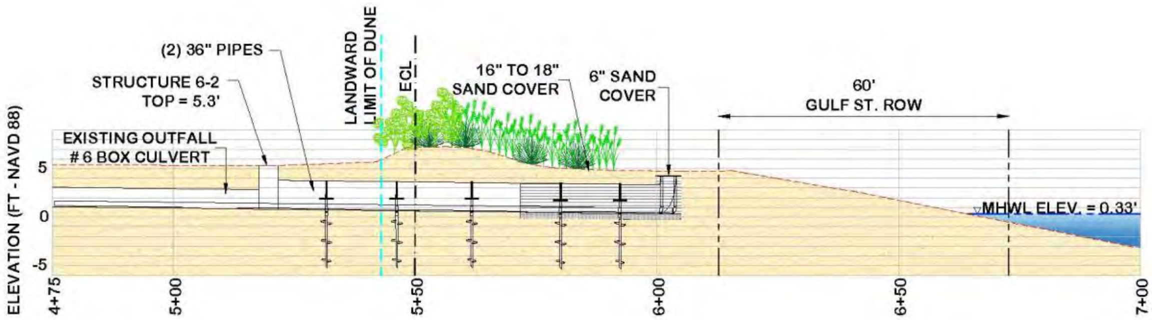


Figure 4-5. Overflow Structure Preliminary Design (Alternatives 1, 2 and 3)

<u>Pump Station Design</u>

Alternative 1 will require a single pump station capable of pumping 100 cfs located within the right-of-way at 3rd Avenue North. Table 4-7 lists the pump station basis of design utilized for the preliminary hydraulic analysis.

Table 4-7. Pump Station Basis of Design (Alternative 1)

Pump Station Location	3rd Avenue North
Consolidated Outfalls	3, 4, 5, 6, 7, 8
Design Flow	100.3 cfs
QTY of Pump	Four 175 Hp 24-Inch Diameter Mixed Flow Pumps with One Jockey Pump
Station Firm Capacity	45,018 gpm @ 35 ft TDH
Pump Station Footprint	25 ft x 35 ft
Number of Force Mains	Three 24-Inch Diameter Force Mains

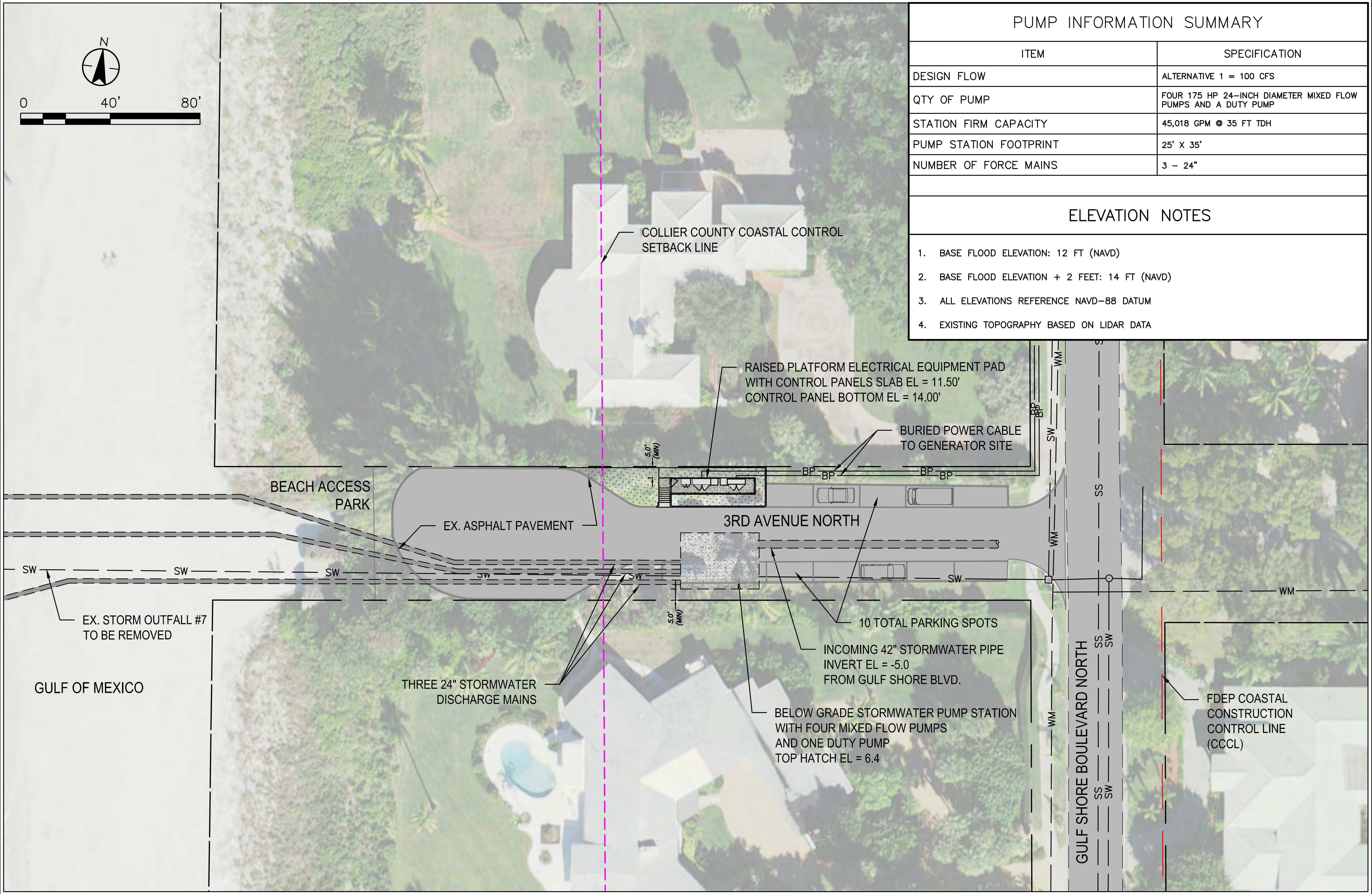
A preliminary site plan was developed for the proposed pump station (Figure 4-6). As with all alternatives presented herein, the purpose of the preliminary site plan is to determine if there is adequate land available and to identify the preliminary and budgetary cost estimate for the pump station component of each alternative. It is important to note that the development of each pump station site will require significant coordination with City staff, adjacent property owners and the community to adequately address the concerns of the community as well as City operations staff.

PUMP INFORMATION SUMMARY

ITEM	SPECIFICATION
DESIGN FLOW	ALTERNATIVE 1 = 100 CFS
QTY OF PUMP	FOUR 175 HP 24-INCH DIAMETER MIXED FLOW PUMPS AND A DUTY PUMP
STATION FIRM CAPACITY	45,018 GPM @ 35 FT TDH
PUMP STATION FOOTPRINT	25' X 35'
NUMBER OF FORCE MAINS	3 - 24"

ELEVATION NOTES

1. BASE FLOOD ELEVATION: 12 FT (NAVD)
2. BASE FLOOD ELEVATION + 2 FEET: 14 FT (NAVD)
3. ALL ELEVATIONS REFERENCE NAVD-88 DATUM
4. EXISTING TOPOGRAPHY BASED ON LIDAR DATA



Naples Beach Restoration & Water Quality Improvement Project

ALTERNATIVE 1 - THIRD AVENUE NORTH

Stantec
3200 Bailey Lane
Suite 200
Naples, FL 34105
(239) 263-6403

Erickson Consulting Engineers, Inc.
7201 Delainey Court
Sarasota, FL 32420
(941) 373-6460

FIG. 4-6

Z:\CADD_Graphics\US Projects\15-304_Naples Outfalls\Exhibits\Fig.4-6_PS-Third-Ave-North-SP_Alt1.dwg May 18, 2016-5:18pm

The layout is preliminary in nature and indicates that the construction of a pump station is feasible within the 3rd Avenue North ROW. The pump station includes the below grade wet well and valve vault with an above grade, elevated control panel structure with access stairs. The wet well and valve vault can be accessed through hatches that meet H20 loading requirements, which would allow for heavy duty loading (between 5,000 lbs and 7,499 lbs). The pump station is provided with Class 1 reliability so that the station can operate at design capacity with one of the pumps out of operation.

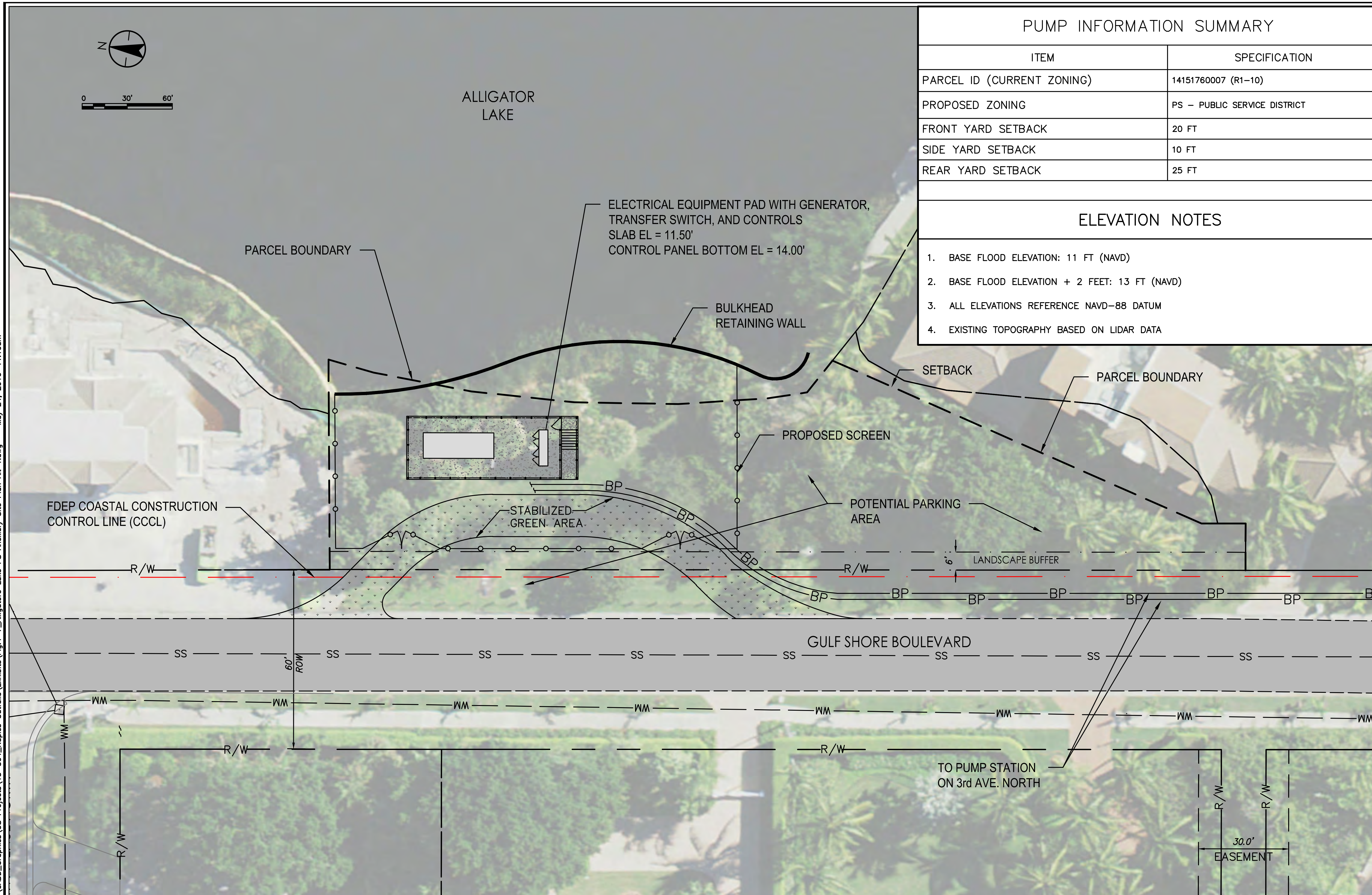
To maintain pedestrian beach access, the control panel and pump station are located 5 ft inside of the 3rd Avenue North ROW. The preliminary site plan is such that maintenance vehicles can easily access the pump and control panels. The preliminary layout minimizes impact to public parking and pedestrian and vehicular access is maintained; however, the available parking is reduced to 10 parking spaces. The adjacent properties have driveway access off of Gulf Shore Blvd North and do not have vehicular access off of 3rd Avenue North. Maintaining public access and parking will constrain the ease and flexibility of pump station operation and maintenance. This alternative requires modification of the 3rd Avenue North ROW to allow for vehicle turnaround. It is important for the City's operations staff to weigh in early on the design to identify the maintenance vehicle requirements and impact to public parking.

To provide a reliable system emergency generator, an automatic transfer switch will be located at the Alligator Lake site as illustrated in Figure 4-7. Table 4-8 summarizes the preliminary generator sizing based the generator being enclosed in a sound enclosure rated for 63 to 78 d(B)A at 21 ft from the source when the generator is at full load.

Table 4-8. Emergency Power Requirements (Alternative 1)

Emergency Power Requirements	650 kW
Generator Footprint with Sound Enclosure	8.5 ft x 23.5 ft
Sound Enclosure Rating	Level 2 Enclosure

The Alligator Lake site is adequately sized to construct the elevated generator structure and automatic transfer switch. Improvements to the site will likely require the construction of a bulkhead retaining wall along Alligator Lake. Geotechnical investigations and preliminary structural engineering will be required to determine additional site requirements, such as the bulkhead retaining wall. Access to the generator was designed to minimize impervious area and consists of a stabilized geoweb material. There is the potential to add 3-4 public parking spaces at this site.



PUMP INFORMATION SUMMARY

ITEM	SPECIFICATION
PARCEL ID (CURRENT ZONING)	14151760007 (R1–10)
PROPOSED ZONING	PS – PUBLIC SERVICE DISTRICT
FRONT YARD SETBACK	20 FT
SIDE YARD SETBACK	10 FT
REAR YARD SETBACK	25 FT

ELEVATION NOTES

1. BASE FLOOD ELEVATION: 11 FT (NAVD)
2. BASE FLOOD ELEVATION + 2 FEET: 13 FT (NAVD)
3. ALL ELEVATIONS REFERENCE NAVD–88 DATUM
4. EXISTING TOPOGRAPHY BASED ON LIDAR DATA

Naples Beach Restoration & Water Quality Improvement Project

ALTERNATIVE 1 - GENERATOR SITE

Stantec
3200 Bailey Lane
Suite 200
Naples, FL 34105
(239) 263-6403

Erickson Consulting Engineers, Inc.
7201 Delainey Court
Sarasota, FL 34240
(941) 373-6460

FIG. 4-7

Offshore HDD Pipeline and Diffuser System

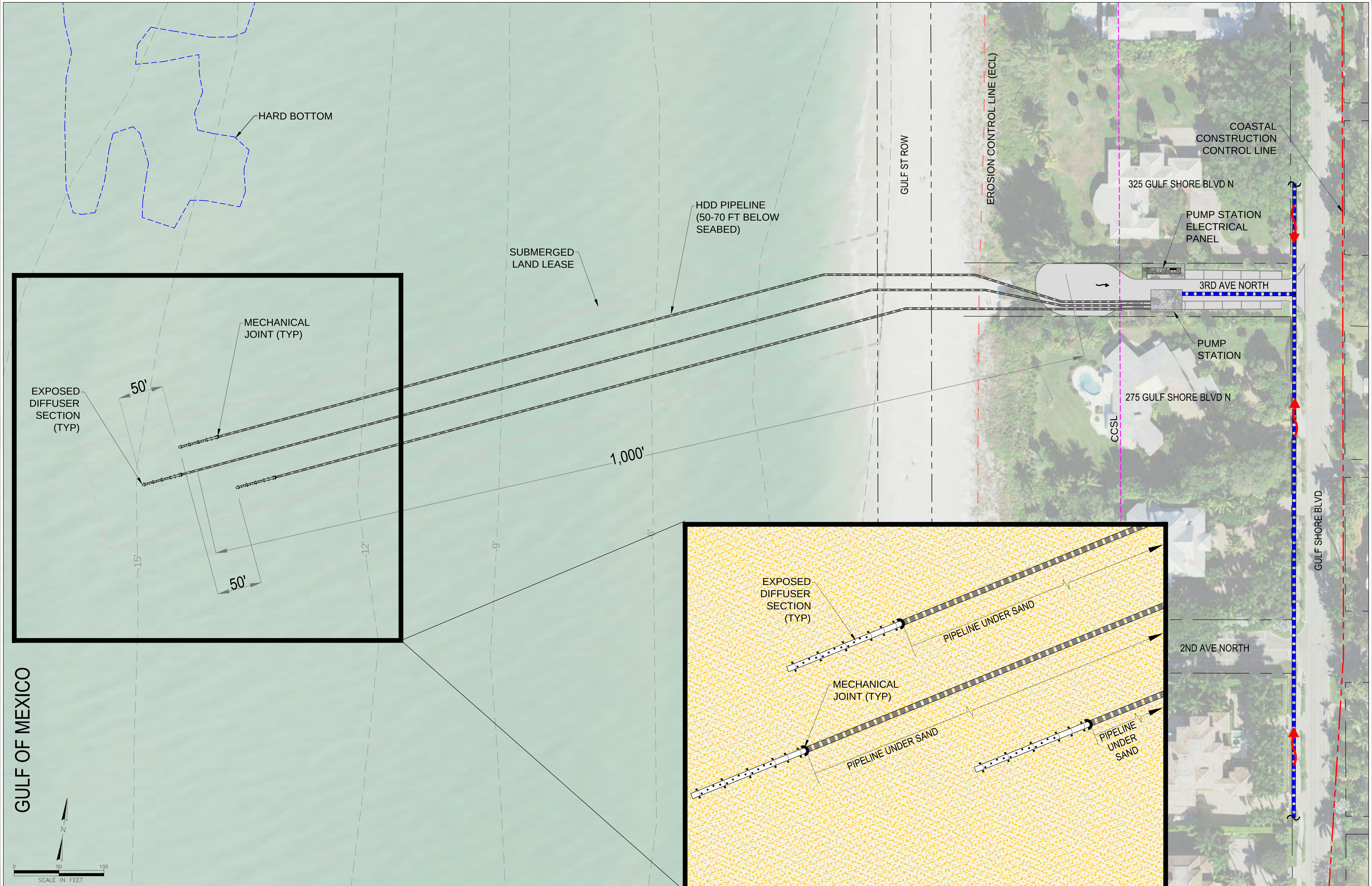
As described above, the pump station associated with Alternative 1 is located at 3rd Avenue North. Total peak system capacity requires three (3) 24 in stormwater discharge lines exiting the pump station to convey the water offshore at a discharge rate of 100 cfs via a horizontal directional drill (HDD) pipeline. The HDD line commences at a point landward of the dune, and requires a total length of approximately 1,000 ft to emerge at the -14 to -16 ft (NAVD 88) depth contour. The pipeline alignment is designed to minimize the pipeline length needed to maintain a 350 ft to 500 ft buffer from the diffuser system to the "3rd Avenue N. Mitigation Reef" hardbottom. The HDD emergence and diffuser system for the three pipelines are staggered to minimize the buffer necessary for freshwater discharge to diffuse and mix to background salinity (Figure 4-8).

As described in Section 3, design requirements for the offshore diffuser structure include the pipeline type and size, flow rate, diffuser size, pipe slope for emergence, mechanical joints, resilience for operations and maintenance and anchoring. For each of the alternatives, a 24-inch FPVC™ pipeline was identified for preliminary design. For Alternative 1, the diffuser design options are listed in Table 4-9. Based on an economies of scale, the optimal diffuser size is approximately 8 to 10 inches in diameter.

Table 4-9. Diffuser Design for 100 cfs Pump Station

Diffuser Dia (in)	Total Number of Diffusers[1]	Total Number of Diffusers/Pipeline[2]
8	30	10
10	20	7

Notes: The *options above provide the diffuser configuration required to meet a discharge mixing velocity of approximately 8-10 fps[1]; three discharge pipelines (Alternative 1)[2]*



Z:\CADD_Graphics\US Projects\15-304_Naples Outfalls\Exhibits\FIG 4.8-Discharge_3rd Ave.dwg May 19, 2016-9:31am

DESIGNED	DRAWN	CHECKED
BC	JC	KE

DATE: 04-29-2016
JOB NO. 15-304
SCALE: AS NOTED

NAPLES BEACH RESTORATION & WATER QUALITY IMPROVEMENT PROJECT

SITING & ALIGNMENT OF NEARSHORE PIPELINE & DIFFUSER WITH PUMP STATION AT 3RD AVE NORTH

Erickson Consulting Engineers, Inc.
7201 Delainey Court
Sarasota, FL 32420
(941) 373-6460

FIG. 4-8

4.2.2 *Alternative 2*

<u>LOS and Pipeline Consolidation Design</u>

As described in Section 4.1 above, Alternative 2 includes a North System and South System with two pump stations (one for each system).

The Alternative 2 “North System” consolidates the existing stormwater flow associated with Outfalls 2 (City contribution), 3, 4, and 5 (from the north) and conveys the flow to a pump station located at 6th Avenue North with water quality treatment and HDD placed discharge pipelines to a Gulf diffuser system.

The Alternative 2 “South System” consolidates the existing stormwater flow associated with Outfalls 6, 7, 8, 9 and 10 (from the south) and conveys the existing flow to a second pump station located at 3rd Avenue North with water quality treatment and HDD placed discharge pipelines to a Gulf diffuser system. To convey flow associated with low frequency rainfall events, an overflow line will be located below the visible beach and open only during extreme storm events. An evaluation of prior beach conditions and minimum widths over the last 25 years and the present dune and vegetation locations and profile conditions provide the design basis for siting and design of the new structure.

Analysis of the pipe size, configuration, elevations and type were based on the Manning’s equation to evaluate consolidation design options for the feeder line and the main trunk line, assuming the peak flow rates given in Table 4-9. The required peak discharge (LOS) of 62 cfs (north system) and 166 cfs (south system) is based on the cumulative flow from a 25-Yr return period rainfall event.

The primary site conditions affecting the pipeline design for Alternative 2 were the low elevation of Gulf Shore Blvd and the adjacent ROW as well as the cumulative capacity required to convey the peak flow for a 25-Yr event. A schematic of the consolidation plan is shown below in Figures 4-8 (north system) and 4-9 (south system). Table 4-10 describes the key design elements of the consolidation plan. The ROW grade elevations at the north end of the main trunk line ranged from 4.8 to 5.0 ft decreasing to 4.2 to 4.5 ft near 6th Ave North. The design line sizes will convey flow for the 25-Yr LOS.

Table 4-9. Peak Flow Collection System Design for 25-Yr LOS (Alternative 2)

Conveyance Direction	Outfall	Outfall Description	Quantity: Peak Flow for the 5-Yr/1-Day Event (cfs)	Quantity: Peak Flow for the 25-Yr/3-Day Event (cfs)	Collection System Flow (Peak cfs)	Cumulative Collection System Flow (Peak cfs)	Pump Station Flow Discharged to Gulf (Peak cfs)	System Overflow Flow Discharged to Gulf (Peak cfs)
Alternative 2 - North System								
To Ex. Outfall 2	2	Naples Beach Hotel and Golf Club	5.7	17.1				
	TOTAL - TO EX OUTFALL 2		**5.7**	**17.1**				
To Pump Station	2	Naples Beach Hotel and Golf Club (City)	8.5	28.4	28.4	28.4		
	3	8th Avenue North	8.5	12.9	12.9	41.3		
	4	7th Avenue North	8.0	12.4	12.4	53.6		
	Sub-Total (2-4)		*25.1*	*53.6*	*53.6*			
Pump Station						61.9	61.9	0.0
To Pump Stn	5	6th Avenue North	5.1	8.2	8.2	8.2		
	Sub-Total (5)		*5.1*	*8.2*	*8.2*			
TOTAL - ALT 2 NORTH			**30.1**	**61.9**	**61.9**	**61.9**	**61.9**	**0.0**
Alternative 2 - South System								
To Pump Station	6	Near Alligator Lake	34.2	76.1	76.1	76.1		
	7	3rd Avenue North	16.4	24.1	24.1	100.2		
	Sub-Total (6-7)		*50.6*	*100.2*	*100.2*			
Pump Station						165.7	89.7	76.1
To Pump Station	8	2nd Avenue North	28.1	42.6	42.6	65.6		
	9	1st Avenue South	8.0	11.2	11.2	23.0		
	10	2nd Avenue South	8.1	11.8	11.8	11.8		
	Sub-Total (8-10)		*44.2*	*65.6*	*65.6*			
TOTAL - ALT 2 SOUTH			**94.8**	**165.7**	**165.7**	**165.7**	**89.7**	**76.1**
TOTAL - ALT 2 NORTH AND SOUTH			**124.9**	**227.6**	**165.7**	**227.6**	**151.5**	**76.1**
TOTAL PEAK RUNOFF (Outfalls 2-10)			**130.5**	**244.7**				

Note: all values are peak flow rates (cfs)

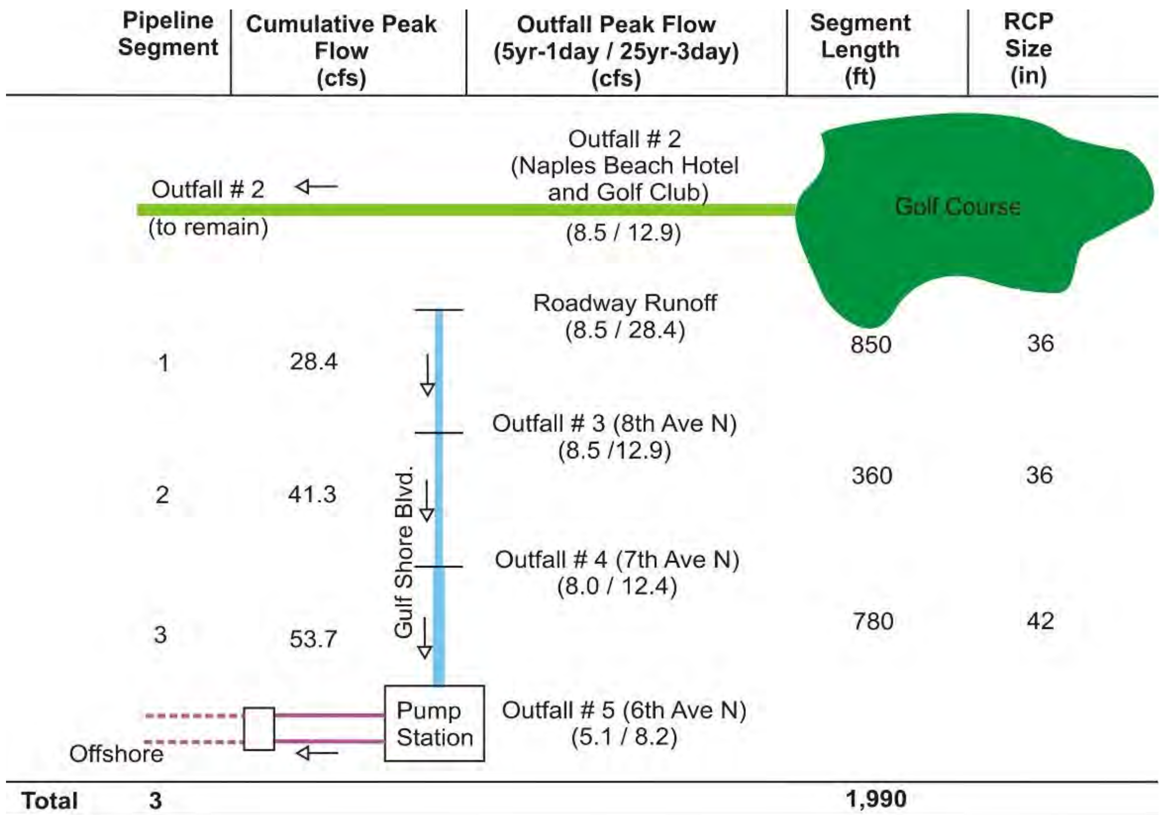


Figure 4-9. Schematic Pipeline Consolidation Plan (Alternative 2: North System)

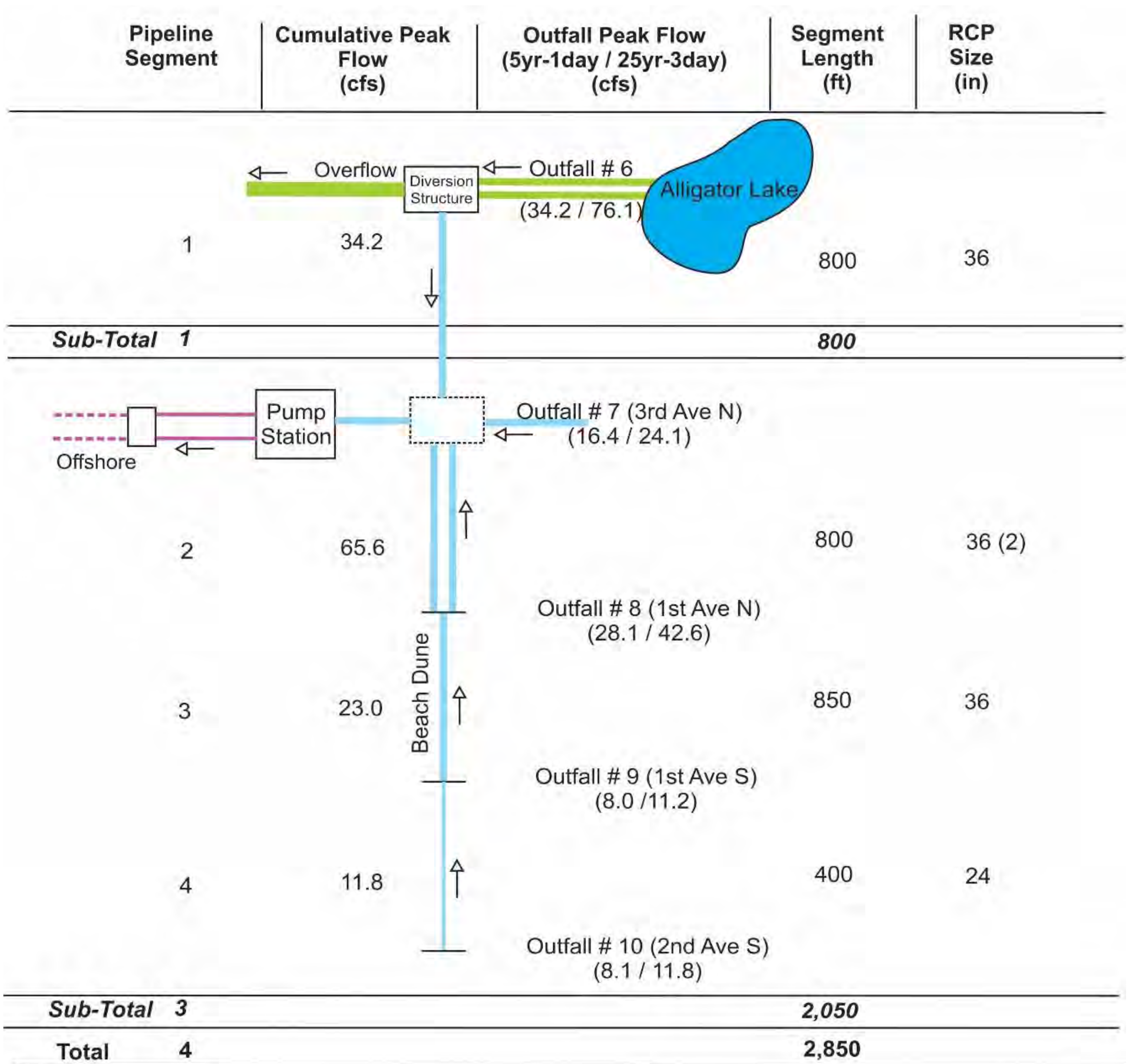


Figure 4-10. Schematic Pipeline Consolidation Plan (Alternative 2: South System)

Table 4-10. Main Trunk Line Elements Consolidation Plan (Alternative 2)

Alternative 2 (North System)							
Conveyance Direction	**Outfall Collection**	**Segment Description**	**Peak Flow 25-Yr/3-Day Event (cfs)**	**Pipe Diameter (in)**	**Number of Pipes**	**Approx Length of Pipe (ft)**	**Maximum Peak Flow for Pipe System (cfs)**
	2 to 3[6]	Beach Club - Gulf Shore Blvd to 8th Ave N - Gulf Shore Blvd	28.4	36	1	850	29.0
	3 to 4	8th Ave N - Gulf Shore Blvd to 7th Ave N - Gulf Shore Blvd	41.3	36	1	360	42.2
	4 to 5	7th Ave N - Gulf Shore Blvd to 6th Ave N - Gulf Shore Blvd	53.7	42	1	780	54.0
PUMP STATION		**6th Ave N (current location of Outfall 5)**	**61.9**	**48.0**	**1**	**150**	**66.4**

Alternative 2 (South System)							
Conveyance Direction	**Outfall Collection**	**Segment Description**	**Peak Flow 25-Yr/3-Day Event (cfs)**	**Pipe Diameter (in)**	**Number of Pipes**	**Approx Length of Pipe (ft)**	**Maximum Peak Flow for Pipe System (cfs)**
	6 to 7[7]	Alligator Lake Control Structure to 3rd Ave N - Gulf Shore Blvd	76.1 34.2 (5-Yr/ 1-Day)	36	1	800	38.9
PUMP STATION		**3rd Ave N (current location of Outfall 7)**	**94.8 To Pump Station** **71.0 To Over-Flow** **165.8 Total**	**36**	**1**	**100**	**96.3**
	8 to 7	1st Ave N - Gulf Shore Blvd to 3rd Ave N - Gulf Shore Blvd	65.6	36	2	800	68.1
	9 to 8	1st Ave S - Gulf Shore Blvd to 1st Ave N - Gulf Shore Blvd	23.0	36	1	850	27.5
	10 to 9	2nd Ave S - Beach Dune to 1st Ave S - Beach Dune	11.8	24	1	400	12.0

For the north system, maintenance and operational responsibility of Outfall 2 would be assigned to the Naples Hotel and Golf Club. The City's street contribution to Outfall 2 is routed to the north system trunk line and conveyed to the north system pump station at 6^{th} Ave N.

For the south system, the pipelines are consolidated between 6^{th} Ave North and the pump station with feeder lines connecting to the main trunk line. The diameter of the main trunk line would increase to 42 in between 7^{th} Ave North and the pump station.

For the south system, as designed for Alternative 1, a new diversion box structure will be constructed to divert flow during extreme low frequency storm events, which exceed the capacity of the pump station, to the system overflow located at Outfall 6 (Figure 4-5).

An alternative pipeline route was evaluated to convey the south system flow from Outfalls 10, 9 and 8 to the pump station at 3rd Avenue North (at Outfall 7) which consolidated the pipeline in the back-beach below the elevation of the present seaward edge of dune vegetation. This alternative route would reduce construction costs associated with a new trunk line placement along Gulf Shore Blvd. The back-beach consolidated pipeline is sited to provide a minimum 3 ft sand cover over the top of pipe. The consolidation plan along the back-beach is described in Table 4-11.

Table 4-11. Main Trunk Line Elements Consolidation Plan (Alternative 2: South System Consolidation along Back-Beach)

Conveyance Direction	Outfall Collection	Segment Description	Peak Flow for the 25-Yr/3-Day Event (cfs)	Pipe Diameter (in)	Number of Pipes	Approx Length of Pipe (ft)	Maximum Peak Flow for Pipe System (cfs)
Down-stream	6 to 7	Alligator Lake Control Structure to 3rd Ave N - Gulf Shore Blvd	76.1 34.2 (5-Yr/ 1-Day)	36	1	800	46.3
PUMP STATION		**3rd Ave N (current location of Outfall 7)**	**165.7** **98.6 (5-Yr/ 1-Day)**	**48**	**1**	**350**	**102.0**
Down-stream	8 to 7	1st Ave N - Beach Dune to 3rd Ave N - Beach Dune	65.6	48	1	800	67.4
	9 to 8	1st Ave S - Beach Dune to 1st Ave N - Beach Dune	23.0	36	1	850	29.0
Up-stream	10 to 9	2nd Ave S - Beach Dune to 1st Ave S - Beach Dune	11.8	24	1	500	12.8

Pump Station Design

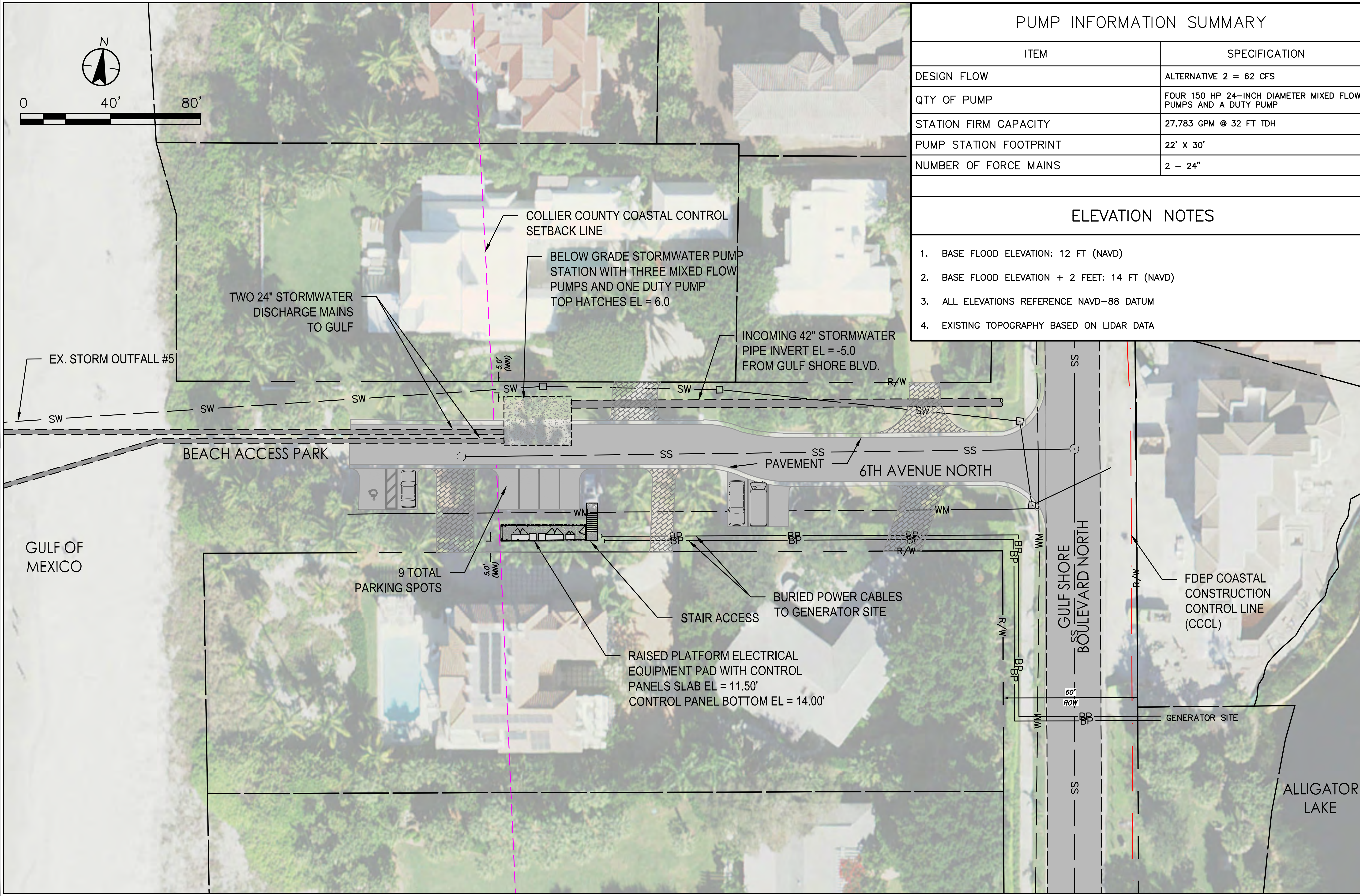
Alternative 2 will require the construction of two pump stations. Table 4-12 lists the preliminary basis of design for each pump station utilized for the preliminary hydraulic analysis.

Table 4-12. Pump Station Basis of Design (Alternative 2)

Pump Station Location	3rd Ave North	6th Ave North
Consolidated Outfalls	6, 7, 8, 9, 10	2, 3, 4, 5
Design Flow	94.8 cfs	61.9 cfs
QTY of Pump	Four 200 HP 24-Inch Diameter Mixed Flow Pumps with One Jockey Pump	Three 150 HP 24-Inch Diameter Mixed Flow Pumps with One Jockey Pump
Station Firm Capacity	42,549 gpm @ 45 ft TDH	27,783 gpm @ 32 ft TDH
Pump Station Footprint	25 ft x 35 ft	22 ft x 30 ft
Number of Force Mains	Two 24-Inch Dia. Force Mains	Two 24-Inch Dia. Force Mains

The Alternative 2 preliminary site plans were developed for the proposed pump stations as shown in Figure 4-11 and Figure 4-10. The pump station layout at the 3rd Avenue North site is similar to the layout presented in Alternative 1; however, the pump station only requires two discharge force mains. In addition, the generators and ancillary equipment at the Alligator Lake site serve both pump stations for Alternative 2 thereby requiring a larger footprint than that required for Alternative 1 (Figure 4-13).

A preliminary site plan was developed for the pump station located at 6th Ave North. This pump station includes the below grade wet well and valve vault with an above grade and elevated control panel structure with access stairs. The wet well and valve vault can be accessed through hatches that meet H20 loading requirements, which would allow for heavy duty loading (between 5,000 lbs and 7,499 lbs). The pump station is provided with Class 1 reliability so that the station can operate at design capacity with one of the pumps out of operation.



PUMP INFORMATION SUMMARY

ITEM	SPECIFICATION
DESIGN FLOW	ALTERNATIVE 2 = 62 CFS
QTY OF PUMP	FOUR 150 HP 24-INCH DIAMETER MIXED FLOW PUMPS AND A DUTY PUMP
STATION FIRM CAPACITY	27,783 GPM @ 32 FT TDH
PUMP STATION FOOTPRINT	22' X 30'
NUMBER OF FORCE MAINS	2 - 24"

ELEVATION NOTES

1. BASE FLOOD ELEVATION: 12 FT (NAVD)
2. BASE FLOOD ELEVATION + 2 FEET: 14 FT (NAVD)
3. ALL ELEVATIONS REFERENCE NAVD-88 DATUM
4. EXISTING TOPOGRAPHY BASED ON LIDAR DATA

Naples Beach Restoration & Water Quality Improvement Project

ALTERNATIVE 2 - SIXTH AVENUE NORTH (NORTH SYSTEM PUMP STATION)

Stantec
3200 Bailey Lane
Suite 200
Naples, FL 34105
(239) 263-6403

Erickson Consulting Engineers, Inc.
7201 Delainey Court
Sarasota, FL 32420
(941) 373-6460

FIG. 4-11

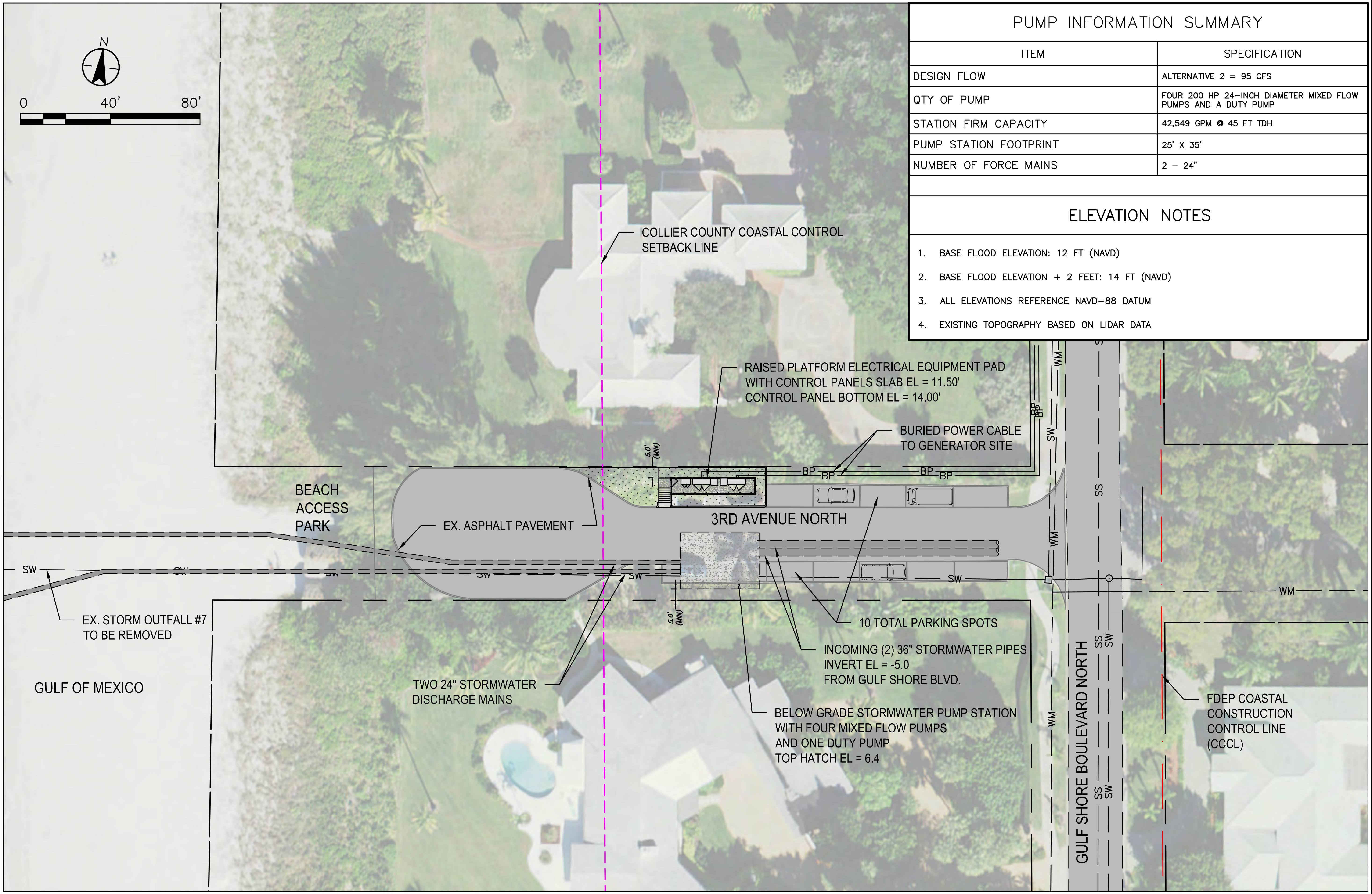
Z:\CADD_Graphics\US Projects\15-304_Naples Outfalls\Exhibits\Fig.4-11_PS-SP_Alt2.dwg May 19, 2016-4:58pm

PUMP INFORMATION SUMMARY

ITEM	SPECIFICATION
DESIGN FLOW	ALTERNATIVE 2 = 95 CFS
QTY OF PUMP	FOUR 200 HP 24–INCH DIAMETER MIXED FLOW PUMPS AND A DUTY PUMP
STATION FIRM CAPACITY	42,549 GPM @ 45 FT TDH
PUMP STATION FOOTPRINT	25' X 35'
NUMBER OF FORCE MAINS	2 – 24"

ELEVATION NOTES

1. BASE FLOOD ELEVATION: 12 FT (NAVD)
2. BASE FLOOD ELEVATION + 2 FEET: 14 FT (NAVD)
3. ALL ELEVATIONS REFERENCE NAVD–88 DATUM
4. EXISTING TOPOGRAPHY BASED ON LIDAR DATA



Z:\CADD_Graphics\US Projects\15-304_Naples Outfalls\Exhibits\Fig.4-12_PS-Third-Ave-North-SP_Alt2.dwg May 19, 2016-4:55pm

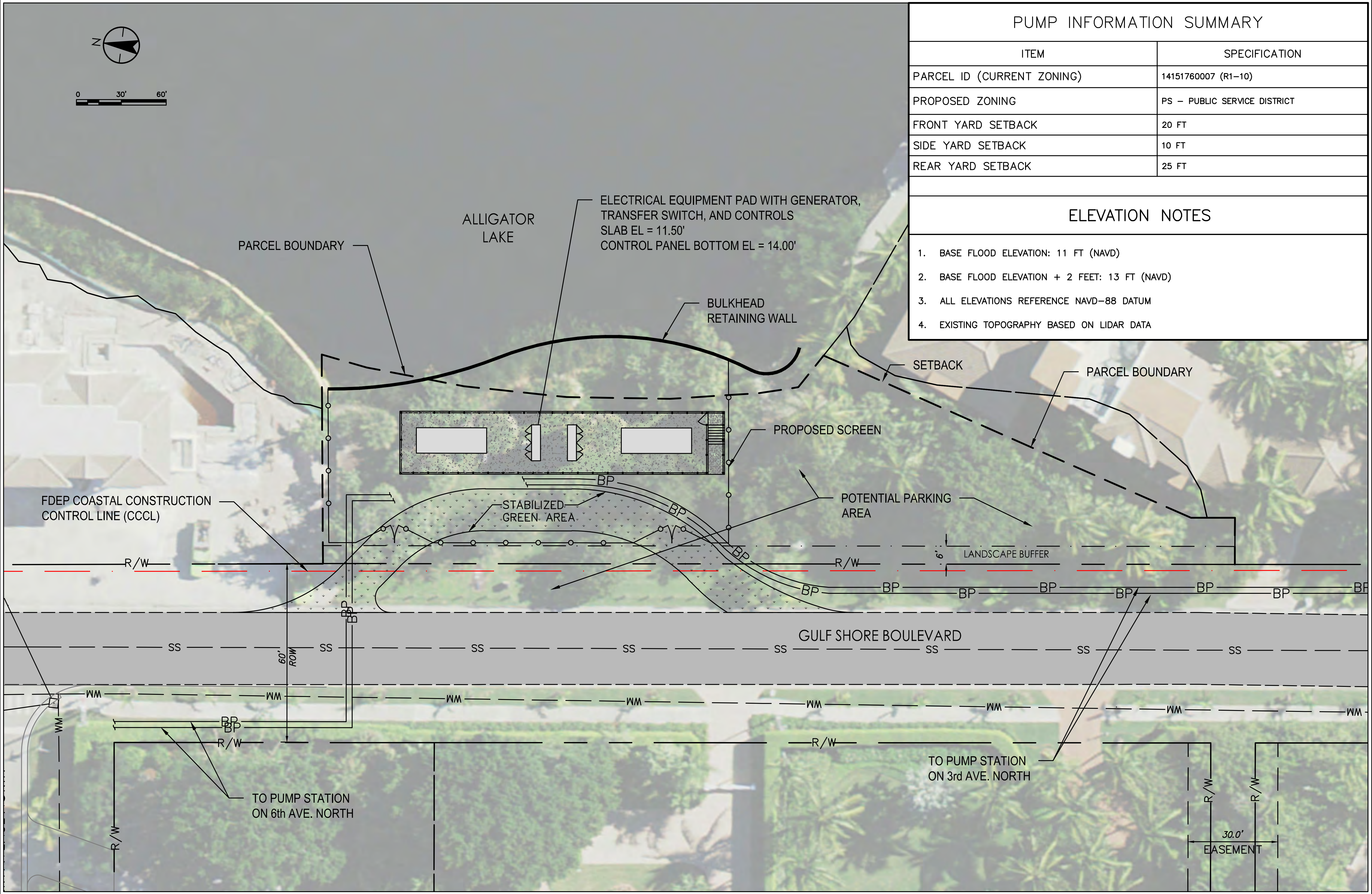
Naples Beach Restoration & Water Quality Improvement Project

ALTERNATIVE 2 - THIRD AVENUE NORTH (SOUTH SYSTEM PUMP STATION)

Stantec
3200 Bailey Lane
Suite 200
Naples, FL 34105
(239) 263-6403

Erickson Consulting Engineers, Inc.
7201 Delainey Court
Sarasota, FL 32420
(941) 373-6460

FIG. 4-12



PUMP INFORMATION SUMMARY

ITEM	SPECIFICATION
PARCEL ID (CURRENT ZONING)	14151760007 (R1–10)
PROPOSED ZONING	PS – PUBLIC SERVICE DISTRICT
FRONT YARD SETBACK	20 FT
SIDE YARD SETBACK	10 FT
REAR YARD SETBACK	25 FT

ELEVATION NOTES

1. BASE FLOOD ELEVATION: 11 FT (NAVD)
2. BASE FLOOD ELEVATION + 2 FEET: 13 FT (NAVD)
3. ALL ELEVATIONS REFERENCE NAVD–88 DATUM
4. EXISTING TOPOGRAPHY BASED ON LIDAR DATA

Naples Beach Restoration & Water Quality Improvement Project

ALTERNATIVE 2 - GENERATOR SITE

Stantec
Stantec
3200 Bailey Lane
Suite 200
Naples, FL 34105
(239) 263–6403

Erickson Consulting Engineers, Inc.
ECE Erickson Consulting Engineers
7201 Delainey Court
Sarasota, FL 32420
(941) 373–6460

FIG. 4-13

To maintain pedestrian beach access, the control panel and pump station were located 5 ft within the 6th Avenue North ROW. The site plan is such that maintenance vehicles can easily access the pump and control panels. This preliminary layout minimizes impact to public parking and pedestrian and vehicular access is maintained; however, the available parking was reduced to 4 parking spaces and 1 handicap space. There are four (4) residential properties adjacent to the ROW with driveway access from 6th Ave North. The pump station was sited to minimize the impact to the driveway access once the system is on-line; however, these properties will be inconvenienced during construction activities. Maintaining public access and parking will constrain the ease and flexibility of pump station operation and maintenance. It is important for the City's operations staff to weigh in early on the design to identify the maintenance vehicle requirements and impact to public parking.

To provide a reliable system, an emergency generator will be required for each pump station. Two emergency generators and automotive transfer switches will be located at the Alligator Lake site as illustrated in Figure 4-7. Table 4-13 lists the preliminary generator sizing based the generator being enclosed in a sound enclosure rated for 63 to 78 d(B)A at 21 ft from the source when the generator is at full load.

Table 4-13. Emergency Power Requirements (Alternative 2)

Pump Station Location	3rd Ave North	6th Ave North
Emergency Power Requirements	650 kW	350 kW
Generator Footprint with Sound Enclosure	8.5 ft x 23.5 ft	5.8 ft x 23.5 ft
Sound Enclosure Rating	Level 2 Enclosure	Level 2 Enclosure

<u>Offshore HDD Pipeline and Diffuser System</u>

As described above, two pump stations are required for Alternative 2, located at 6th Avenue North for the north system and 3rd Avenue North for the south system. For each location, total peak capacity requires two (2) 24 in stormwater discharge lines exiting the pump station to convey water offshore at a discharge rate of 62 cfs (north system) and 95 cfs (south system) via a HDD pipeline.

At 6th Avenue North (north system), the HDD line may require a total length of approximately 1,700 ft to emerge at the -16 to -17 ft (NAVD 88) depth contour (Figure 4-14). As with the other locations, the pipeline alignment is designed to minimize the pipeline length needed to maintain a 350 ft to 500 ft buffer from the diffuser system to the hardbottom feature(s). For Alternative 2 "North System," the diffuser design is described in Table 4-14. Based on an economies of scale, the optimal diffuser size is approximately 8 to 10 inches in diameter.

Table 4-14. Diffuser Design for 62 cfs Pump Station

Diffuser Dia (in)	Total Number of Diffusers[1]	Total Number of Diffusers/Pipeline[2]
8	20	10
10	15	8

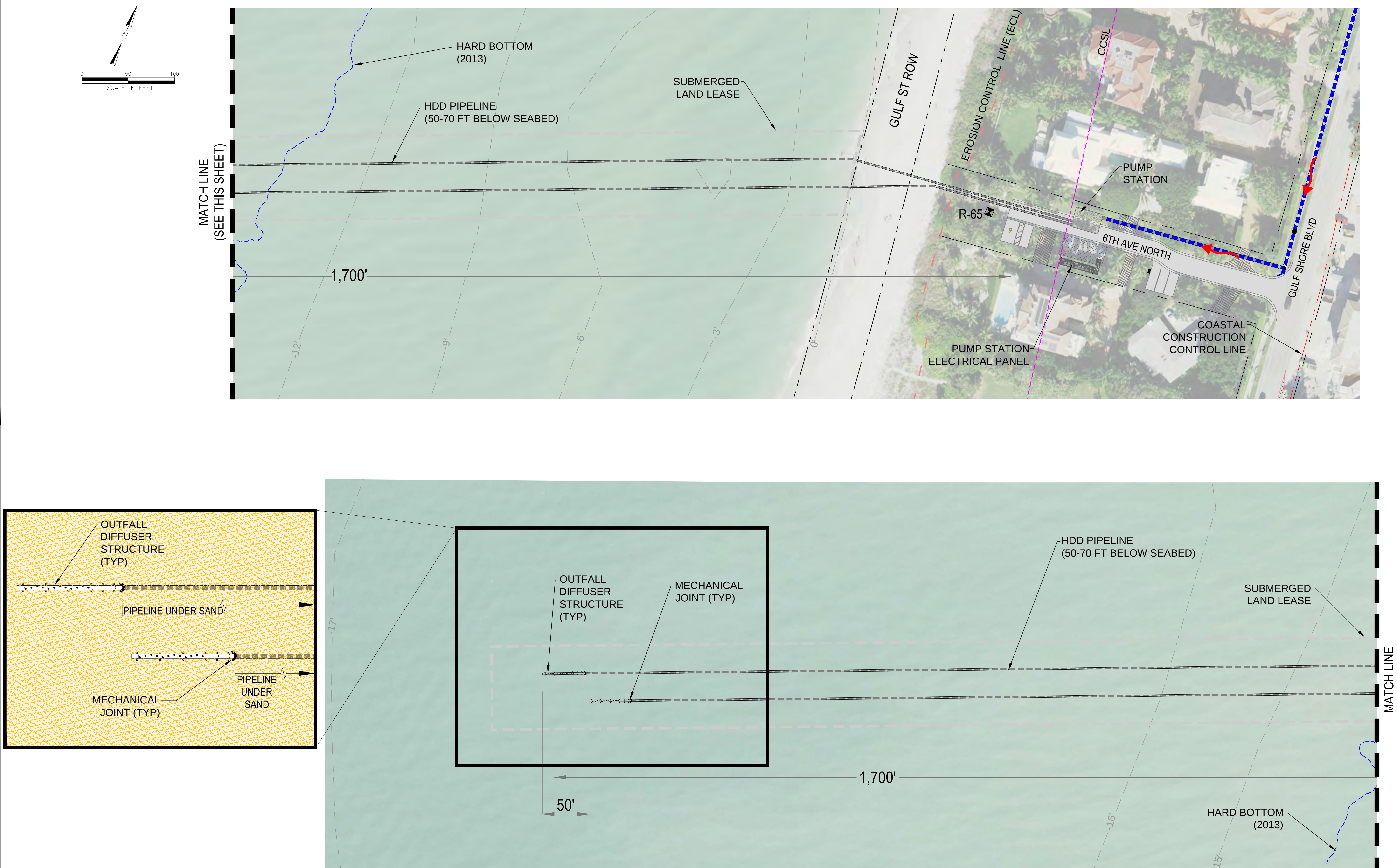
Notes: The *options above provide the diffuser configuration required to meet a discharge mixing velocity of approximately 8-10 fps*[1]*; two discharge pipelines (Alternative 2 North System)*[2]

At 3rd Avenue North (south system), the HDD line, emergence and diffuser system are identical to Alternative 1, expect this configuration requires only two pipelines (Figure 4-15). For Alternative 2 "South System," the diffuser design is described in Table 4-15. Based on an economies of scale, the optimal diffuser size is approximately 8 to 10 inches in diameter.

Table 4-15. Diffuser Design for 95 cfs Pump Station

Diffuser Dia (in)	Total Number of Diffusers[1]	Total Number of Diffusers/Pipeline[2]
8	30	15
10	20	10

Notes: The *options above provide the diffuser configuration required to meet a discharge mixing velocity of approximately 8-10 fps*[1]*; two discharge pipelines for (Alternatives 2 and 3 South System)*[2]



Z:\CADD_Graphics\US Projects\15-304_Naples Outfalls\Exhibits\FIG 4.14-Discharge_6th Ave.dwg May 19, 2016-9:52am

DESIGNED	DRAWN	CHECKED
BC	JC	KE

DATE: 04-29-2016

JOB NO. 15-304

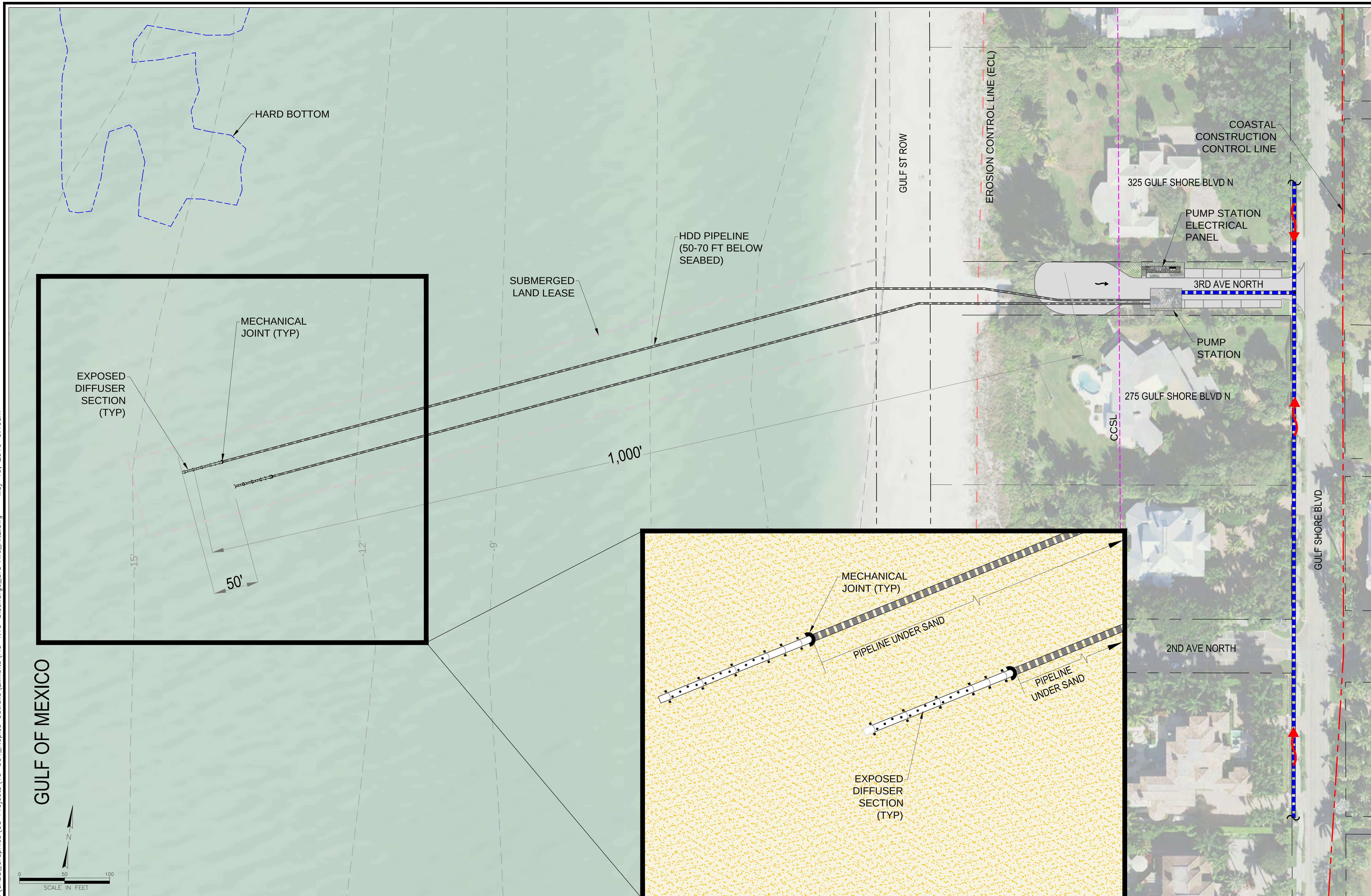
SCALE: AS NOTED

NAPLES BEACH RESTORATION &
WATER QUALITY IMPROVEMENT PROJECT

SITING & ALIGNMENT OF NEARSHORE PIPELINE &
DIFFUSER WITH PUMP STATION AT 6TH AVE NORTH

Erickson Consulting Engineers, Inc.
7201 Delainey Court
Sarasota, FL 32420
(941) 373-6460

FIG. 4-14



Z:\CADD_Graphics\US Projects\15-304_Naples Outfalls\Exhibits\FIG 4.15-Discharge_3rd Ave_Alt2.dwg May 19, 2016-9:10am

DESIGNED BC | DRAWN JC | CHECKED KE

DATE: 04-29-2016

JOB NO. 15-304

SCALE: AS NOTED

NAPLES BEACH RESTORATION & WATER QUALITY IMPROVEMENT PROJECT

SITING & ALIGNMENT OF NEARSHORE PIPELINE & DIFFUSER WITH PUMP STATION AT 3RD AVE NORTH

Erickson Consulting Engineers, Inc.
7201 Delainey Court
Sarasota, FL 32420
(941) 373-6460

FIG. 4-15

4.2.3 Alternative 3

<u>LOS and Pipeline Consolidation Design</u>

As described above, Alternative 3 includes a North System and South System with two pump stations (one for each system).

The Alternative 3 "North System" consolidates the existing stormwater flow associated with Outfalls 2, 3, 4, and 5 (from the north) and conveys the flow to a pump station located in the vicinity of the Naples Beach Hotel and Golf Club with water quality treatment and HDD placed discharge pipelines to a Gulf diffuser system. The existing, large stormwater line at Outfall 2 will be removed and peak discharge from the Naples Beach Hotel and Golf Club will be routed to the City's new pump station and treatment system.

The Alternative 3 "South System" is identical to the stormwater improvement system described above for Alternative 2 with the exception of Outfall 5 which is routed to Alligator Lake. This Alternative consolidates the existing stormwater flow associated with Outfalls 5, 6, 7, 8, 9 and 10 and conveys the flow to a pump station located at 3rd Avenue North with water quality treatment and HDD placed discharge pipelines to an offshore diffuser system. Outfall 5 is consolidated with the "South System" by routing the flow through the existing lake system. To convey flow associated with low frequency rainfall events, an overflow line will be located below the visible beach at Outfall 6 and open only during extreme storm events.

Analysis of the pipe size, configuration, elevations and type was based on the Manning's equation to evaluate consolidation design options for the feeder line and the main trunk line, assuming the peak flow rates given in Table 4-16 below. The required peak discharge (LOS) of 79 cfs (north system) is based on the cumulative flow from a 25-Yr return period rainfall event.

The primary site conditions that affect the pipeline design were the low elevation of Gulf Shore Blvd and the adjacent ROW as well as the cumulative capacity required to convey the peak flow for a 25-Yr event. A schematic of the consolidation plan is shown in Figure 4-16, where the pipeline is consolidated near the Naples Beach Hotel and Golf Club (Outfall 2). The ROW grade elevations at the south end of the main trunk line range from 4.3 ft to 5.5 ft near the approximate pump station location. The diameter of the main trunk line increases to 42 inches, maintaining a single line between 6th Ave North and the Naples Beach Hotel and Golf Club. Table 4-17 describes the key design elements of the consolidation plan for Alternative 3 north system.

Table 4-16. Peak Flow Collection System Design for 25-Yr LOS (Alternative 3)

Conveyance Direction	Outfall	Outfall Description	Quantity: Peak Flow for the 5-Yr/1-Day Event (cfs)	Quantity: Peak Flow for the 25-Yr/3-Day Event (cfs)	Collection System Flow (Peak cfs)	Cumulative Collection System Flow (Peak cfs)	Pump Station Flow Discharged to Gulf (Peak cfs)	System Overflow Flow Discharged to Gulf (Peak cfs)
Alternative 3 - North System								
	2	Naples Beach Hotel and Golf Club	14.2	45.5	45.5	45.5		
	3	8th Avenue North	8.5	12.9	12.9	58.4		
	4	7th Avenue North	8.0	12.4	12.4	70.7		
		Sub-Total (2-4)	*30.7*	*70.7*	*70.7*			
Pump Station						70.7	70.7	0.0
TOTAL - ALT 2 NORTH			**30.7**	**70.7**	**70.7**	**70.7**	**70.7**	**0.0**
	5	6th Avenue North	5.1	8.2	8.2	8.2	5.1	3.2
		Sub-Total (5)	*5.1*	*8.2*	*8.2*			
TOTAL - TO ALLIGATOR LAKE			**5.1**	**8.2**	**8.2**	**8.2**		
Alternative 3 - South System								
To Pump Station	6	Near Alligator Lake	34.2	76.1	76.1	76.1		
	7	3rd Avenue North	16.4	24.1	24.1	100.2		
		Sub-Total (6-7)	*50.6*	*100.2*	*100.2*			
Pump Station						165.7	89.7	76.1
To Pump Station	8	2nd Avenue North	28.1	42.6	42.6	65.6		
	9	1st Avenue South	8.0	11.2	11.2	23.0		
	10	2nd Avenue South	8.1	11.8	11.8	11.8		
		Sub-Total (8-10)	*44.2*	*65.6*	*65.6*			
TOTAL - ALT 3 SOUTH			**94.8**	**165.7**	**165.7**	**165.7**	**89.7**	**76.1**
TOTAL - ALT 3 NORTH, SOUTH, AND ALLIGATOR LAKE			**130.5**	**244.7**	**244.7**	**244.7**	**160.4**	**76.1**

Note: all values are peak flow rates (cfs)

Table 4-17. Main Trunk Line Design Elements Consolidation Plan (Alternative 3)

Alternative 3 (NORTH SYSTEM)							
Conveyance Direction	**Outfall Collection**	**Segment Description**	**Peak Flow 25-Yr/3-Day Event (cfs)**	**Pipe Diameter (in)**	**Number of Pipes**	**Approx Length of Pipe (ft)**	**Maximum Peak Flow for Pipe System (cfs)**
PUMP STATION		**Naples Beach Hotel & Golf Club (current location of Outfall 2)**	**78.9**	**36**	**2**	**360**	**79.6**
↑	3 to 2	8th Ave N - Gulf Shore Blvd to Beach Club - Gulf Shore Blvd	33.5	42	1	850	36.6
	4 to 3	7th Ave N - Gulf Shore Blvd to 8th Ave N - Gulf Shore Blvd	20.6	30	1	360	21.2

Alternative 3 (South System) - Gulf Shore Blvd Alignment							
Conveyance Direction	**Outfall Collection**	**Segment Description**	**Peak Flow 25-Yr/3-Day Event (cfs)**	**Pipe Diameter (in)**	**Number of Pipes**	**Approx Length of Pipe (ft)**	**Maximum Peak Flow for Pipe System (cfs)**
↓	5 to Alligator Lake	6th Ave N - Gulf Shore Blvd to Alligator Lake	8.2	18	1	230	10.7
Alligator Lake			**8.2**				
↓	6 to 7	Alligator Lake Control Structure to 3rd Ave N - Gulf Shore Blvd	76.1 34.2 (5-Yr/ 1-Day)	36	1	800	38.9
PUMP STATION		**3rd Ave N (current location of Outfall 7)**	**94.8 To Pump Station** **71.0 To Over-Flow** **165.8 Total**	**36**	**1**	**100**	**96.3**
↑	8 to 7	1st Ave N - Gulf Shore Blvd to 3rd Ave N - Gulf Shore Blvd	65.6	36	2	800	68.1
	9 to 8	1st Ave S - Gulf Shore Blvd to 1st Ave N - Gulf Shore Blvd	23.0	36	1	850	27.5
	10 to 9	2nd Ave S - Gulf Shore Blvd to 1st Ave S - Gulf Shore Blvd	11.8	24	1	400	12.0

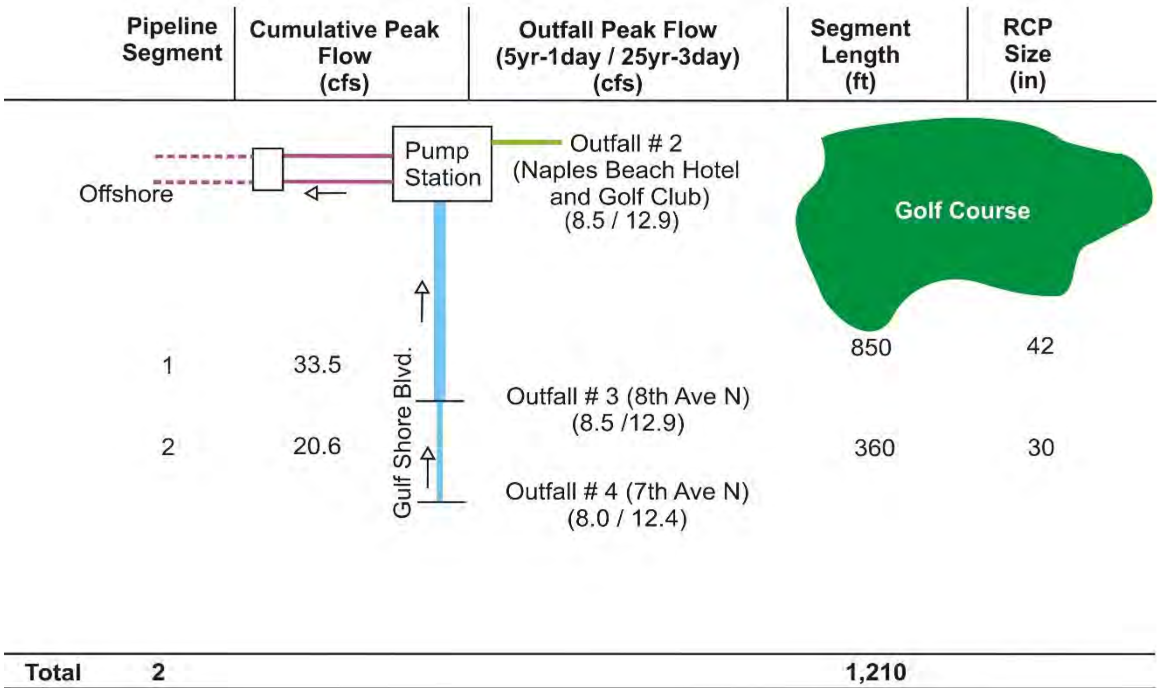


Figure 4-16. Schematic Pipeline Consolidation Plan for North System (Alternative 3)

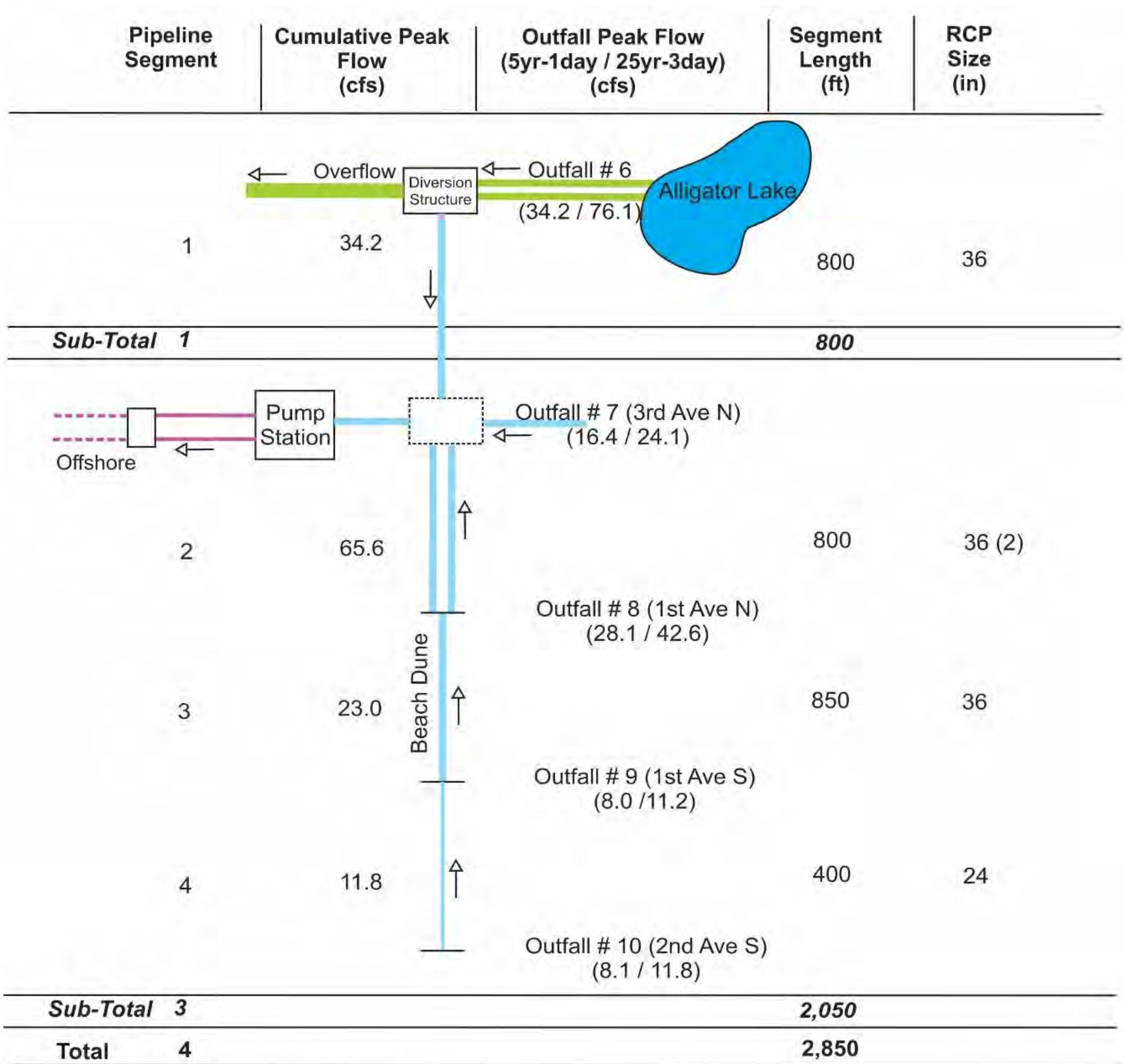


Figure 4-17. Schematic Pipeline Consolidation Plan for South System (Alternative 3)

Pump Station Design

Alternative 3 will require the construction of two pump stations. The pump station layout at the 3rd Avenue North site is identical to the layout presented in Alternative 2 (south system). Table 4-18 lists the preliminary basis of design for the Alternative 3 north system pump station based on the preliminary hydraulic analysis.

Table 4-18. Pump Station Basis of Design (Alternative 3)

Pump Station Location	3rd Ave North	Easement Acquisition Required – Vicinity of Outfall 2
Consolidated Outfalls	5, 6, 7, 8, 9, 10	2, 3, 4
Design Flow	94.8 cfs	70.7 cfs
QTY of Pump	Four 200 HP 24-Inch Diameter Mixed Flow Pumps with One Jockey Pump	Three 250 HP 24-Inch Diameter Mixed Flow Pumps with One Jockey Pump
Station Firm Capacity	42,549 gpm @ 45 ft TDH	35,413 gpm @ 38 ft TDH
Pump Station Footprint	25 ft x 35 ft	22 ft x 30 ft
Number of Force Mains	Two 24-Inch Dia. Force Mains	Two 24-Inch Dia. Force Mains

A preliminary site plan was developed for the proposed Alternative 3 north system pump station to be located in the vicinity of Outfall 2 and will require that the City acquire an easement or property to accommodate the station and ancillary equipment (Figure 4-18). A preliminary site plan was developed for a typical pump station for the purposes of identifying the land requirements as well as the preliminary estimate of cost.

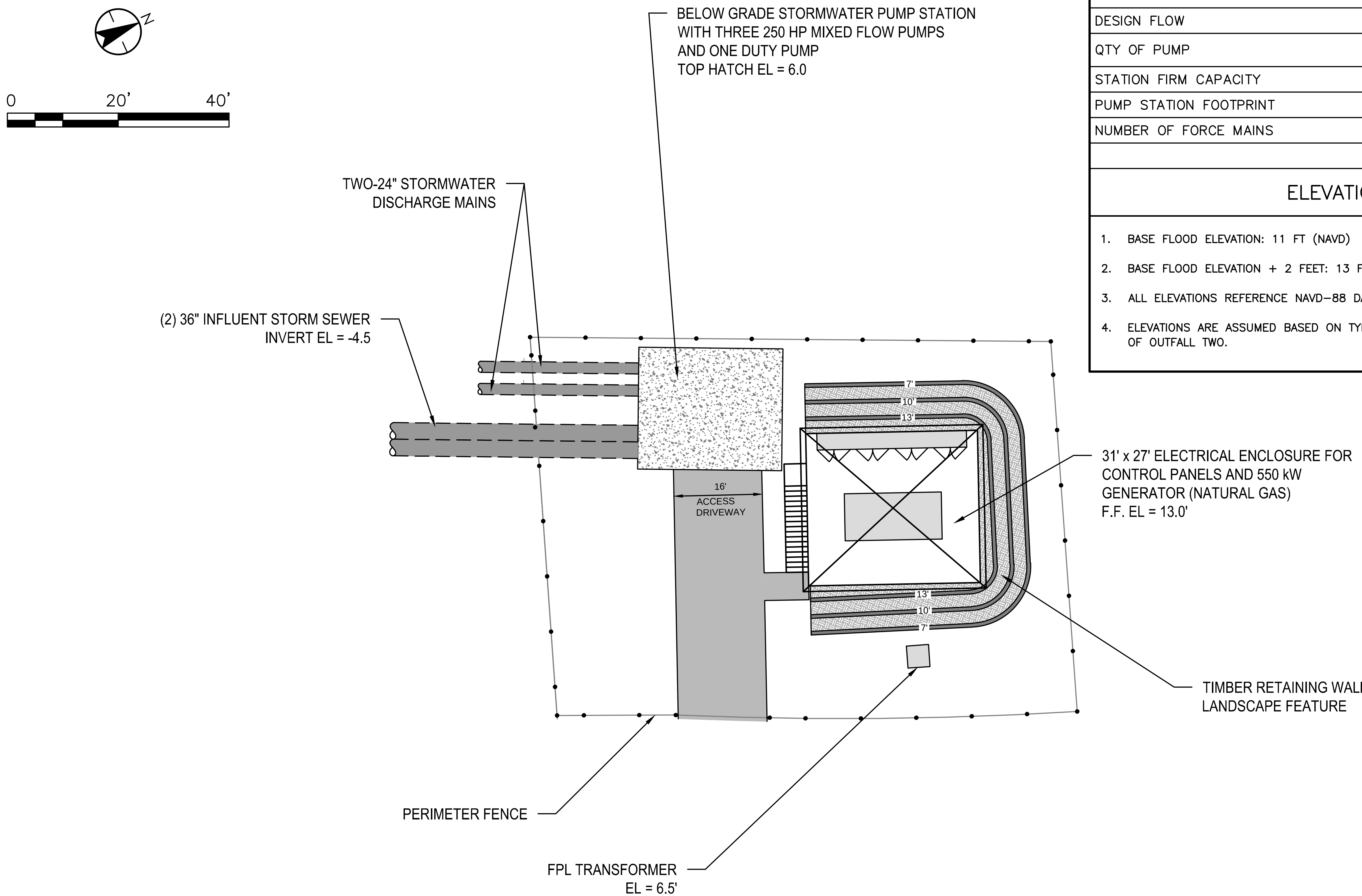
This Alternative 3 north system pump station design includes the construction of a below grade wet well and valve vault. The design deviates from the pump stations proposed at 3rd Avenue North and 6th Avenue North in that it includes an enclosure or building to house the electrical equipment and generator. The wet well and valve vault can be accessed through hatches that meet H20 loading requirements, which would allow for heavy duty loading (between 5,000 lbs and 7,499 lbs). The pump station is provided with Class 1 reliability so that the station can operate at design capacity with one of the pumps out of operation. The preliminary plan includes a perimeter fence at the edge of the easement and 16-foot access drive would allow maintenance vehicles to access the station and enclosure; however, fence and access requirements will depend on the actual site.

An emergency generator will be required for the pump station. Table 4-19 lists the preliminary generator sizing for Alternative 3.

Table 4-19. Emergency Power Requirements (Alternative 3)

Pump Station Location	3rd Ave North	Easement Acquisition Required
Emergency Power Requirements	650 kW	550 kW
Generator Footprint with Sound Enclosure	8.5 ft x 23.5 ft	8.5 ft x 23.5 ft
Sound Enclosure Rating	Level 2 Enclosure	NA

The Alligator Lake site will support the electrical and ancillary equipment for the south system pump station located at 3rd Avenue North. The footprint required at this site for Alternative 3 is less than that of Alternative 2 (Figure 4-19).



PUMP INFORMATION SUMMARY

ITEM	SPECIFICATION
DESIGN FLOW	ALTERNATIVE 3 = 79 CFS
QTY OF PUMP	THREE 250 HP 24-INCH DIAMETER MIXED FLOW PUMPS AND A DUTY PUMP
STATION FIRM CAPACITY	35,413 GPM @ 38 FT TDH
PUMP STATION FOOTPRINT	22' X 23'
NUMBER OF FORCE MAINS	2 – 24"

ELEVATION NOTES

1. BASE FLOOD ELEVATION: 11 FT (NAVD)
2. BASE FLOOD ELEVATION + 2 FEET: 13 FT (NAVD)
3. ALL ELEVATIONS REFERENCE NAVD-88 DATUM
4. ELEVATIONS ARE ASSUMED BASED ON TYPICAL ELVATIONS IN THE VACINITY OF OUTFALL TWO.

Naples Beach Restoration &
Water Quality Improvement Project

ALTERNATE 3 - NORTH SYSTEM TYPICAL PUMP STATION

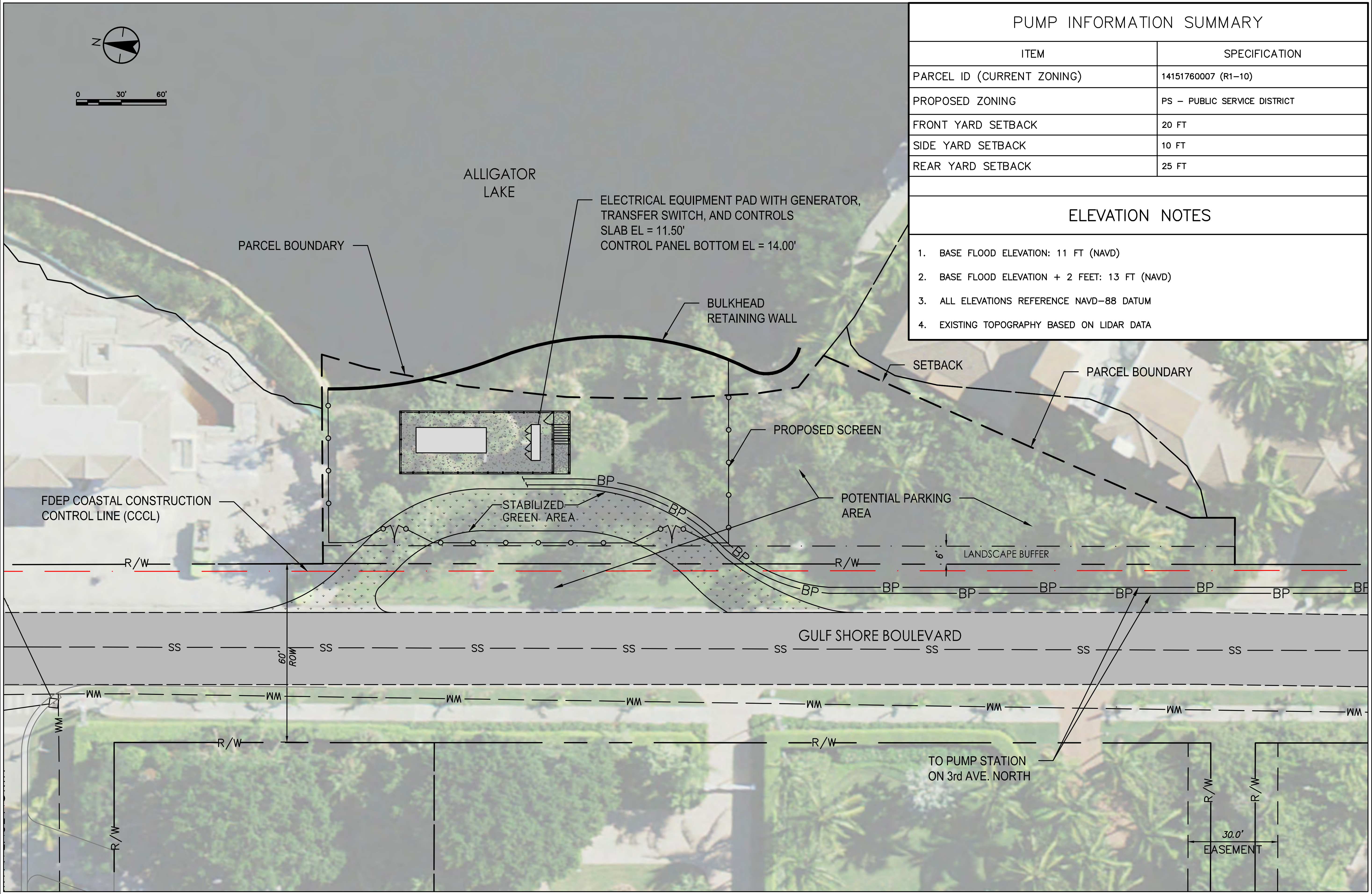
Stantec
Stantec
3200 Bailey Lane
Suite 200
Naples, FL 34105
(239) 263-6403

Erickson Consulting Engineers, Inc.
ECE
Erickson Consulting Engineers
7201 Delainey Court
Sarasota, FL 32420
(941) 373-6460

FIG. 4-18

Naples Beach Restoration &
Water Quality Improvement Project

ALTERNATIVE 3 - GENERATOR SITE



PUMP INFORMATION SUMMARY

ITEM	SPECIFICATION
PARCEL ID (CURRENT ZONING)	14151760007 (R1-10)
PROPOSED ZONING	PS – PUBLIC SERVICE DISTRICT
FRONT YARD SETBACK	20 FT
SIDE YARD SETBACK	10 FT
REAR YARD SETBACK	25 FT

ELEVATION NOTES

1. BASE FLOOD ELEVATION: 11 FT (NAVD)
2. BASE FLOOD ELEVATION + 2 FEET: 13 FT (NAVD)
3. ALL ELEVATIONS REFERENCE NAVD-88 DATUM
4. EXISTING TOPOGRAPHY BASED ON LIDAR DATA

Stantec
3200 Bailey Lane
Suite 200
Naples, FL 34105
(239) 263-6403

Erickson Consulting Engineers, Inc.
7201 Delainey Court
Sarasota, FL 32420
(941) 373-6460

FIG. 4-19

Z:\CADD_Graphics\US Projects\15-304_Naples Outfalls\Exhibits\Fig.4-19_Alligatore Lake PS Ancillary Site Plan Alt 3.dwg May 24, 2016-11:06am

Offshore HDD Pipeline and Diffuser System

As described above, two pump stations are required for Alternative 3, one located in the vicinity of the Naples Beach Hotel and Golf Club (north system) and the other at 3rd Avenue North (south system). The pump station, offshore HDD and diffuser system for the 3rd Avenue North (south system) site is identical to that described for Alternatives 2 in Section 4.2.2.

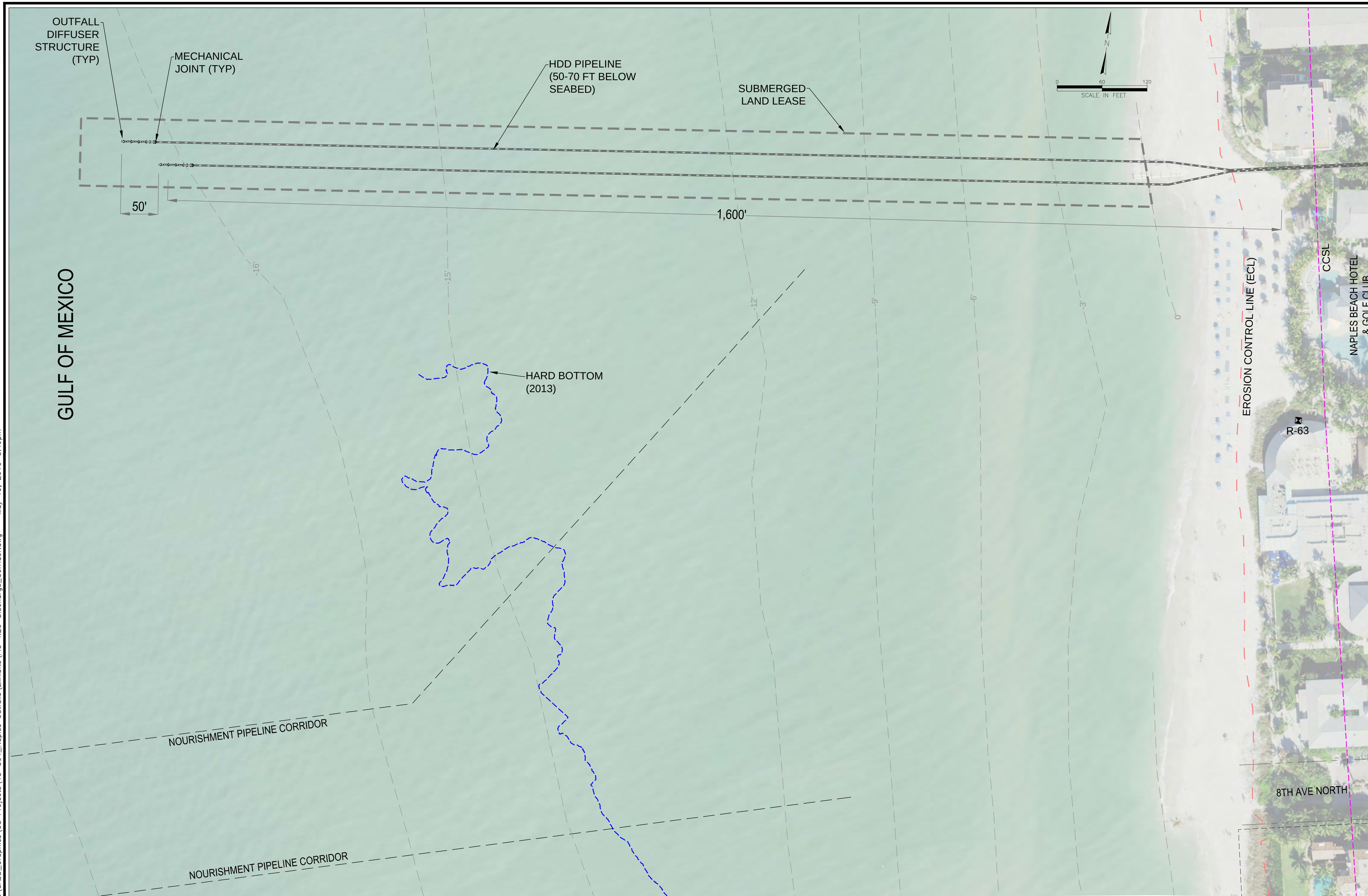
For the pump station in the vicinity of the Naples Beach Hotel and Golf Club (north system), the total peak system capacity requires two (2) 24 inch stormwater discharge mains exiting the pump station to convey water offshore at a discharge rate of 79 cfs via a HDD. From this pump station, the HDD requires a total length of approximately 1,000 ft to emerge at the -16 ft (NAVD 88) depth contour. The pipeline alignment is designed to minimize the pipeline length needed to maintain a 350 ft to 500 ft buffer from the diffuser system to the hardbottom feature(s). In addition, these HDD pipelines must avoid a pipeline corridor permitted for the Collier County Beach Nourishment Project (Figure 4-20).

For Alternative 3 "North System," the diffuser design is described in Table 4-9. Based on an economies of scale, the optimal diffuser size is approximately 8 to 10 inches in diameter.

Table 4-20. Diffuser Design for79 cfs Pump Station

Diffuser Dia (in)	Total Number of Diffusers[1]	Total Number of Diffusers/HDD[2]
8	30	15
10	15	8

Notes: The *options above provide the diffuser configuration required to meet a discharge mixing velocity of approximately 8-10 fps*[1]*; two discharge pipelines (Alternative 3 North System)*[2]



Z:\CADD_Graphics\US Projects\15-304_Naples Outfalls\Exhibits\FIG 4.20-Discharge_Corridor.dwg May 19, 2016-5:49pm

DESIGNED BC | DRAWN JC | CHECKED KE
DATE: 04-29-2016
JOB NO. 15-304
SCALE: AS NOTED

NAPLES BEACH RESTORATION & WATER QUALITY IMPROVEMENT PROJECT

SITING & ALIGNMENT OF NEARSHORE PIPELINE RELATIVE TO BEACH NOURISHMENT PIPELINE CORRIDOR

Erickson Consulting Engineers, Inc.
7201 Delainey Court
Sarasota, FL 32420
(941) 373-6460

FIG. 4-20

4.2.4 Cost Comparison of Alternatives

A preliminary Engineer's Estimate of Probable Construction Cost was developed for each of the Project Alternatives. This cost estimate is provided at the preliminary level of design and was developed based on the team's experience on similar projects as well as consultations with qualified construction contractors and suppliers. The Project cost estimate will be refined at the 60% design level with actual construction costs varying depending on final permit conditions, material and contractor availability, economic climate and final site conditions encountered at the time of construction.

The Project costs were developed for the major components of work including mobilization/demobilization, outfalls consolidation, pump station system, water quality treatment system and the HDD line and diffuser system. A brief summary of the costs associated with these components is provided herein.

Mobilization/Demobilization

The mobilization and demobilization costs represent the construction related cost required to transport the required equipment, materials and personnel to and from the jobsite to complete the work. The mobilization costs are comprised of the land-based mobilization cost, marine-based mobilization cost and the pump station mobilization cost as each of these aspects requires specialized equipment and materials. In general, the overall mobilization/demobilization cost is typically 5-10% of the total Project cost.

Outfalls Consolidation

The outfalls consolidation cost represent the construction related cost to procure all materials and complete all work related to the outfalls consolidation plan. These costs include the severing of existing outfall connections with pipe disposal, demolishion and disposal of drainage structures, procurement and installation of new pipeline, culverts, drainage inlet structures and manholes, the procurement of materials and associated construction of the overflow structure, and site restoration (i.e. vegetation replacement, sidewalks, re-paving, etc). For Alternative 1, these cost associated with the connection of Outfall 2 to Moorings Bay and Outfalls 9-10 to Basin III are included.

Pump Station System

The preliminary pump station cost includes the procurement and installation of all site preparations, equipment (pumps and generators), fittings and piping, valves, structures and electrical components to construct and commission the pump station.

Water Quality Treatment System

The extent of water quality treatment is unknown; however, budgetary costs were developed for a typical water quality treatment system which includes a filtration system (Vortex Separator), UV disinfection system and the associated electrical connections to the pump station. The cost estimate for these components were based on recently completed projects and conceptual costing information from suppliers. These estimates will be refined at the preliminary (30%) and detailed (60%) levels for the treatment system designs developed as a result of the findings of the water quality sampling and testing program.

HDD and Diffuser System

The cost associated with the HDD line and diffuser system include the procurement of the pipeline, installation of the pipeline via HDD techniques and the outfall structures inclusive of the diffusers, mechanic joints, end caps and helix anchors for each line.

Contingency

To account for the higher degree of uncertainty at the preliminary costing level, a 20% contingency is added to the total cost. At the 60% level the quantities and assumptions will be re-evaluated, the cost estimate refined and the contingency reduced.

Table 4-21 below provides the Preliminary Engineer's Estimate of Probable Construction Cost for the Project.

Table 4-21. Preliminary Engineer's Opinion of Probable Construction Cost

Item	Description	Alternative 1	Alternative 2		Alternative 3	
			North System (Phase I)	South System (Phase II)	North System (Phase I)	South System (Phase II)
1	Mobilization/Demobilization	$578,300	$586,900	$593,300	$496,530	$593,300
2	Outfalls Consolidation	$4,084,000	$1,723,800	$2,507,300	$1,786,000	$2,507,300
3	Pump Station System	$2,403,680	$2,312,200	$2,403,680	$1,809,200	$2,403,680
4	Water Quality Treatment System	$1,115,000	$1,025,000	$1,387,500	$1,025,000	$1,387,500
5	HDD & Diffuser System	$2,794,000	$3,038,000	$1,946,000	$2,882,000	$1,946,000
	Sub-Total (Items 1-5)	*$10,974,980*	*$8,685,900*	*$8,837,780*	*$7,998,730*	$8,837,780
	Contingency (20%)	$2,195,000	$1,737,200	$1,767,600	$1,599,700	$1,767,600
	Sub-Total by System	**$13,169,980**	**$10,423,100**	**$10,605,380**	**$9,598,430**	**$10,605,380**
	Total	**$13,169,980**	**$21,028,480**		**$20,203,810**	

4.3 Evaluation of Alternatives

The types of opportunities, sensitivities and associated challenges are identified herein for each of the stormwater consolidation, pump stations, facilities and offshore discharge system components. The benefits and opportunities include: stormwater flood prevention and protection and water quality improvements; City owned property uniquely situated to allow pump station siting and support facilities (backup generators, overflow and attenuation); proven technologies and systems; and recent regulatory approvals for similar systems. Challenges and sensitivities include construction logistics and land requirements for the pump station, water quality treatment, environmental (nearshore hardbottom and surrounding seabed); and social considerations. To evaluate these criteria and evaluate the alternatives, an analysis of the required LOS, available Gulf front/adjacent sites and characteristics, pipeline consolidation and pump station design requirements, and nearshore resources and beach features was performed to assess the benefits and sensitivities of each alternative. Each of the three (3) alternative systems was evaluated based on the criteria described herein. System components to prevent adverse impacts (social, environmental), meet siting requirements, and incorporate mitigative measures and engineering and operational protocols were identified, assessed, and incorporated into the design during the preliminary design development phase.

4.4 Evaluation Factors and Methodology

A structured decision making process as described below identifies and evaluates the full range of relevant opportunities and sensitivities pertaining to stormwater conveyance, treatment and offshore discharge options to meet the level of service for a 25-yr return interval rainfall event.

The feasibility and design development was conducted to appropriately initiate the Project and drive selection of the most technically, environmentally, economically and socially feasible alternative(s). The investigative studies to identify opportunities and sensitivities to establish the intent, alternatives and issues to be considered included:

- Validation of project intent and objectives;
- Key building block decisions; and
- Alternatives identification, aligned with key strategic objectives.

4.4.1 Overview and Assumptions

- Financial comparison has been done based on the cost estimate determined and discussed in Section 4.2.4 above.
- While weighted scores used to rank the alternatives do not represent an absolute measure of the sensitivity or benefit of any particular alternative, these scores are

an estimated quantification of a subjective risk/benefit assessment and represent relative scores between the alternatives, by the engineers and environmental consultants and the City.

- The sensitivities/risks and benefits detailed in this section are deemed pertinent to distinguish relative scores between the alternatives.
- A comprehensive assessment of the selected alternative(s) will be refined during the 60% design development phase.

4.4.2 Stakeholders

Identifying potential stakeholders provides context for the development of appropriate evaluation criteria and possible alternatives for further assessment. During the development and evaluation of alternatives, meetings were held with the following stakeholders to receive input during the development of the Project alternatives.

- City of Naples
- Local community
- State (Water Management District, FDEP) and Federal (USACE) Governments
- Non-Government Organizations (e.g. Conservancy of Southwest Florida, Waterkeeper Alliance)
- Contractors (local, international)

While a specific public meeting was not held with the local community, these stakeholders has voiced their opinions and concerns which have driven the solutions to date through the Council. Prior council meetings and statements from the community were reviewed and considered in developing and assessing the alternatives.

4.4.3 Key Success Factors

Identifying key success factors is necessary to establish appropriate evaluation criteria and alternatives for further assessment. The key success factors identified are listed below.

1. Optimizing Capital and Operational Expenditures
2. Successful Execution and Constructability
3. Project Start Up/Delivery
4. Expandability and Phased Expansion
5. Minor/Ameliorated Environmental Impacts
6. Minimum Visual Impairment (Aesthetics)
7. Minimal Adverse Impact to Area Stakeholders

4.5 Assessment Criteria and Weightings

The evaluation applies a weighting of the factors against the current condition to determine the weighted and ranked outcome summary. The evaluation criteria and weighting of factors is summarized in Table 4-22.

Table 4-22. Naples Outfall Consolidation: Weighting of Project Risks

Criteria	Description	Wgt
Technical		**40%**
Meets Project Objectives	Project design objectives are met or exceeded	15%
Technical Complexity	Technical consideration and complexity	5%
Operational Integrity and Reliability	Ability to maintain asset facility, equipment, anticipated "up time", impact on traffic, durability, equipment associated with Project	7.5%
Constructability	Materials handling requirements, site access, socio-economic resource availability, opportunities and quality control	7.5%
Scalability	Ability to expand with specified phased timescales and associated economies of scale	5%
Financial		**30%**
Capital Expenditure (CAPEX)	Estimated Capital Expenditure and cash flow implications	15%
Effectiveness Per Dollar Expended	Capital expenditure as a function of the level of service (LOS) for stormwater management	15%
Non-Technical		**30%**
Social Considerations	Impact upon stakeholder interests, livelihood and concerns, visibility from shoreline, and local communities concerns, NGOs, beach users	10%
Environmental Impact	Impact to physical and ecological processes and resources including but not limited to sea turtle nesting, hardbottom and shoreline stability	15%
Regulatory Approvals (Permitting)	Potential impact on timeline, anticipated outcomes of alternatives in relation to government regulatory expectations	5%
Health and Safety	Health and safety resulting from greater flood protection, improved water quality, reduced impediments for beach users, and local community	5%
		100%

Criteria with weightings of 10% or greater are considered to have a notable influence on the overall decision. Weightings of 5% or less are unlikely to have a significant bearing on the overall decision, in their own right. Some additional explanation is provided in the table below for the weightings that are either of individual high (≥10%) or low (<5%) influence. A summary of the ranking scale used in this assessment is given in Table 4-23.

Table 4-23. Evaluation of Alternatives in Terms of Expected Benefits and Costs (Opportunities and Sensitivities)

Ranking	Description
-7 / +7	Significant comparative negative/positive project impact
-4 / +4	Medium comparative negative/positive project impact
0	Neutral impact for project

An evaluation matrix of the alternatives is provided as Appendix G. A brief summary of the key findings which influenced the ranking is provided below for each evaluation criteria.

4.5.1 Technical (40%)

Meets Project Goals and Objectives (15%)

Alternative(s) capacity to meet the Project goals and objectives:

1. Reduce flooding and improve water quality;
2. Eliminate erosion rates from outfall induced scour and improve lateral beach access by removing pipelines;
3. Reduce adverse impacts to the beach and nearshore natural resources (sea turtles and hardbottom);
4. Meet or exceed the existing L*evel of Service* (LOS) to convey flow and improve the stormwater system's resilience for:
    a. 5-yr/1-hr rain event (City of Naples Comprehensive Plan) and
    b. 25-yr/3-day rain event (SFWMD); and
5. Convey treated stormwater to a pump station(s) and offshore;

All three alternatives received a positive score as each consolidates and eliminates beach outfalls, reduces flooding and improves water quality. The single most important factor in distinguishing amongst the Project alternatives was the Level of Service (percentage of total flow consolidated and treated). The secondary factor in the scoring was Alternative 3's removal of both Outfall 2 pipes from the beach. As a result, Alternative 3 achieved the highest ranking for this criteria.

Technical Complexity (5%)

Technical complexity includes all technical aspects of the each alternative, such as:

a) Proven systems and technologies and
b) Construction complexity (due primarily to the pipeline consolidation component).

The technical complexity of the pump station and offshore horizontal directional drill (HDD) are proven technologies and systems with sufficient space and siting options. Thereby, the key component to score technical complexity was determined to be the pipeline consolidation due to the relatively low elevations of the road ROW (generally 5 ft or less) and the pipe sizes required to consolidate the flow. While the pipeline materials are proven systems and technologies, the consolidation plan will require establishing new inlets structures and pipeline siting that avoids utility conflicts and requires replacement of the potable water line (asbestos cement).

Operational Integrity and Reliability (7.5%)

Factors to consider include:

a) Ability to maintain asset facility and equipment through required servicing and maintenance
b) Pump station and nearshore discharge system integrity and reliability to provide fully functional and efficient solution.

All systems were deemed to be operationally reliable. The distinguishing factor for scoring was the use of a single pump station for Alternative 1 as compared to two pump stations for Alternatives 2 and 3. All alternatives enhance the operational integrity and reliability of the stormwater system and therefore received a positive score.

Implementation / Construction (7.5%)

Refers to the complexity of implementing and constructing the alternative. Factors to consider include:

a) Complexity of methods/technologies necessary to construct the alternative and
b) Complexity of construction due to spatial constraints.

All design and construction technologies are technically feasible and local contractors are experienced; therefore, all alternatives received a positive score. Factors varying amongst the alternatives include the space available for construction, number of pump stations and pipeline consolidation along Gulf Shore Blvd.

Scalability (5%)
Factors to consider include:

a) The characteristics of the pump station and discharge system capacity to perform under an increased or expanded level of service
b) A system that scales well and will be able to maintain its level of performance or efficiency when tested by larger operational demands (LOS).

Alternative 1 was determined to not be scalable as the pipeline sizes and pump station are at maximum capacity at the time of initial construction. Alternatives 2 and 3 can be built in phases and the pump station capacities can be increased in the future. In addition, with Alternative 3 the potential golf course improvements result in reduced demand on the system further increasing scalability.

4.5.2 Financial (30%)

Capital Expenditure (CAPEX) (15%)
Capital expenditure is the amount spent to implement the alternative (i.e. the overall cost to construct and implement a Project alternative). Section 4.2.4 provides a cost comparison for the alternatives.

Effectiveness Per Dollar Expended (15%)
Dollar expenditures as a function of the Level of Service provided by the alternative was evaluated considering the percent of the total peak stormwater runoff volume managed by the alternative's overall capital expenditure.

4.5.3 Non-Technical (30%)

Social Considerations (10%)
Social considerations refer to the ability of the alternative to address the concerns of the City Council, the community and the local environmental and civic organizations (i.e., Water Keeper Alliance and the Conservancy of SW Florida). These considerations in scoring the alternatives included aesthetics, impacts on tourism, water quality improvements, impacts to public use/access and parking, etc. All alternatives were positively ranked.

Environmental Impact (10%)
Environmental impact refers to both positive and adverse effects the alternative may have on the surrounding environment (natural resources, etc.) as compared to the City's existing stormwater outfall system including:

a) Beach stability and shoreline preservation (reduced sand nourishment impacts on traffic, roads, resources and finances);
b) Nearshore resources protected (sea turtle nesting and success of hatchlings, shorebirds); and
c) Nearshore hardbottom (water quality, mixing zone and distance to resources from discharge)

Regulatory Approvals (Permitting) (5%)

Alternative(s) expected success and timeline to receive permits through federal, state and local regulatory agencies. This criteria was given a relatively low value as each of the alternatives considered was deemed permittable based on meetings with the key regulatory agencies. Although it was recognized that pipelines and pump station locations would vary, and that the total number and size of the outfalls would increase, the time and level of effort required to process regulatory permits for all alternatives was relatively equal. Therefore, the scoring was relatively similar. Regulatory permitting is further described in Section 6.1.

Health and Safety (5%)

Alternative(s) potential to improve the health, safety and welfare of the City of Naples Beach community. The analysis, as this criteria applies the City's Project, evaluated the improvements to public safety that would be achieved by reduced flood related public and private property damage, human safety achieved by improved flood protection during severe storms (i.e. 25-Yr return interval storms or greater). All alternatives were found to improve recreation and swimming by reducing the potential for injuries due to obstacles and improving water quality. Alternative 3 scored the highest as all outfalls are removed from the beach, the overall objectives of the Project are met, the alternative minimizes impacts to beach accesses and roadway maintenance of traffic and the alternative results in the lowest cost for total stormwater flow managed.

4.6 Evaluation Matrix Final Ranking

Representatives from the design team and City Staff assembled to discuss and score each criteria on April 25, 2016. The rationale behind the scoring is explained in Appendix F which details the identified Project benefits and challenges by criteria.

As described in Table 4-24, the relative rankings of the alternatives are:

1. Alternative 3
2. Alternative 1
3. Alternative 2

Alternative 3 scored the highest due to the highest percentage of flow consolidated, and resulting effectiveness per dollar spent, as well as removal of all outfalls from the visible beach, its ability to be constructed in phases, and its lower environmental impact. Alternative 3 offers the most flexibility with regard to construction phasing and future expansion. For example, if the Alternative 3 south system is constructed first, the opportunity will exist in the future to construct the north system for Alternative 3 upon securing funding and procurement of an easement for use of land. Should land use for the Alternative 3 north system prove difficult to acquire, the City will have the option to reconfigure the lines to convert the system to Alternative 1 ***or*** construct the north system Alternative 2 design.

Table 4-24. Ranking of Alternatives

Evaluation Criteria	Weight	Alternative 1		Alternative 2		Alternative 3	
		Raw	Weighted	Raw	Weighted	Raw	Weighted
Technical	**40%**		**0.0**		**0.0**		**0.0**
Meets Project Objectives	15%	**4**	**0.60**	**4**	**0.75**	**6**	**0.90**
Technical Complexity	5%	**-6**	**-0.30**	**-5**	**-0.25**	**-4**	**-0.20**
Operational Integrity and Reliability (Pump Station)	7.5%	**6**	**0.45**	**4**	**0.30**	**4**	**0.30**
Constructability	7.5%	**4**	**0.30**	**3**	**0.23**	**5**	**0.38**
Scalability	5%	**2**	**0.10**	**4**	**0.20**	**5**	**0.25**
Financial	**30%**		**0.0**		**0.0**		**0.0**
Capital Expenditure (CAPEX)	15%	**-1**	**-0.15**	**-3**	**-0.45**	**-3**	**-0.45**
Effectiveness per Dollar Spent	15%	**3**	**0.45**	**4**	**0.60**	**5**	**0.75**
Non-Technical	**30%**		**0.0**		**0.0**		**0.0**
Social Considerations	10%	**4**	**0.40**	**2**	**0.20**	**5**	**0.50**
Environmental Impact	10%	**4**	**0.40**	**5**	**0.50**	**6**	**0.60**
Regulatory Approvals (Permitting)	5%	**6**	**0.30**	**4**	**0.20**	**5**	**0.25**
Health and Safety (Flood Protection, Public Safety, Recreation)	5%	**4**	**0.20**	**5**	**0.25**	**6**	**0.30**
	100%		**2.75**		**2.38**		**3.58**

5 30% DESIGN OF THE RECOMMENDED ALTERNATIVE

An evaluation of three alternative Project plans, conducted by the Project's consulting team of engineers and scientists working with the City's key engineering and scientific professionals, identified Alternative 3 as the preferred Project design and plan to advance to the 30% design development phase. Alternative 3 is comprised of a "North System" and "South System" as follows:

- **North Drainage and Treatment System** – consolidates the existing stormwater flow associated with Outfalls 2, 3 and 4 (25-Yr) and conveys the flow to a pump station located in the vicinity of the Naples Beach Hotel and Golf Club with treatment and discharge (25-Yr) through directionally drilled discharge lines and a diffuser system placed offshore in the Gulf. All pipeline consolidation is along Gulf Shore Blvd.

- **South Drainage and Treatment System** - consolidates the existing stormwater flow associated with existing Outfalls 5, 6, 7, 8, 9 and 10 (25-Yr) and conveys the flow to a pump station located at 3rd Avenue North with treatment and discharge (5-Yr) discharge through directionally drilled discharge lines and a diffuser system placed offshore in the Gulf. An overflow line will be located at Outfall 6 to convey stormwater during extreme storm events when peak discharge volumes exceed the maximum rates for the pump stations. The overflow line will be located below the visible beach and open only during extreme storm events. The potential exists for pipeline consolidation along the back-beach or Gulf Shore Blvd.

Preliminary Project Drawings (30% design) are provided in Appendix G.

5.1 Existing Conditions

As described above, the key pipeline consolidation, pump station and outfall components and their physical locations are:

1. Pipeline consolidation – along Gulf Shore Blvd (and/or the back-beach)
2. North System Pump Station Location "to be determined" - Vicinity of Naples Beach Hotel and Golf Club
3. South System Pump Station Location - 3rd Avenue North City Beach Access
4. Back-up Generator for South System Pump Station - Alligator Lake Parcel #141517600007

5. Discharge Pipelines, Diffuser and Anchoring System Location - Gulf of Mexico approximately 1,000-1,500 ft offshore (below seabed) with diffusers in 14-16 ft water depth

The existing site conditions at these locations and the factors that guided the design development of Alternative 3 are described below for each of the primary Project components.

Gulf Shore Road (Pipeline Consolidation)

Elevations along the Gulf Shore Blvd ROW are low and range from approximately 5.5 ft to 4.2 ft (NAVD 88). Gulf Shore Blvd has a mild crown with elevations generally 0.2 ft above the ROW, and conveys runoff to inlets located along this roadway and within the ROW. These inlets are located primarily at the intersection of Gulf Shore Blvd and the beach access streets associated with the nine beach outfalls. The collected runoff from these discharge lines flow directly to the Gulf of Mexico via the beach outfalls.

The stormwater infrastructure is continually inundated with ground water and tidal surge due to the low elevation of the underground pipeline network that results from the low roadway and ROW grades. Standing water was observed in all storm sewer structures during field investigations for design and site reconnaissance. It appears standing water in the system is most likely tidal surge due to the low elevation of the lines and the invert elevations of the existing pipe terminus' at the Gulf. Tidal surge inundation is readily observed daily at the Alligator Lake outfall structure which is directly connected to Outfall 6 (2-30 in). During high tide, water flows east through the pipe network and weir structure into Alligator Lake. In addition to the low elevation of the system, the standing water can also be attributed to insufficient pipe slope and outfall blockage. As sea level rise continues, the inundation of the system by Gulf waters and related upstream flooding will increase due to the reduced differential in elevation from the City's upland drainage pipes and the Gulf water levels. Gulf discharge is thereby affected by the semi-diurnal tides, storm surge and the increasing elevation of mean sea water due to sea level rise estimated at 0.9 ft over the next 40 years.

Existing pipe sizes within the Gulf Shore Blvd and beach access ROWs typically range between 15 in to 25 in, with the exception of box culverts at Outfall 2 (3 ft by 4 ft) and Outfall 6 (2 ft by 6 ft). As previously noted, Outfalls 2 and 6 represent the largest discharges within the Project Area.

The City's existing infrastructure within Gulf Shore Blvd and beach access ROWs are shown on Figure 5-1, Figure 5-2 and Figure 5-3 and include:

- Potable Water (City of Naples) – typically located along the west side of the Gulf Shore Blvd ROW.
- Reclaim Water (City of Naples) – limited to the area immediately surrounding Central Ave at the south end of the Project Area between Outfalls 8 & 9. The reclaim water lines cross Gulf Shore Blvd at two locations north and south of Central Ave.
- Sanitary Sewer (City of Naples) – the main trunk line is located along the center of Gulf Shore Blvd with collection lines extending along the beach access ROWs.
- Storm Sewer (City of Naples) – collection points are typically at intersections with lines conveying west along the beach access ROWs to each of the beach outfalls. At specific locations where the storm sewer system conveys parallel to Gulf Shore Blvd, the line is typically located along the east ROW of Gulf Shore Blvd. However, between 2nd Ave N and 3rd Ave N the line is located along the center of Gulf Shore Blvd, adjacent to the main sanitary sewer trunk line. The line is located on along the west ROW of Gulf Shore Blvd between 3rd Ave N and 4th Ave N and then again between 8th Ave N and Oleander Dr.
- Cable (CenturyLink – internet, phone, TV) – typically located along the east side of the Gulf Shore Blvd ROW with various Gulf Shore Blvd service connection crossings. Cable lines are underground.
- Power (FPL) –located along the side streets and east ROW, with cross overs to the west side of the Gulf Shore Blvd ROW. The power lines are typically overhead with some underground portions, specifically between North Lake Drive and 7th Ave N.

The existing potable water line is asbestos cement pipe. Construction near or around the existing water distribution system located on the west ROW of Gulf Shore Blvd will necessitate full replacement of the water line. Replacement of the existing water main is planned by the City as a future infrastructure improvement project, which provides an opportunity to complete both projects concurrently. Consequently, this would reduce construction dollars and impacts to surrounding neighborhoods and traffic control that would result from individual projects. The new consolidated stormwater line may also be located within the east ROW of Gulf Shore Blvd should the City pursue a roadway expansion project to construct a bike lane.

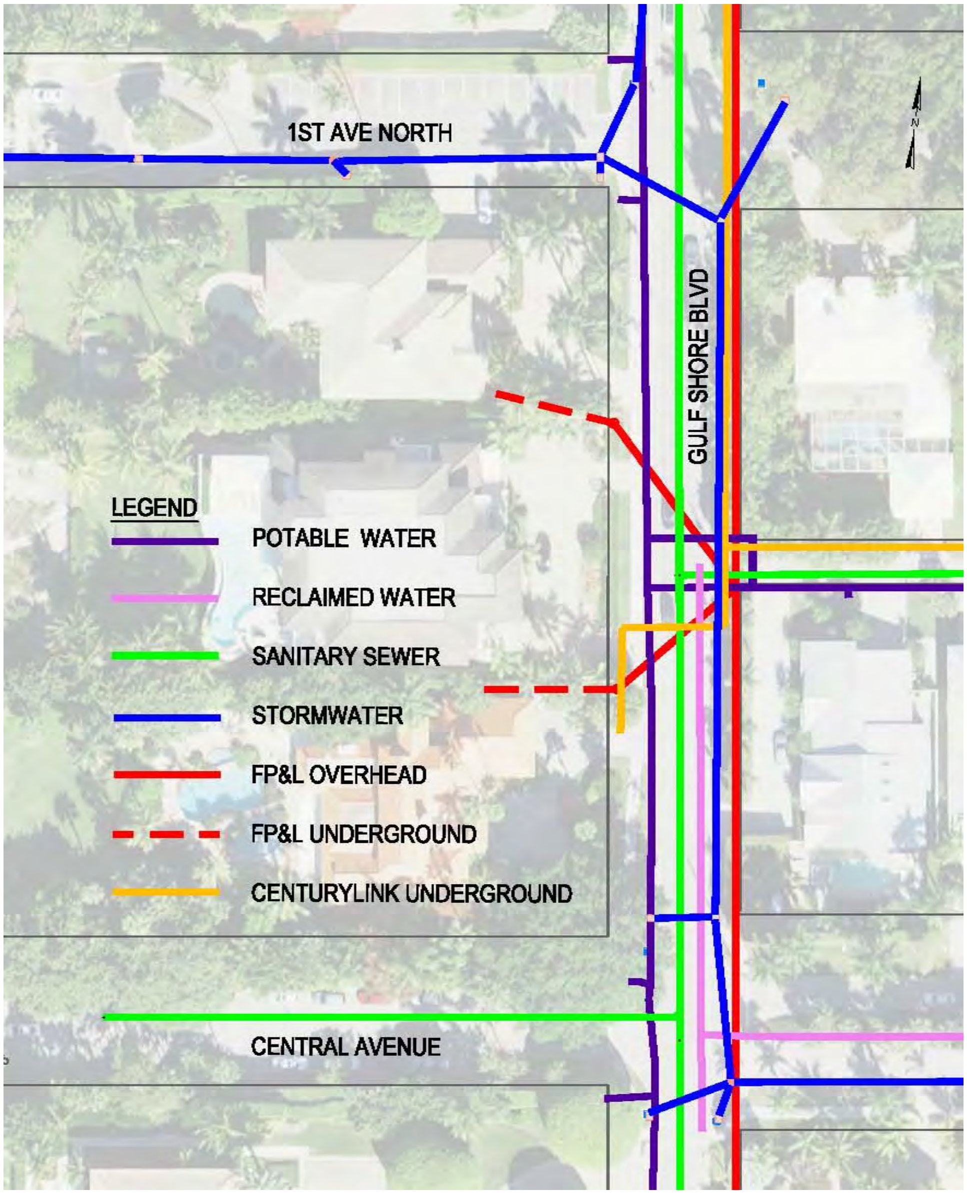


Figure 5-1. Typical Utility Configuration Along Gulf Shore Blvd

Figure 5-2. Typical Intersection with Utilities – Storm Drain with Adjacent Fiber Optic Cable Manholes

Figure 5-3. Typical Intersection with Utilities – Storm Drain in Foreground with Potable Water Line in Background

Dune elevations are low at approximately +6 ft (NAVD 88), with the seaward berm elevations typically +4 to +5 ft (NAVD 88) and mildly sloping to the water line. At present, beach widths vary from 85 to 100 ft as a result of a recent beach sand placement project. The Project is located within the limits of the Collier County Beach Nourishment Project, an established, funded program to maintain beach widths on the order of 100 ft with a 6-yr to 8-yr beach renourishment interval.

The dune system south of 6th Avenue North is generally characterized as coastal shrub (seagrape and beach naupaka) fronted by dune grass (sea oats) with railroad vine and beach sunflower. Extending north from 6th Avenue North, the coastal shoreline is characterized by the presence of coastal structures (i.e. revetments and seawalls) located within a modest dune feature or exposed due to the lack of a dune feature (Figure 5-4).

Figure 5-4. General Dune Vegetation Configuration along Naples Beach

<u>Vicinity of Naples Beach Hotel and Golf Club (North System Pump Station Location)</u>

The North System pump station will be located in the vicinity of the Naples Beach Hotel and Golf Club if a site can be procured through purchase or perpetual easement. After a site for the pump station is determined, a supplemental assessment of the site specific conditions will be conducted.

<u>3rd Avenue North City Beach Access (South System Pump Station Location)</u>

3rd Ave North is a beach access road, west of Gulf Shore Blvd, and is in the City owned right-of-way (Figure 5-5). As part of the pump station siting feasibility study, an assessment of this site was conducted. The following was observed:

- 3rd Avenue North terminates at the Gulf of Mexico and provides a public beach access corridor from Gulf Shore Boulevard to the beach front.
- 3rd Avenue North features fourteen (14) coin-operated parking spaces distributed evenly on both sides of this beach access. Five of these parking spaces were occupied at the time of a recent site visit.

- Public use was observed including persons walking, jogging and bike riding along Gulf Shore Boulevard.
- The surrounding landscaping was well maintained, including grass, shrubs and palm trees.
- 3^{rd} Avenue North is bordered by one single family residential parcel to the north and one single family residential parcel to the south (both driveway accesses for these homes connect to Gulf Shore Boulevard).
- There is a small pedestrian access to the south single family residence, at the western end of 3^{rd} Avenue North.

Figure 5-5. 3^{rd} Avenue North, Facing West

The 3^{rd} Avenue North Beach Access Site consists of paved, asphalt road, ROW, metered and un-metered public beach parking spaces and driveways associated with the adjacent residential properties. The southern and northern property boundaries are bordered by walls, sod and planted landscape vegetation associated with the adjacent residential properties. The western-most portion of the site contains coastal scrub vegetation. The dune vegetation consists of sea oats (*Uniola paniculata*), railroad vine (*Ipomea pes-carpe*), sea ox-eye daisy (*Borrichia frutescens*), and seagrape.

There is a potential for protected sea turtles and protected shorebirds to nest or utilize portions of the coastal scrub habitat. Temporary or permanent impacts to the coastal scrub would likely require coordination with the FWC and FWS to avoid impacts to nesting marine sea turtles and nesting shorebirds/wading birds.

The existing site grade elevation is generally at 6.3 ft (NAVD 88). The BFE for this site 12 ft (NAVD 88). However, according to the Florida Building Code requirements, the minimum height for the electrical components is +2 ft above BFE, so all electrical equipment must at a minimum elevation of +14 ft (NAVD 88) which is approximately 8 ft above existing grade.

<u>Gulf Shore Boulevard by Alligator Lake (South System Pump Station Generator Location)</u>
As part of the pump station siting, an assessment of the City owned property adjacent to Alligator Lake (Parcel # 14151760007) was conducted. Currently, this parcel is operated as a public lakeside park (Figure 5-6).

Figure 5-6. City-Owned Parcel Adjacent to Alligator Lake
(Parcel # 14151760007)

The following was observed during site assessment:

- Several persons were observed walking, jogging and riding bicycles along Gulf Shore Blvd.
- The parcel has an on-site water fountain, a garbage can and park bench indicating this location is used by stakeholders in the area.
- No persons were noted to be specifically using the site at this time.
- The landscaping features (palm trees and other plantings) are well maintained.

The site appears to have been cleared of native vegetation in the past and planted with trees and sod. There is a potential for the American alligator and protected wading birds to inhabit or utilize the lake; however, no state or federal listed species were observed utilizing or inhabiting the site. Additionally there were no protected species listed by the U.S. Fish and Wildlife Service (FWS) or Florida Fish and Wildlife Conservation Commission (FWC).

The permitted uses in this district do not allow for a public utility facility such as a pump station. For the proposed pump station to be placed on this parcel, rezoning would be required to PS (Public Service District). The site constraints for PS (Public Service District) at this site would be as follows:

- Minimum Yard Setbacks:
    - Front: 20 ft from ROW
    - Side: 10 ft
    - Rear: 25 ft
- Maximum height: 30 ft

The existing site grade elevation is generally 4.9 ft (NAVD 88). The Base Flood Elevation (BFE) for the parcel is 11 ft (NAVD 88). However, according to the Florida Building Code requirements, the minimum height for the electrical components are to be located 2 ft above the BFE. As such, all electrical equipment must be located at a minimum elevation of 13 ft (NAVD 88), which is approximately 8 feet above existing grade.

To rezone a property for the construction of a stormwater pumping station, the City will complete a petition and submit it to the City Manager, together with the required fee and supportive materials. If the City Manager determines the rezone petition to be in order, the City Manager is required to notify property owners located within 500 feet of the property, informing them of the date, time, place and reason for the public hearing. At the public hearing, the planning advisory board shall hear the petitioner or the petitioner's designated representative and all other interested parties who may appear and request to be heard.

The planning advisory board ultimately submits its recommendation for approval or denial, or approval with conditions, in writing, together with the minutes of the hearing, to the City Council. After considering the recommendation of the planning advisory board, the City Council may approve or deny the petition, or approve the petition with conditions.

Offshore Location and Siting of Pipeline Diffuser System

Hardbottom is present offshore of all three pump station locations identified, but is not continuous. Opportunities exist to align and surface the pipeline offshore by deep drilling under the seabed seaward of these nearshore areas of hardbottom. To provide a sufficient mixing zone (freshwater diffused and mixed with the ambient seawater), a buffer of 250- 400 ft was established as a design requirement for the siting and layout of the offshore diffuser structure away from hardbottom resources. The minimum depth for the diffuser pipe is proposed at 14-16 ft of depth, and is based on the "depth of closure" for this beach-shoreline area. This depth is based on a historical analysis of beach profile changes and represents the depth where sediment movement is negligible, and where seabottom remains the same over time.

Subsurface soil conditions, pipeline size and pipeline characteristics will determine the final drill hole size and depth of drill. Core borings taken in the area provide background information to support the assumptions for the use of HDD. In general terms, consolidated limestone subsurface strata provide the optimum conditions to support the bore hole diameter. Project specific deep geotechnical borings are recommended during the 60% design phase, within the vicinity of the selected HDD location(s), to a depth of approximately 80 to 90 ft below the ground surface to identify subsurface strata and material hardness.

5.2 Level of Service

Rainfall data was compiled and analyzed for the Project to obtain an overview of rainfall intensities and frequencies in recent years (refer to Section 0). As seen in Table 5-1, between 2003 and 2015 (a period of 13 years) there have been a total of 40 events where the daily reported rainfall exceeded 2 inches, 6 events where the daily report rainfall exceeded 3 inches and 3 events where the daily reported rainfall exceeded 4 inches.

Table 5-1. Days with Rainfall Exceeding 0.5 Inch
(Naples Municipal Airport Rainfall Gauge)

Year	Total Days Exceeded					Total # Days
	0.5 in	1 in	2 in	3 in	4 in	
2003	42	20	7	3	1	148
2004	25	12	2	0	0	125
2005	35	18	9	1	1	142
2006	30	20	4	0	0	93
2007	18	9	2	0	0	96
2008	33	15	3	0	0	103
2009	25	6	0	0	0	96

Table 5-1. Days with Rainfall Exceeding 0.5 Inch (Continued)						
Year	Total Days Exceeded					Total # Days
	0.5 in	1 in	2 in	3 in	4 in	
2010	34	11	3	0	0	96
2011	24	13	2	0	0	96
2012	25	12	1	0	0	99
2013	31	14	4	1	0	109
2014	33	9	1	1	1	104
2015	22	6	2	0	0	105
TOTAL	**377**	**165**	**40**	**6**	**3**	**1,412**
AVG	**29**	**13**	**3**	**0**	**0**	**109**
OCCURENCE	**26.6%**	**11.6%**	**2.8%**	**0.4%**	**0.2%**	**100%**

Rainfall intensities by return period, as given by the SFWMD, are provided in Table 5-7 (SFWMD, 2014). For comparison of historic data to the return period events, there were 13 days exceeding 4 inches between January 2003 and February 2016.

Table 5-2. Rainfall Intensities by Return Period

Return Period	Rainfall (Inches)
5-Yr/1-Hr	3.0
5-Yr/1-Day	5.5
25-Yr/3-Day	11.5
100-Yr/3-Day	15.0

Level of Service (LOS), as it applies to the Project, is the design peak flow that the stormwater system can convey and contain prior to backup of the system (i.e., standing water within the street(s)). The LOS is a primary consideration in the system's design as it establishes the system's capacity (pump station, pipeline and stormwater structures sizing) and associated components (e.g. filter systems, etc) and as well as the system's overflow line(s). The overflow line is required to provide discharge capacity during extreme low frequency storm events (i.e. conveys flows to the Gulf as a back-up or "overflow" to the primary forcemain system).

Peak flow rates by storm event, based on the AECOM SWMM model, were introduced in Section 2.6. The design LOS peak discharge is based upon the 5-yr/1-hr event as stipulated in the City's current stormwater ordinance. The 5-yr/24-hr and the 25-yr/3-day event are the LOS required by the SFWMD.

The siting and land requirements for consolidating the outfalls to convey flow to a centralized pump station(s) is largely dependent on the existing infrastructure and the level of service provided by the largest outfalls. Three of the nine outfalls carry in excess of 60% of the total outflow to the Gulf. Outfall 2, located at the northernmost limit of the Project Area, represents 19% of the total flow, whereas Outfalls 6 and 8, in the southern portion of the Project Area, represent 31% and 17% of the total flow, respectively. As a result, the consolidation, and therefore pump station location(s), must be in close proximity to these outfalls due to spatial constraints and the geometric requirements of the pipeline to carry the flow.

As described in Section 4.1.3, the pipeline consolidation system's main trunk line for Alternative 3 (Preferred Project) is segmented and the flow separated into North and South Systems (Table 5-3) based on an evaluation of the:

- magnitude of flow and distance of consolidation;
- need to avoid deeply placed, or large pipeline that would result in a structure conflict at the existing box culvert associated with Outfall 6;
- location and characteristics of the landward beach berm and dune that may allow less costly routing to consolidate the pipeline along the back-beach for outfalls situated south of Outfall 6, whereas this option is impractical north of Outfall 6 due to existing shoreline conditions (i.e. revetments and seawalls); and
- The Naples Beach Hotel and Golf Club has applications approved with the South Florida Water Management District (SFWMD) and the City for modification to the existing stormwater management system to accommodate redesign golf course layouts and other site development. The modifications would result in a reduction of the discharge volumes and flow rates to Outfall 2 commissioned by the Club entitled "Stormwater Management Report for Naples Beach Hotel Golf Course" (Grady Minor, 2015).

Table 5-3. Level of Service Requirements for Alternative 3 (Preferred Project)

Outfall #	Outfall Location Description	Peak Discharge (cfs)	
		5-Yr/1-Hr Event	25-Yr/3-Day Event
2-4	North System	39	71
5-10	South System	109	174
	TOTALS	**148**	**245**

Notes: *Peak flow rates shown include the reduction in flow contribution from the Naples Beach Hotel & Golf Club (Grady Minor, 2015).*

Overall, Alternative 3 (Preferred Alternative) conveys 100% of the design peak flow. The Project design plan consolidates and conveys 100% of the 5-yr peak flow and 71% of the 25-yr flow to two pump stations for discharge offshore through HDD pipelines. The remaining 29% of the 25-yr flow is handled through an overflow line to be located at Outfall 6 for conveyance of peak flow that exceed design capacity during extreme storm events. The overflow line will be located below the visible beach and open only during unusually high flow rates associated with extreme storm events. As described in Table 5-1, Hurricane Wilma and similar storm events over the past 14 years (2003- present) would not have resulted in flow that exceed the peak capacity of the system and result in opening of this overflow line. Figure 5-7 provides an overview of the systems consolidation design and peak flow rates.

The "North System" consolidates the existing stormwater flow associated with existing Outfalls 2, 3 and 4 (25-Yr peak flow) conveys the flow to a pump station located in the vicinity of the Naples Beach Hotel and Golf Club with treatment and discharge lines deep drilled and a diffuser system placed offshore in the Gulf.

The "South System" consolidates the existing stormwater flow associated with existing Outfalls 5, 6, 7, 8, 9 and 10 (25-Yr). The 5-yr flow is conveyed to a pump station located at 3rd Avenue North with treatment and discharge through a diffuser system using directional drilled deep pipelines offshore. The system includes the consolidation and conveyance of discharge from the Naples Beach Hotel and Golf Club allowing removal of the large stormwater line at Outfall 2. The 25-yr overflow is conveyed to a line located at Outfall 6 as described above.

Figure 5-7. Overview of Alternative 3 (Preferred Alternative)

5.3 Pipeline Consolidation

As described above, Alternative 3 (Preferred Alternative) includes a North System and South System with two pump stations (one for each system) located in the vicinity of the Naples Beach Hotel and Golf Club and 3rd Avenue North, respectively. Design of the pipe size, configuration, elevation and type were based on the Manning's equation assuming the design peak flow rates (LOS).

North System

The required peak discharge (LOS) of 79 cfs (north system) is based on the cumulative flow from a 25-Yr return period rainfall event. The primary site conditions that affected the pipeline design were the low elevation of Gulf Shore Blvd and the adjacent ROW as well as the cumulative capacity required to convey the peak flow for a 25-Yr event. A schematic of the consolidation plan is described by Table 5-4 and Figure 5-8, where the pipeline is consolidated near the Naples Beach Hotel and Golf Course (Outfall 2). The ROW grade elevations at the south end of the main trunk line range from 4.3 ft to 5.5 ft near the approximate pump station location. The diameter of the main trunk line increases to 42 inches, maintaining a single line between 6th Ave North and the Naples Beach Hotel and Golf Club. Table 5-5 describes the key design elements of the consolidation plan for the Alternative 3 north system.

Table 5-4. Peak Flow Collection System Design for 25-Yr LOS
(Alternative 3 North System: Preferred Alternative)

Conveyance Direction	Outfall	Outfall Description	Quantity		Collection System Flow	Cumulative Collection System Flow	Pump Station Flow Discharged to Gulf	System Overflow Flow Discharged to Gulf
			Peak Flow for the 5-Yr/1-Day Event	Peak Flow for the 25-Yr/3-Day Event				
Pump Station (North)						70.7	70.7	0.0
↑		*Sub-Total (2-4)*	*30.7*	*70.7*	*70.7*			
	2	Naples Beach Hotel and Golf Club[2]	14.2	45.5	45.5	45.5		
	3	8th Avenue North	8.5	12.9	12.9	58.4		
	4	7th Avenue North	8.0	12.4	12.4	70.7		
		TOTAL - ALT 2 NORTH	**30.7**	**70.7**	**70.7**	**70.7**	**70.7**	**0.0**

Note: all values are peak flow rates (cfs)

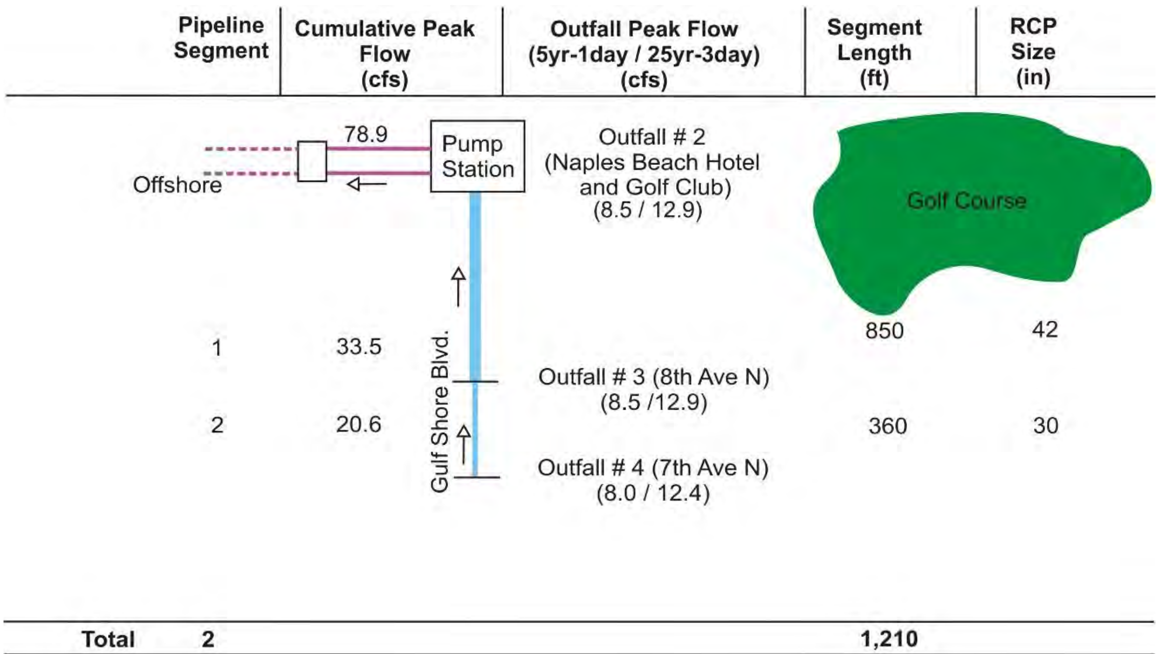


Figure 5-8. Schematic Pipeline Consolidation Plan for North System (Alternative 3: Preferred Alternative)

Table 5-5. Main Trunk Line North System Consolidation Plan (Alternative 3: Preferred Alternative)

Conveyance Direction	Outfall Collection	Segment Description	Peak Flow 25-Yr/3-Day Event (cfs)	Pipe Diameter (in)	Number of Pipes	Approx Length of Pipe (ft)	Maximum Peak Flow for Pipe System
PUMP STATION		**Naples Beach Hotel & Golf Club (current location of Outfall 2)**	**78.9**	**36**	**2**	**360**	**79.6**
↑	3 to 2	8th Ave N - Gulf Shore Blvd to Beach Club - Gulf Shore Blvd	33.5	42	1	850	36.6
	4 to 3	7th Ave N - Gulf Shore Blvd to 8th Ave N - Gulf Shore Blvd	20.6	30	1	360	21.2

South System

For the South System, the required peak discharge (LOS) of 166 cfs is based on the cumulative flow from a 25-Yr return period rainfall event. The primary site conditions that affected the pipeline design were the low elevation of Gulf Shore Blvd and the adjacent ROW as well as the cumulative capacity required to convey the peak flow for a 25-Yr event. A schematic of the consolidation plan is described by Table 5-6 and Figure 5-9, where the pipeline is consolidated near 3rd Avenue North (Outfall 7). The pipelines are consolidated between 6th Ave North and the pump station with feeder lines connecting to the main trunk line. Table 5-7 describes the key design elements of the consolidation plan for the Alternative 3 South System.

Table 5-6. Peak Flow Collection System Design for 25-Yr LOS
(Alternative 3 South System: Preferred Alternative)

Conveyance Direction	Outfall	Outfall Description	Quantity: Peak Flow for the 5-Yr/1-Day Event	Quantity: Peak Flow for the 25-Yr/3-Day Event	Collection System Flow	Cumulative Collection System Flow	Pump Station Flow Discharged to Gulf	System Overflow Flow Discharged to Gulf
	5	6th Avenue North	5.1	8.2	8.2	8.2		8.2
	Sub-Total (5)		*5.1*	*8.2*	*8.2*			
TOTAL - TO ALLIGATOR LAKE			**5.1**	**8.2**	**8.2**	**8.2**		
To Pump Station	6	Near Alligator Lake	34.2	76.1	76.1	76.1		
	7	3rd Avenue North	16.4	24.1	24.1	100.2		
	Sub-Total (6-7)		*50.6*	*100.2*	*100.2*			
Pump Station (South)						165.7	94.8	71.0
To Pump Station	8	2nd Avenue North	28.1	42.6	42.6	65.6		
	9	1st Avenue South	8.0	11.2	11.2	23.0		
	10	2nd Avenue South	8.1	11.8	11.8	11.8		
	Sub-Total (8-10)		*44.2*	*65.6*	*65.6*			
TOTAL - ALT 3 SOUTH			**94.8**	**165.7**	**165.7**	**165.7**	**94.8**	**79.2**

Note: all values are peak flow rates (cfs)

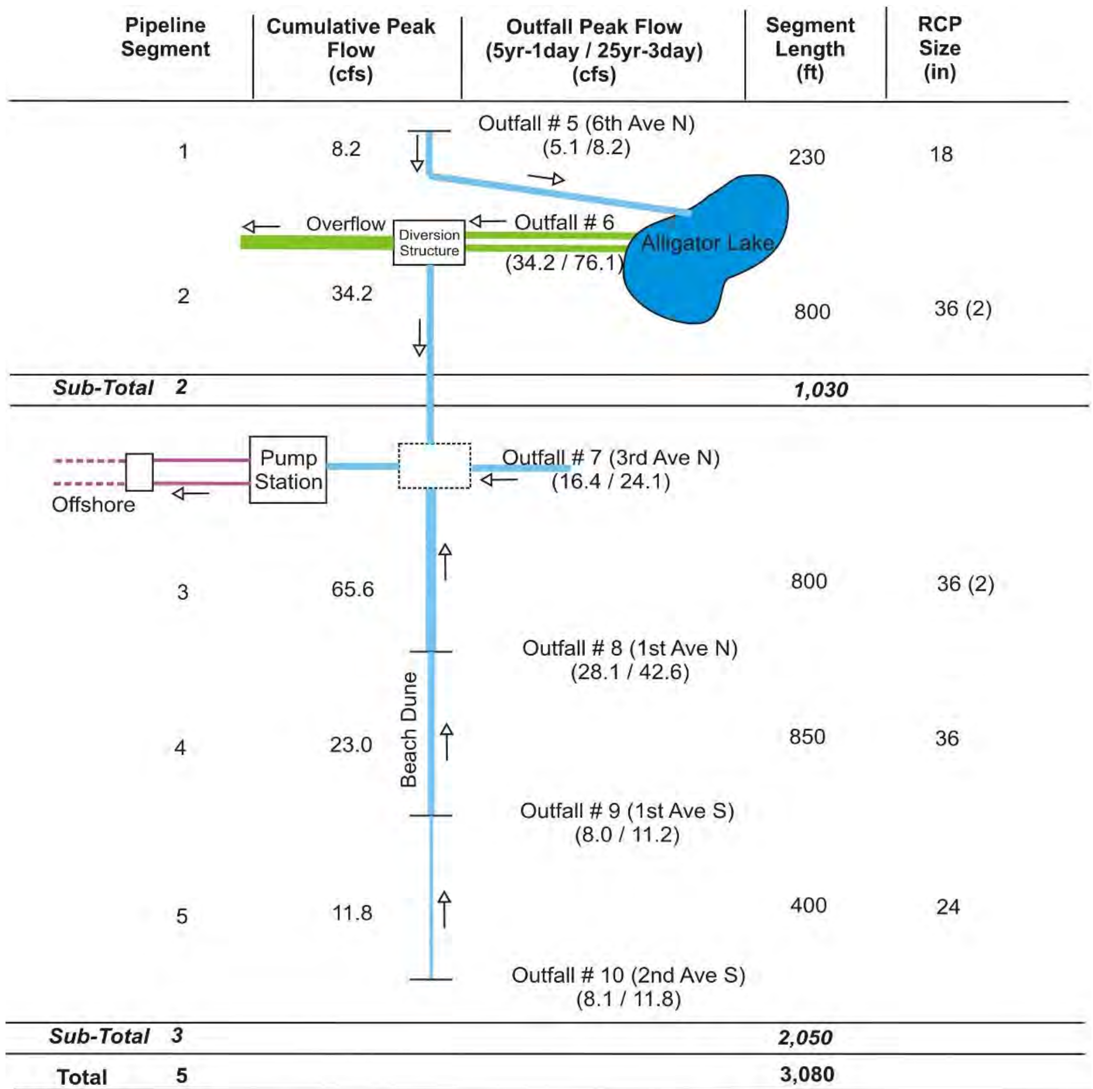


Figure 5-9. Schematic Pipeline Consolidation Plan for South System
(Alternative 3: Preferred Alternative)

As described in the figure above, a structure is required to attenuate the flow velocities and consolidate the four lines entering the 3rd Ave North pump station. In addition, a new diversion box structure will be constructed to divert flow during extreme low frequency storm events, which exceed the capacity of the pump station, to the system overflow. It was deemed most cost effective to divert flow and eliminate the requirement for multiple lines and a diversion structure near the pump station. At the 60% design level, the optimal design for this intersect, the diversion structure, and the grades/final elevations of the overflow line along the existing Outfall 6 easement will be evaluated.

Table 5-7. Main Trunk Line South System Consolidation Plan
(Alternative 3: Preferred Alternative)

Conveyance Direction	Outfall Collection	Segment Description	Peak Flow 25-Yr/3-Day Event (cfs)		Pipe Diameter (in)	Number of Pipes	Approx Length of Pipe (ft)	Maximum Peak Flow for Pipe System (cfs)
↓	5 to Alligator Lake	6th Ave N - Gulf Shore Blvd to Alligator Lake	8.2		18	1	230	10.7
Alligator Lake			**8.2**					
↓	6 to 7	Alligator Lake Control Structure to 3rd Ave N - Gulf Shore Blvd	76.1		36	1	800	38.9
			34.2	(5-Yr/ 1-Day)				
PUMP STATION		**3rd Ave N (current location of Outfall 7)**	**94.8**	**To Pump Station**	**36**	**1**	**100**	**96.3**
			71.0	**To Over-Flow**				
			165.8	**Total**				
↑	8 to 7	1st Ave N - Gulf Shore Blvd to 3rd Ave N - Gulf Shore Blvd	65.6		36	2	800	68.1
↑	9 to 8	1st Ave S - Gulf Shore Blvd to 1st Ave N - Gulf Shore Blvd	23.0		36	1	850	27.5
↑	10 to 9	2nd Ave S - Gulf Shore Blvd to 1st Ave S - Gulf Shore Blvd	11.8		24	1	400	12.0

An alternative pipeline route was evaluated to convey the south system flow from Outfalls 10, 9 and 8 to the pump station at 3rd Avenue North (at Outfall 7) which consolidated the pipeline in the back-beach below the elevation of the present seaward edge of dune vegetation. This alternative route would reduce construction costs associated with a new trunk line placement along Gulf Shore Blvd. The back-beach consolidated pipeline is sited to provide a minimum 3 ft sand cover over the top of pipe.

Consolidation routes and pipeline sizing are provided on the 30% design drawings (Appendix G).

The Outfall 6 overflow line for direct Gulf discharge will be located below the visible beach and will open by hydraulic force during extreme rainfall events. An evaluation of prior beach conditions and minimum widths over the last 25 years, and the present dune and vegetation locations and profile conditions provided the preliminary design basis for the siting and design of the new structure as seen in Figure 5-10.

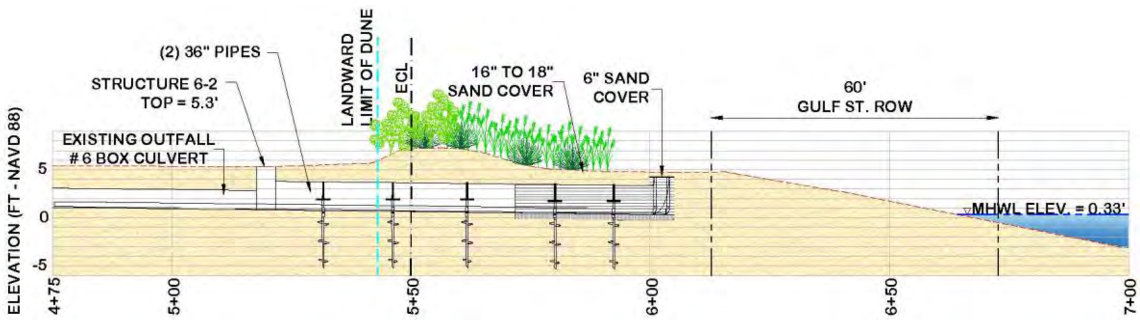


Figure 5-10. Overflow System Profile View

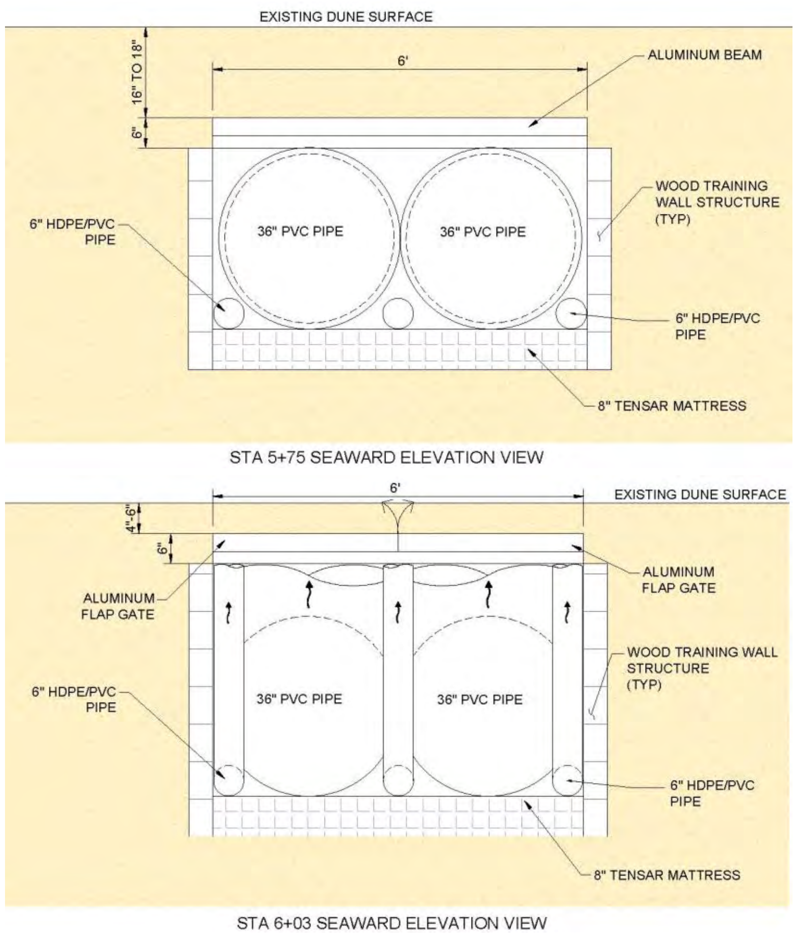


Figure 5-11. Overflow System Elevation Views

5.4 Pump Station

Alternative 3 (Preferred Alternative) will require the construction of two pump stations located in the vicinity of the Naples Beach Hotel and Golf Club (North System) and 3rd Avenue North (South System).

North System

The preliminary basis of design for the Alternative 3 North System pump station described in Table 5-8.

Table 5-8. Pump Station Basis of Design (Alternative 3: North System)

Pump Station Location	Easement Acquisition Required – Vicinity of Outfall 2
Consolidated Outfalls	2, 3, 4
Design Flow	71 cfs
QTY of Pump	Three 250 HP 24-Inch Diameter Mixed Flow Pumps with One Jockey Pump
Station Firm Capacity	35,413 gpm @ 38 ft TDH
Pump Station Footprint	22 ft x 30 ft
Number of Force Mains	Two 24-Inch Dia. Force Mains

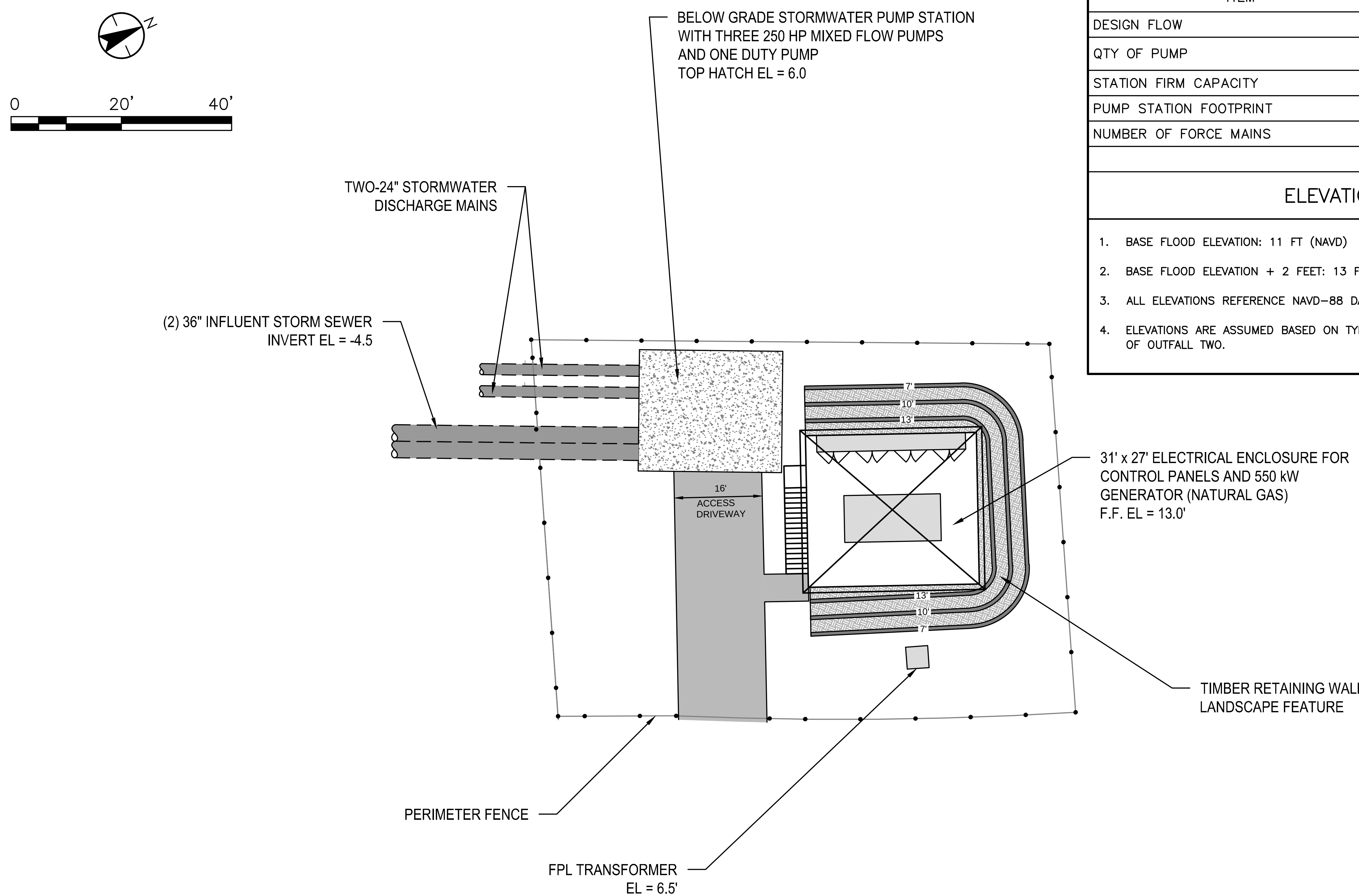
A preliminary site plan was developed for the Alternative 3 North System pump station to be located in the vicinity of Outfall 2 and will require that the City acquire an easement or property to accommodate the station and ancillary equipment (Figure 5-12). A preliminary site plan was developed for a typical pump station for the purposes of identifying the land requirements as well as the preliminary estimate of cost.

This Alternative 3 North System pump station design includes the construction of a below grade wet well and valve vault. The design includes an enclosure or building to house the electrical equipment and generator. The wet well and valve vault can be accessed through hatches that meet H20 loading requirements, which would allow for heavy duty loading (between 5,000 lbs and 7,499 lbs). The pump station is provided with Class 1 reliability so that the station can operate at design capacity with one of the pumps out of operation. The preliminary plan includes a perimeter fence at the edge of the easement and 16-foot access drive would allow maintenance vehicles to access the station and enclosure; however, fence and access requirements will depend on the actual site.

An emergency generator will be required for the north pump station. Table 5-9 lists the preliminary generator sizing for the Alternative 3 North System station.

Table 5-9. Emergency Power Requirements (Alternative 3: North System)

Pump Station Location	Easement Acquisition Required
Emergency Power Requirements	550 kW
Generator Footprint with Sound Enclosure	8.5 ft x 23.5 ft
Sound Enclosure Rating	NA



PUMP INFORMATION SUMMARY

ITEM	SPECIFICATION
DESIGN FLOW	ALTERNATIVE 3 = 79 CFS
QTY OF PUMP	THREE 250 HP 24-INCH DIAMETER MIXED FLOW PUMPS AND A DUTY PUMP
STATION FIRM CAPACITY	35,413 GPM @ 38 FT TDH
PUMP STATION FOOTPRINT	22' X 23'
NUMBER OF FORCE MAINS	2 - 24"

ELEVATION NOTES

1. BASE FLOOD ELEVATION: 11 FT (NAVD)
2. BASE FLOOD ELEVATION + 2 FEET: 13 FT (NAVD)
3. ALL ELEVATIONS REFERENCE NAVD-88 DATUM
4. ELEVATIONS ARE ASSUMED BASED ON TYPICAL ELVATIONS IN THE VACINITY OF OUTFALL TWO.

Naples Beach Restoration &
Water Quality Improvement Project

ALTERNATE 3 - NORTH SYSTEM TYPICAL PUMP STATION

Stantec
Stantec
3200 Bailey Lane
Suite 200
Naples, FL 34105
(239) 263-6403

Erickson Consulting Engineers, Inc.
ECE Erickson Consulting Engineers
7201 Delainey Court
Sarasota, FL 32420
(941) 373-6460

FIG. 5.12

Z:\CADD_Graphics\US Projects\15-304_Naples Outfalls\Exhibits\Fig.5.12_-SP_Alt3-NorthSystem.dwg May 20, 2016-8:31am

South System

The preliminary basis of design for the Alternative 3 South System pump station is described in Table 5-10.

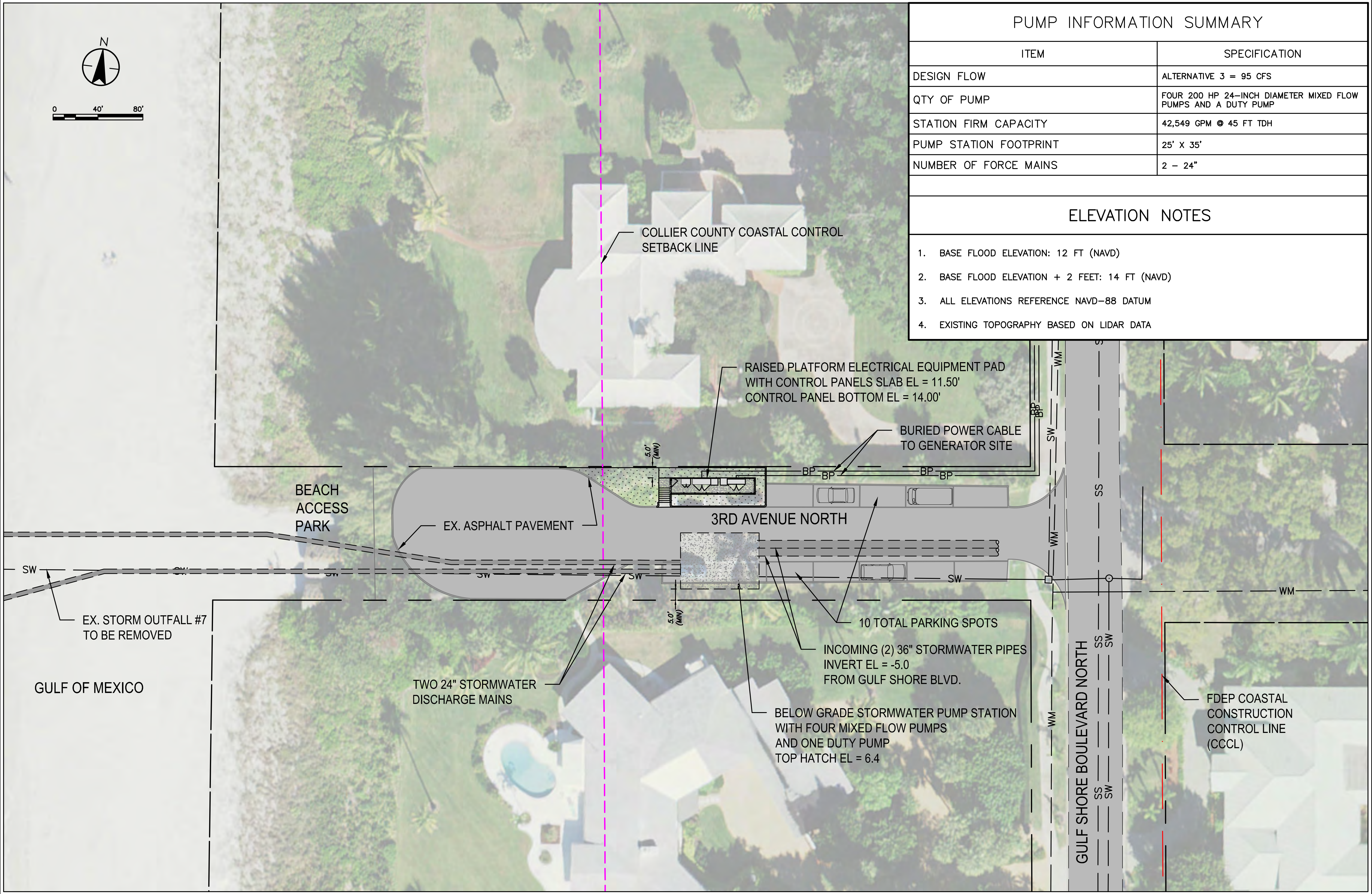
Table 5-10. Pump Station Basis of Design (Alternative 3: South System)

Pump Station Location	3rd Ave North
Consolidated Outfalls	6, 7, 8, 9, 10
Design Flow	94.8 cfs
QTY of Pump	Four 200 HP 24-Inch Diameter Mixed Flow Pumps with One Jockey Pump
Station Firm Capacity	42,549 gpm @ 45 ft TDH
Pump Station Footprint	25 ft x 35 ft
Number of Force Mains	Two 24-Inch Dia. Force Mains

A preliminary site plan was developed for the Alternative 3 South System pump station located at 3rd Ave North (Figure 5-13). This pump station includes the below grade wet well and valve vault with an above grade and elevated control panel structure with access stairs. The wet well and valve vault can be accessed through hatches that meet H20 loading requirements, which would allow for heavy duty loading (between 5,000 lbs and 7,499 lbs). The pump station is provided with Class 1 reliability so that the station can operate at design capacity with one of the pumps out of operation.

To maintain 3rd Avenue North pedestrian beach access to, the control panel and pump station were located 5 ft within the ROW. The site plan is such that maintenance vehicles can easily access the pump and control panels. This preliminary layout minimizes impact to public parking and pedestrian and vehicular access is maintained via 10 parking spaces.

The Alligator Lake site will house the generator elevated structure and automatic transfer switch. Improvements to the site will likely require the construction of a bulkhead retaining wall along Alligator Lake. Geotechnical investigations and preliminary structural engineering will be required to determine additional site requirements, such as the bulkhead retaining wall. Access to the generator was designed to minimize impervious area and consists of a stabilized geoweb material. There is the potential to regain public parking spaces at the Alligator Lake generator site.



PUMP INFORMATION SUMMARY

ITEM	SPECIFICATION
DESIGN FLOW	ALTERNATIVE 3 = 95 CFS
QTY OF PUMP	FOUR 200 HP 24-INCH DIAMETER MIXED FLOW PUMPS AND A DUTY PUMP
STATION FIRM CAPACITY	42,549 GPM @ 45 FT TDH
PUMP STATION FOOTPRINT	25' X 35'
NUMBER OF FORCE MAINS	2 - 24"

ELEVATION NOTES

1. BASE FLOOD ELEVATION: 12 FT (NAVD)
2. BASE FLOOD ELEVATION + 2 FEET: 14 FT (NAVD)
3. ALL ELEVATIONS REFERENCE NAVD-88 DATUM
4. EXISTING TOPOGRAPHY BASED ON LIDAR DATA

Naples Beach Restoration & Water Quality Improvement Project

ALTERNATIVE 3 - THIRD AVENUE NORTH (SOUTH SYSTEM PUMP STATION)

Stantec
3200 Bailey Lane
Suite 200
Naples, FL 34105
(239) 263-6403

Erickson Consulting Engineers, Inc.
7201 Delainey Court
Sarasota, FL 32420
(941) 373-6460

FIG. 5-13

In addition, the generators and ancillary equipment at the Alligator Lake site serve the 3rd Ave North pump station (Figure 5-14). Table 5-11 lists the preliminary generator sizing based the generator being enclosed in a sound enclosure rated for 63 to 78 d(B)A at 21 ft from the source when the generator is at full load.

Table 5-11. Emergency Power Requirements (Alternative 3: South System)

Pump Station Location	3rd Ave North
Emergency Power Requirements	650 kW
Generator Footprint with Sound Enclosure	8.5 ft x 23.5 ft
Sound Enclosure Rating	Level 2 Enclosure

5.5 Offshore Discharge System (Pipeline and Diffusers System)

Two pump stations are required to manage the flow for the 25-yr peak flow conditions for Alternative 3: one located in the vicinity of the Naples Beach Hotel and Golf Club (north system) and the other at 3rd Avenue North (south system).

North System

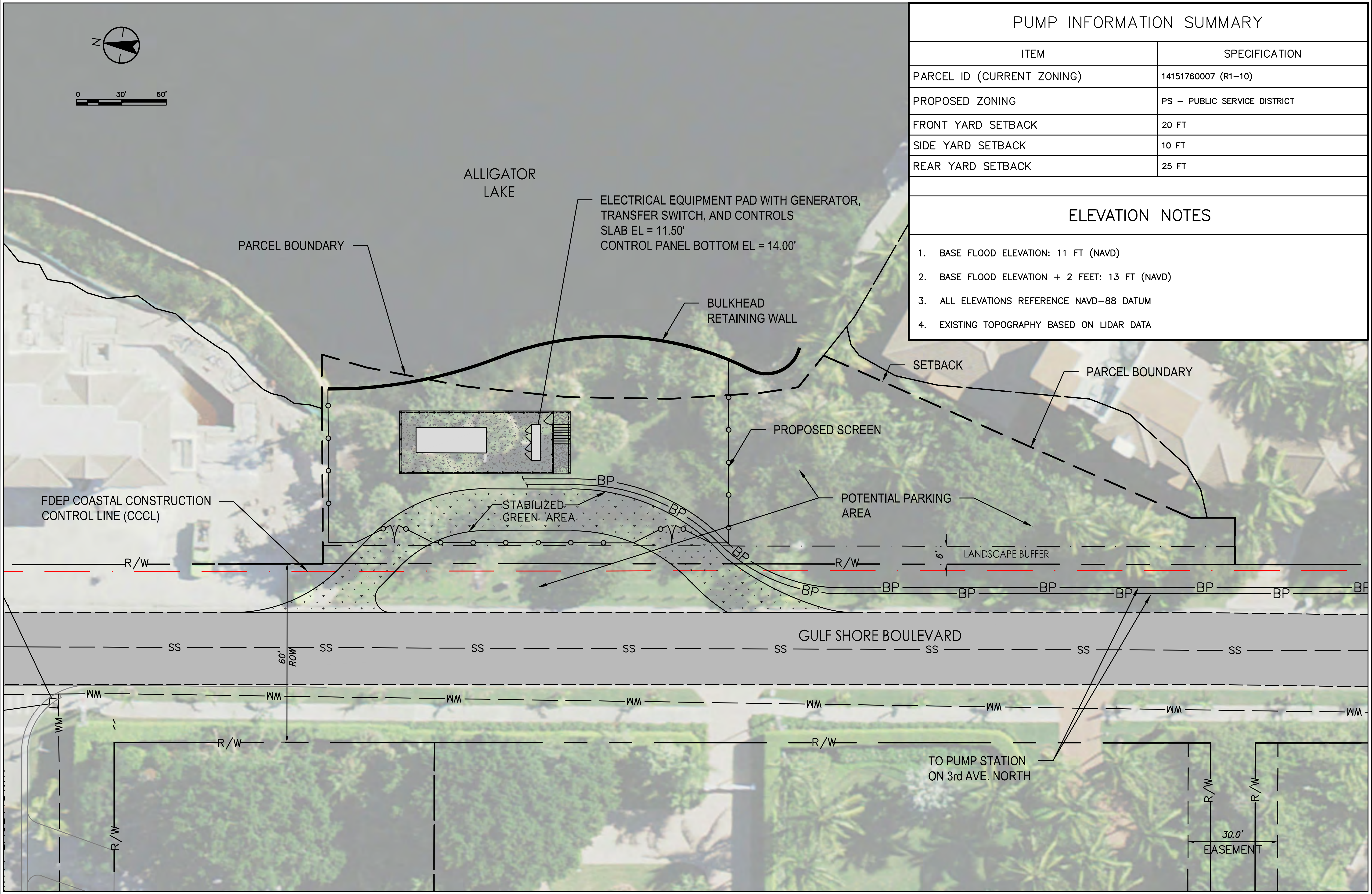
For the pump station in the vicinity of the Naples Beach Hotel and Golf Club (north system), the total peak system capacity requires two (2) 24 inch stormwater discharge mains exiting the pump station to convey water offshore at a discharge rate of 79 cfs through a HDD placed line. From this pump station, the HDD pipeline requires a total length of approximately 1,600 ft to emerge at the -16 ft (NAVD 88) depth contour. The pipeline alignment is designed for a pipeline length needed to maintain a 250 ft to 500 ft buffer (mixing zone) from the diffuser system to the hardbottom feature(s). In addition, these HDD pipelines are located outside the Collier County Beach Nourishment Project pipeline corridor (Figure 5-15).

The peak discharge flow rate through the pipeline and the required mixing velocity was evaluated to size the diffuser system. Mixing velocity (fps) determines the diameter of each diffuser and the number of diffusers required to disperse the peak discharge flow rate (cfs). Based on an economies of scale, the optimal diffuser size is approximately 8 to 10 inches in diameter with the required number of diffusers as estimated in Table 5-12.

Table 5-12. Diffuser Design for 79 cfs Pump Station (Alternative 3: North System)

Diffuser Dia (in)	Total Number of Diffusers[1]	Total Number of Diffusers/HDD[2]
8	30	15
10	15	8

Notes: The options above provide the diffuser configuration required to meet a discharge mixing velocity of approximately 8-10 fps[1]; two discharge pipelines (Alternative 3 North System)[2]



PUMP INFORMATION SUMMARY

ITEM	SPECIFICATION
PARCEL ID (CURRENT ZONING)	14151760007 (R1–10)
PROPOSED ZONING	PS – PUBLIC SERVICE DISTRICT
FRONT YARD SETBACK	20 FT
SIDE YARD SETBACK	10 FT
REAR YARD SETBACK	25 FT

ELEVATION NOTES

1. BASE FLOOD ELEVATION: 11 FT (NAVD)
2. BASE FLOOD ELEVATION + 2 FEET: 13 FT (NAVD)
3. ALL ELEVATIONS REFERENCE NAVD–88 DATUM
4. EXISTING TOPOGRAPHY BASED ON LIDAR DATA

Naples Beach Restoration & Water Quality Improvement Project

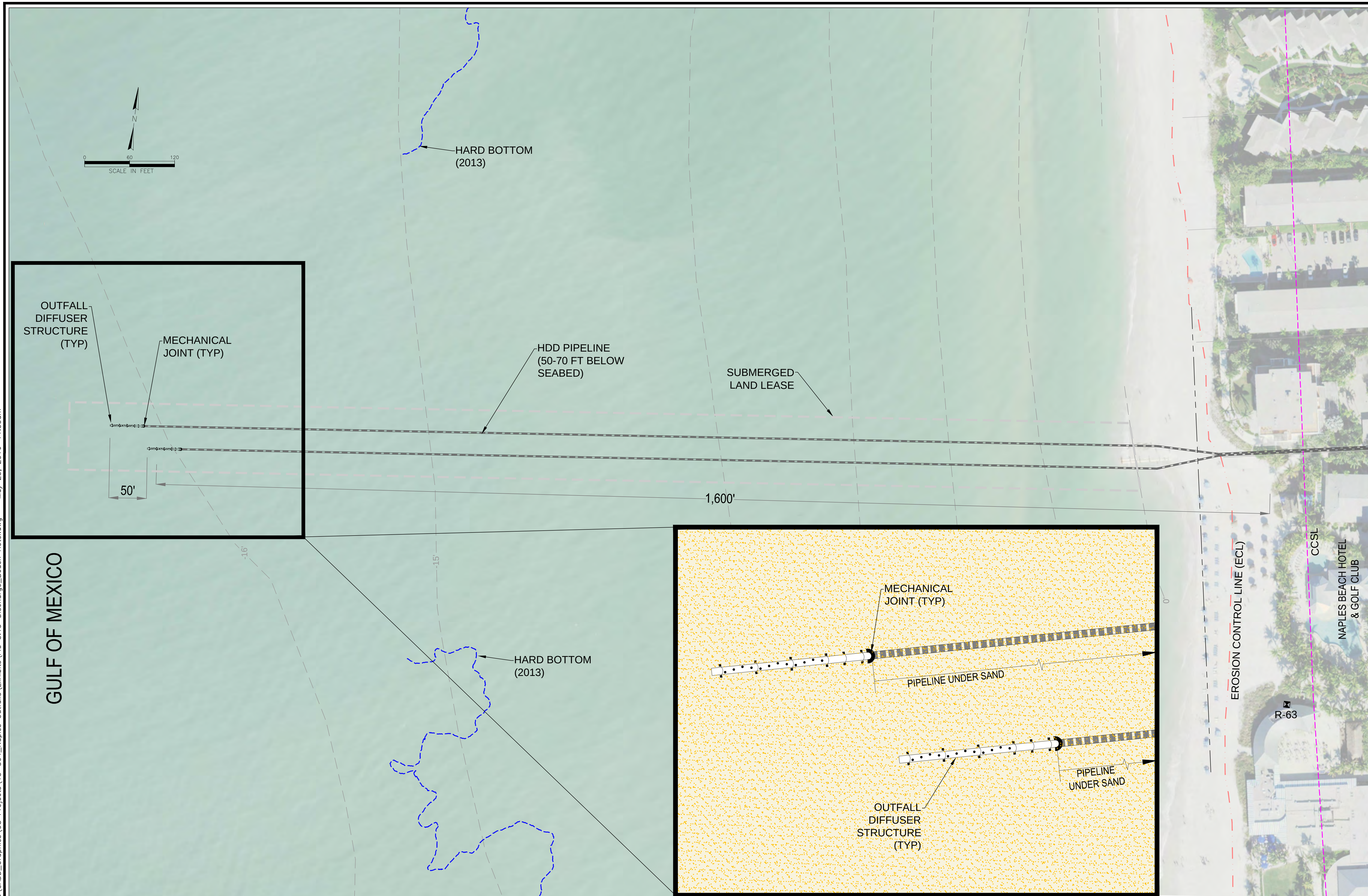
ALTERNATIVE 3 - GENERATOR SITE

Stantec
3200 Bailey Lane
Suite 200
Naples, FL 34105
(239) 263-6403

Erickson Consulting Engineers, Inc.
7201 Delainey Court
Sarasota, FL 32420
(941) 373-6460

FIG. 5-14

Z:\CADD_Graphics\US Projects\15-304_Naples Outfalls\Exhibits\Fig.5-13_Alligatore Lake PS Ancillary Site Plan Alt 3.dwg May 25, 2016-11:44am



Z:\CADD_Graphics\US Projects\15-304_Naples Outfalls\Exhibits\FIG 5.15-Discharge_Beach Hotel.dwg May 25, 2016-11:55am

DESIGNED BC | DRAWN JC | CHECKED KE
DATE: 04-29-2016
JOB NO. 15-304
SCALE: AS NOTED

NAPLES BEACH RESTORATION &
WATER QUALITY IMPROVEMENT PROJECT

SITING & ALIGNMENT OF NEARSHORE PIPELINE &
DIFFUSER WITH PUMP STATION AT 6TH AVE NORTH

Erickson Consulting Engineers, Inc.
7201 Delainey Court
Sarasota, FL 32420
(941) 373-6460

FIG. 5-15

At the location of pipeline emergence, an angled mechanical joint is recommended to transition from the HDD placed pipeline with an upward, angled orientation to the pipeline diffuser section that is parallel to the seabed. A second, straight mechanical joint is then placed within approximately 5-10 ft of the HDD emergence point to provide a diffuser system disconnect point for future (15-20 Yr) diffuser system replacement. Pipeline buoyancy, pipeline position support and anticipated loads on the diffuser system will dictate the anchoring system requirements. A conceptual diffuser system design is provided in Figure 5-16.

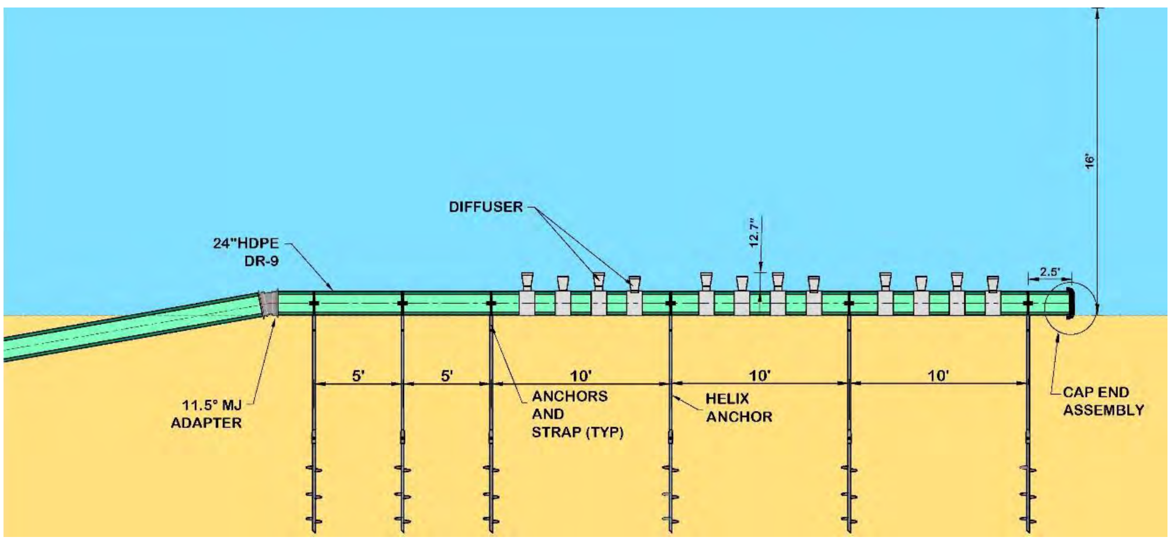


Figure 5-16. Conceptual Diffuser System

Pipeline buoyancy is calculated based on the pipeline material, the buoyancy of the discharged water and the displacement of the pipeline. These factor affect the loads that the anchor must counteract. Additional forces the must be considered include boat anchors and similar types of potential impacts and loads that could affect the discharge pipeline system. The integrity of the overall diffuser system is maintained by design of the diffuser components to breakaway, as the diffusers are significantly less expensive to replace than the entire diffuser system and the system will remain fully functional with the loss of individual diffusers.

<u>South System</u>

As described above, total peak system capacity for the south system requires two (2) 24 in stormwater discharge mains exiting the pump station to convey the water offshore at a discharge rate of 95 cfs via a horizontal directional drill (HDD) pipeline. The HDD line commences at a point landward of the dune, and requires a total length of approximately 1,000 ft to emerge at the -14 to -16 ft (NAVD 88) depth contour. The pipeline alignment is designed to minimize the pipeline length needed to maintain a 350 ft to 500 ft buffer from the diffuser system to the "3rd Avenue N. Mitigation Reef" hardbottom. The HDD emergence and diffuser system for the three pipelines are staggered to minimize the buffer necessary for freshwater discharge to diffuse and mix to background salinity (Figure 4-8).

For the Alternative 3 south system, the diffuser design options are listed in Table 5-13. Based on an economies of scale, the optimal diffuser size is approximately 8 to 10 inches in diameter.

Table 5-13. Diffuser Design for 95 cfs Pump Station (Alternative 3: South System)

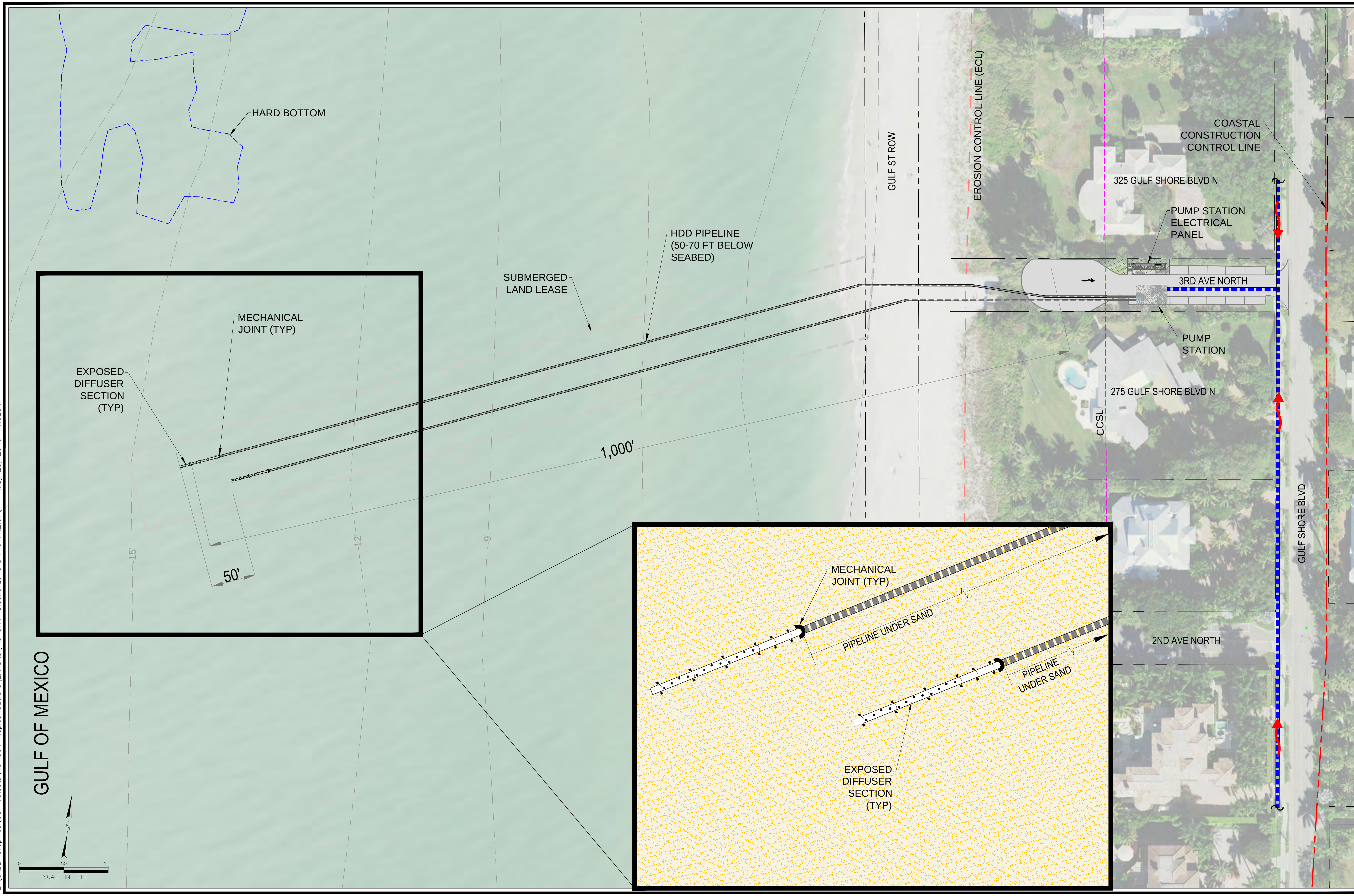
Diffuser Dia (in)	Total Number of Diffusers[1]	Total Number of Diffusers/Pipeline[2]
8	30	15
10	20	10

Notes: The *options above provide the diffuser configuration required to meet a discharge mixing velocity of approximately 8-10 fps[1]; two discharge pipelines for (Alternatives 2 and 3 South System)[2]*

5.6 Probable Project Costs and Schedule

A preliminary engineer's opinion of probable construction cost was developed for each of the main project components at the 30% design level. These costs are based on experience on similar projects as well as consultations with qualified construction contractors and the acquisition of quotes from various material and service suppliers. Actual construction costs will vary depending on final design quantities, permit conditions, material and contractor availability, economic climate and final site conditions encountered at the time of construction. Table 5-14 provides the overall Project cost by component. Cost estimates and assumptions are also provided in Appendix F.

Table 5-14 and Table 5-15 provides the probable design and permitting schedule for the Project. The duration for permitting the Project is expected to be anywhere from 12 to 18 months dependent upon the selected alternative and the related design components such as routing the pipeline along dune or along Gulf Shore Blvd.



Z:\CADD_Graphics\US Projects\15-304_Naples Outfalls\Exhibits\FIG 5.17-Discharge_3rd Ave_Alt2.dwg May 25, 2016-11:52am

DESIGNED BC | DRAWN JC | CHECKED KE
DATE: 04-29-2016
JOB NO. 15-304
SCALE: AS NOTED

NAPLES BEACH RESTORATION & WATER QUALITY IMPROVEMENT PROJECT

SITING & ALIGNMENT OF NEARSHORE PIPELINE & DIFFUSER WITH PUMP STATION AT 3RD AVE NORTH

Erickson Consulting Engineers, Inc.
7201 Delainey Court
Sarasota, FL 32420
(941) 373-6460

FIG. 5-17

Table 5-14. Engineer's Opinion of Probable Cost and Phasing (Alternative 3)

Item	Description	North System (Phase I)	South System (Phase II)
1	Mobilization/Demobilization	$496,530	$593,300
2	Outfalls Consolidation	$1,786,000	$2,507,300
3	Pump Station System	$1,809,200	$2,403,680
4	Water Quality Treatment System	$1,025,000	$1,387,500
5	HDD & Diffuser System	$2,882,000	$1,946,000
	Sub-Total (Items 1-5)	*$7,998,730*	$8,837,780
	Contingency (20%)	$1,599,700	$1,767,600
	Sub-Total by System	**$9,598,430**	**$10,605,380**
	Total	**$20,203,810**	

If the Alternative 3 south system is constructed first, the opportunity will exist in the future to construct the north system for Alternative 3 upon securing funding and procurement of an easement for use of land. Should land use for the Alternative 3 north system prove difficult to acquire, the City will have the option to reconfigure the lines to convert the system to construct the north system Alternative 2 design ***or*** Alternative 1. A similar approach can be used if the North System is selected as Phase 1. Cost savings related to reducing the frequency of beach nourishment is estimated at $2M over 10 years as a result of removing the 9 outfalls from the beach.

Table 5-15. Probable Design and Permitting Schedule

PROJECT TIMELINE AND MILESTONES

Activity	2015				2016												2017												2018											
	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Phase 1: Feasibility Study and 30% Design																																								
Assessment of Existing Information and Data (Physical, Biological, Environmental WQ and Stormwater), Supplemental Data Collection, Base Maps																																								
Stormwater Pump Station, Outfalls Consolidation and Offshore Gulf Discharge Feasibility Assessment																																								
30% Design, Regulatory Pre-Application Meetings																																								
Technical Report and Presentation to City Council																																								
City Selects Design Alternative(s) and Phasing										★																														
Phase 2: Project Design and Permitting																																								
Supplemental Site Investigations (geotechnical borings, Surveying) and Engineering																																								
Stormwater Modeling & Analysis																																								
Develop 60% Design																																								
Submit Permit Applications (Federal and State)																																								
RAI Responses and Permitting Coordination																																								
Final Design and Construction Document Preparation																																								
Phase 3: Construction																																								

6 OTHER CONSIDERATIONS

6.1 Regulatory Permits

Permitting of the Project requires coordination with State and Federal regulatory agencies including:

1. South Florida Water Management District (SFWMD)
2. Florida Department of Environmental Protection (FDEP)
3. U.S. Army Corps of Engineers (USACE)

6.1.1 South Florida Water Management District (SFWMD)

<u>Authority</u>

The South Florida Water Management District (SFWMD or "District") regulates stormwater management systems and activities with a focus on stormwater quantity and quality for residential and commercial developments through Chapter 62-330, FAC. While FDEP also regulates stormwater projects, there jurisdiction is typically limited to power plants, wastewater treatment plants and single-family home projects.

A stormwater project is considered by the District to be a stormwater retrofit project if it provides new or additional treatment capacity and improves flood control to an existing stormwater management system.

<u>Permit</u>

The Project is expected to require an Environmental Resource Permit (ERP) from SFWMD (or FDEP) and considered as a stormwater retrofit project as it improves both the quantity and quality of the existing stormwater system, and does not increase the dischargers of untreated water.

<u>Pre-Application Meeting</u>

A pre-application meeting was held with representatives from the SFWMD and FDEP on April 25, 2016 to review the project history and need, project goals and objectives, major project components and permitting considerations. This meeting included a discussion of prior similar permits issued in Sarasota County by the SWFMWD. There were no major concerns raised by any party that would deem the Project not permittable. SFWMD did indicate they would require additional modeling prior to acceptance of an ERP application. At the conclusion of the meeting, the inclination amongst the parties is that SFWMD would take the lead in permitting the Project.

A copy of the meeting notes are provided in Appendix I.

6.1.2 Florida Department of Environmental Protection (FDEP)

Authority

Chapter 161, Florida Statues (F.S.) regulates construction in the beach/coastal and nearshore zones. The State assigns the jurisdiction to the Florida Department of Environmental Protection (FDEP) for issuing permits for work occurring in the coastal and nearshore zones. These include (1) Joint Coastal Permit (JCP), (2) Environmental Resource Permit (ERP) and (3) Coastal Construction Control Line (CCCL) Permit.

The Beaches, Inlets & Ports Program of FDEP processes JCP applications. A JCP is required for activities that meet all of the following criteria:

- Located on Florida's natural sandy beaches facing the Atlantic Ocean, the Gulf of Mexico, the Straits of Florida or associated inlets;
- Activities that extend seaward of the mean high water line;
- Activities that extend into sovereign submerged lands; and
- Activities that are likely to affect the distribution of sand along the beach.

The Beaches, Inlets & Ports Program also processes ERPs in accordance with Chapter 373, F.S. The ERP review ensures that such construction activities do not degrade water quality (such as through the loss of wetlands, improper in-water construction techniques, or discharge of inadequately treated water from dredged material disposal sites), or damage marine resources (including corals, seagrasses, mangroves or habitat for manatees or marine turtles).

The CCCL Program processes permits for work and activities occurring seaward of the State's jurisdictional CCCL Line, governed by Chapter 62B-33, FAC.

In October 2000, the U.S. Environmental Protection Agency (EPA) authorized FDEP to implement the National Pollutant Discharge Elimination System (NPDES) stormwater permitting program in the State of Florida. The NPDES stormwater program regulates point source discharges of stormwater into surface waters of the State of Florida from certain municipal, industrial and construction activities.

Permit

As described above, the ERP is likely to be reviewed and issued by SFWMD with application review support for work occurring in or near coastal waters.

The Project is expected to receive an exemption letter for the offshore discharge pipeline, outfall diffuser structure, and the activity of horizontally directionally drilling (HDD) the pipeline. While these activities are located seaward of MHW, they do not in any way affect the sandy beach and therefore a JCP is not required. This precedent was set in permits issued to similar projects in Sarasota County.

The Project is expected to require a Coastal Construction Control Line (CCCL) permit for structures located seaward of the CCCL. These include the pump station and ancillary structures, as well as any temporary disturbances for the HDD staging. A CCCL permit would also be required to route pipeline along the dune.

In addition, the outfall diffuser structures will require a submerged lands lease from FDEP.

Construction/structures sited on sovereign submerged lands require a lease (i.e. easement) from the Submerged Lands Department. This lease are will be inclusive of the underground offshore discharge pipelines and the offshore diffuser and anchoring system.

The City currently holds a permit for Municipal Separate Stormwater Sewer System ("MS4") NPDES issued by the FDEP for management of stormwater discharges (Permit No. FLR04E080).

<u>Pre-Application</u>

A pre-application meeting was held with the FDEP CCCL and Engineering Departments on April 19, 2016 to review the Project history and need, Project goals and objectives, major Project components and permitting considerations. This meeting included a discussion of prior similar permits as well as HDD and offshore discharge pipeline exemptions issued previously in Sarasota County by FDEP. There were no major concerns raised that would deem the Project not permittable.

A copy of the meeting notes are provided in Appendix I.

6.1.3 U.S. Army Corps of Engineers (USACE)

<u>Authority</u>

The USACE regulates work and structures that are located in, under or over navigable waters of the United States. "Waters of the United States" are navigable waters, tributaries to navigable waters, wetlands adjacent to those waters, and/or isolated wetlands that have a demonstrated interstate commerce connection. Within the Project Area, the USACE exercises jurisdiction over the Gulf of Mexico and Alligator Lake under Section 10 (of the Rivers and Harbors Act of 1899).

Permit

The Project will require an Individual Permit from the USACE. The Project will be publically noticed on the Federal Register for a period of 15 to 30 days. In addition, the USACE is expected to solicit comments from the National Oceanic and Atmospheric Administration (NOAA) (to ensure charting of the utility line) as well as the U.S. Coastal Guard (to ensure this agency has no objection). Approval of USACE permits is contingent upon them being deemed to be in the public interest.

6.1.4 Local Permitting

The Alligator Lake parcel (1415176007) is within the City's R1-10 residential zoning district. The permitted uses in the district do not allow for a public utility facility to be permitted and construction. In order for the generator(s) to be built on this parcel, rezoning would be required. This site would be rezoned as a PS Public Service District.

To rezone a property for the construction of a stormwater pumping station, the City may complete a petition and submit it to the City Manager, together with the required fee and supportive materials as required. If the City Manager determines the rezone petition to be in order, the City Manager is required to notify property owners located within 500 ft of the property involved in the petition, informing them of the date, time, place and reason for the public hearing. The planning advisory board ultimately submits its recommendation for approval or disapproval, or approval with conditions, to the City Council. After considering the recommendation of the planning advisory board, the City Council may approve or deny the petition, or approve the petition with conditions.

6.1.5 Permitting Precedence

Two projects in Sarasota County with similar objectives were previously permitted the above identified regulatory agencies.

Siesta Beach Project

At Siesta Beach in Sarasota County, a single outfall was identified as a source of bacteria resulting in multiple no swim advisories on this high profile beach. The bacteria levels were found to be the result of blocked discharge from sand building which resulted in the flooding of the adjacent roadway. A directionally drilled pipeline (16") with offshore diffuser and anchoring system was permitted to discharge water collected and water quality treatment by an upland pump station. This project was constructed in 2013/14. This project was permitted by FDEP (CCCL Permit), SFWMD (ERP) and USACE (Individual Permit) for offshore pipelines with treated freshwater discharge in the Gulf of Mexico. In addition, an exemption from FDEP was issued for the pipeline and offshore diffuser and anchoring system.

City of Venice Project

The City of Venice designed a similar project to eliminate high bacteria counts through the use of 2-24" pipelines to discharge water collected and water quality treatment by a pump station. This project was permitted by FDEP (CCCL Permit), SFWMD (ERP) and USACE (Individual Permit) for offshore pipelines with treated freshwater discharge in the Gulf of Mexico. In addition, an exemption from FDEP was issued for the pipeline and offshore diffuser and anchoring system.

6.2 Grant Funding Opportunities

Water quality treatment will result in the greatest potential for funding from the State and potentially the US Army Corps of Engineers. Secondarily, increased LOS (flood control) may lend itself to additional funding opportunities. Sources of potential funding are described individually below and summarized in Table 6-1.

- **TDML Water Quality Restoration Grants (FDEP)**
  The TDML program provides State funding to local governments for the implementation of Urban Stormwater BMPs. Projects which reduce stormwater pollutant loadings from urban areas that discharge to impaired water bodies in the State of Florida are eligible, with a specific emphasis on stormwater retrofit projects. Funds are available for construction, project related monitoring and project related public education. Land acquisition as well as engineering and design are ineligible for funding. Funding requires a 50% match with 25% of that coming from the local government. Eligible match activities include construction, design, engineering, monitoring, public education and land acquisition.

- **EPA 319(h) Clean Water Act Grants (FDEP)**
  EPA 319(h) are federally funded grants awarded by FDEP for projects or programs that are designed to reduce nonpoint sources of pollution. These projects must be conducted within the state's NPS priority watersheds, which are the state's SWIM watersheds and National Estuary Program waters. Projects that solely treat stormwater after it has entered a major conveyance system are ineligible. As such, the current project must be combined with existing City stormwater BMP efforts to achieve funding should the funding agency find this acceptable. Funds are available for construction, monitoring to evaluate BMP effectiveness and public education activities associated with the project. Projects must include a minimum

40% non-federal match. Eligible match activities include construction, design, engineering, monitoring and public education.

- **Clean Water State Revolving Loan Program (FDEP)**
  The Clean Water State Revolving Fund is a financial assistance program for water infrastructure, capitalized by federal grants through EPA. The program provides low interest loans to local governments to plan, design and build/upgrade stormwater facilities. The loan terms include a 20-year amortization and low-interest rates which typically average less than 50 percent of the market rate.

- **Cooperative Funding Initiative (SFWMD)**
  The stormwater component of the Cooperative Funding Program was established to share the cost of local projects that address water quality and flooding issues caused by stormwater runoff. Public and private entities including local governments, districts, utilities, gold courses, homeowner associations, agricultural interests and other water users are eligible to apply. The District's focus is stormwater *and* water quality improvements. Projects which only provide for flood protection do not qualify. Funding requires a 50 percent match.

- **Restore Act (Deepwater Horizon)**
  The Restore Act provides funding for environmental restoration within 23 Gulf Counties as settlement for the Deepwater Horizon Oil Spill. Restore Act Funding is separated into three "pots" as follows:

  - Pot 1 (Direct Component). The RESTORE Act Direct Component (Pot 1) allocates funds directly to each of the 23 Florida Gulf Coast counties pursuant to a formula specified in the RESTORE Act. The final project ranking for Pot 1 funds was completed in September 2013. The City's Project for "Stormwater Beach Outfall Removal – Re-routing Outfalls 9-10 to Basin III" was ranked #4 requesting funds in the amount of $750,000 with a City match of $200,000.

  - Pot 2 (Council Selected Component). The primary focus of these funds is directed towards environmental restoration projects with regional ecological benefits. The removal of the beach outfalls significantly improves water quality and restores habitat along a mile of shoreline and may be eligible along competition for the funds is expected to be high.

- Pot 3 (Spill Impact Component). Pot 3 is controlled directly by the Florida Gulf Coast Consortium, with funding for coastal flood protection and related infrastructure and restoration and protection of natural resources, ecosystems, fisheries, marine and wildlife habitats, beaches and coastal wetlands of the Gulf Coast region. Planning, design and construction phases are eligible for funding.

6.3 Stakeholder Involvement

Potential project stakeholders were identified early in the alternatives development and evaluation process. These stakeholders include:

- City of Naples (Streets & Stormwater, Maintenance, Utilities, Natural Resources)
- Local community
- State (Water Management District, FDEP) and Federal (USACE) Governments
- NGOs (e.g. Conservancy of Southwest Florida, Waterkeeper Alliance)
- Contractors (local, international)

City staff including representatives from the Streets and Stormwater, Maintenance, Natural Resources and Utilities departments have been intricately involved in the Project development through meetings and workshops.

During the development and evaluation of alternatives, meetings were also held with the Conservancy of Southwest Florida and the Waterkeeper Alliance, as well as the Naples Beach Hotel and Golf Club, to gain input during the development of the Project alternatives, with coordination continuing through alternative selection and development of the 30% design.

While a specific public meeting was not held with the local community, this stakeholder has voiced their opinions and concerns which have driven the solutions to date through the Council. Prior council meetings and statements from the community were reviewed and considered in developing and assessing the alternatives and developing the 30% design.

Stakeholder involvement will continue to be incorporated into the next steps of the Project.

Table 6-1. Summary of Potential Funding Opportunities

Agency	Funding Source	Program Description	Eligibility	Activities Funded	Critical Dates	Funding Available	Comments
FDEP	TMDL Water Quality Restoration Grants	Annual State funding for implementation of Urban Stormwater BMPs	Local governments ; Water Management Districts	Projects which **reduce stormwater pollutant loadings from urban areas** that discharge to impaired State waterbodies**;** primarily targeted for **stormwater retrofit projects.**	Applications are continually accepted and projects are ranked in March, July and November; The project must be at the 60% design phase.	$3M annually	The applicant provides a minimum of 50% of the total project cost in matching funds, of which at least 25% are provided by the local government
FDEP	EPA through Section 319(h) of the Federal Clean Water Act	Projects or programs which reduce nonpoint sources of pollution; must be conducted within the state's NPS priority watersheds, which are the state's SWIM watersheds and National Estuary Program waters.	State agencies, local governments, colleges, universities, nonprofit organizations, public utilities, and state water management districts; Projects that implement point source pollution improvements that treat stormwater after it has entered a major conveyance system are ineligible.	Demonstration and evaluation of BMPs, nonpoint pollution reduction in priority watersheds, ground water protection from nonpoint sources, public education programs on nonpoint source management, etc	Project proposals are due each year in late May with project selection completed by September.	$7M annually	40% nonfederal match required; improvements that treat stormwater after collection is ineligible, add on public education and other project elements to procure funding.
FDEP	Clean Water State Revolving Fund Loan Program (CWSRF)	Low-interest loans to local governments for water pollution control facilities.	Local governments	Projects must be cost-effective, environmentally and financially sound and consistent with local comprehensive plans; public participation must be provided; loan repayment plan must be detailed.	Revolving	$200M million annually ($25M segment cap)	The Loan Terms include a 20-year amortization and low-interest rates which average less than 50 percent of the market rate.
SFWMD	Cooperative Funding Program	State shared cost of local projects that address water quality and flooding issues caused by stormwater runoff.	Public and private entities including local governments, districts, utilities, gold courses, homeowner associations, agricultural interests and other water users.	The District's focus is stormwater and **water quality improvements,** if the project is for flood protection only, it would not qualify.	Annual awards; Funding application due May 20 for the 2016 open application period.	Varies	Minimum 50 percent match will be required for all projects

Deepwater Horizon	Restore Act (Pot 1) - Direct Component	The RESTORE Act Direct Component (Pot 1) allocates funds directly to each of the 23 Florida Gulf Coast counties pursuant to a formula specified in the RESTORE Act.	Gulf Coast Consortium	Stormwater Beach Outfall Removal – Re-routing Outfalls 9-10 to Basin III is **currently ranked #4**.	Not currently accepting new applications.	$750,000 with a City match of $200,000	
Deepwater Horizon	Restore Act (Pot 2) -Council Selected Component	Initial Funded Priorities list was released December 9, 2015. The Council is focusing on 10 key watersheds across the gulf. Possible fit with the "Gulf of Mexico Conservation Enhancement Grant Program"	Gulf Coast Consortium, primarily for environmental restoration with regional ecological benefits.	Enhancing land protection and conservation; improve habitats and water quality on conserved lands; restoring and managing critical aquatic shoreline and upland habitat utilizing hydrologic, landscape, vegetation and wildlife management actions; **implement water quality and habitat restoration** techniques.	Reviewed once per year	Future amounts unknown	
Deepwater Horizon	Restore Act (Pot #3) - Spill Impact Component	Council administrates this pot; states must complete State Expenditure Plans for council approval before receipt. Allocation of funds per state was effective on April 12, 2016.	Gulf Coast Consortium	Coastal flood protection and related infrastructure; Restoration and protection of the natural resources, ecosystems, fisheries, marine and wildlife habitats, beaches and coastal wetlands of the Gulf Coast region	Continual through online project portal.	Future amounts unknown	

7 SUMMARY

Currently, the City of Naples Drainage Basin II system collects stormwater and discharges through nine publically owned outfalls located within the intertidal beach “swash” zone which serves a drainage area of approximately 395 acres. This report assesses the feasibility and design requirements to consolidate the nine publically owned outfalls to a stormwater pump station(s) in a location that would receive all or a portion of the stormwater currently discharging along Naples Beach within Drainage Basin II; and discharge the collected and treated stormwater through a deep drilled offshore gulf discharge pipeline(s).

Once the design requirements were identified, three viable alternatives were identified and the designs further developed for evaluation and ranking. The alternatives were developed to give the City Council a range of alternatives that are practical and meet the prescribed Project goals and objectives which include:

1. Reduce flooding and improve water quality;
2. Eliminate erosion rates from outfall induced scour and improve lateral beach access by removing pipelines;
3. Reduce adverse impacts to the beach and nearshore natural resources (sea turtles and hardbottom);
4. Meets or exceeds the existing L*evel of Service* (LOS) to convey flow and improve the stormwater system’s resilience for:
    a. 5-yr/1-hr rain event (City of Naples Comprehensive Plan) and
    b. 25-yr/3-day rain event (SFWMD);
5. Convey treated stormwater to a pump station(s) and offshore; and
6. Community education and outreach (project goals & objectives).

To evaluate the alternatives, an analysis of the required LOS, available Gulf front/adjacent sites and characteristics, pipeline consolidation and pump station design requirements, and nearshore resources and beach features was performed to assess the benefits and sensitivities of each alternative. Representatives from the design team and City Staff (Streets & Stormwater and Natural Resources) assembled to discuss and score each criteria on April 25, 2016 across various technical, economic and social criteria.

“Alternative 3” scored the highest primarily due to (a) greatest percentage of flow consolidated, (b) resulting effectiveness per dollar spent, as well as removal of all outfalls from the visible beach, (c) scalability that would allow the system to be constructed in phases, (d) its highest beneficial environmental and social impacts, and (e) consolidation of the existing stormwater lines results in the shorter line length and cost. Alternative 3 ("Preferred Alternative") is comprised of a "North System" and "South System" as follows:

- **North Drainage and Treatment System** – consolidates the existing stormwater flow associated with Outfalls 2, 3 and 4 (25-Yr) and conveys the flow to a pump station located in the vicinity of the Naples Beach Hotel and Golf Club with treatment and discharge lines deep drilled and a diffuser system placed offshore in the Gulf. All pipeline consolidation is along Gulf Shore Blvd. The north system treats 100% of the 25-yr peak flow through the pump station.

- **South Drainage and Treatment System** - consolidates the existing stormwater flow associated with existing Outfalls 5, 6, 7, 8, 9 and 10 (25-Yr) and conveys the flow to a pump station located at 3rd Avenue North with treatment and discharge (5-Yr) through a diffuser system using directional drilled deep pipelines offshore. The south system treats 77% of the 25-yr peak flow through the pump station. An overflow line will be located at Outfall 6 to convey stormwater during extreme storm events, when peak discharge volumes exceed the maximum rates for the pump stations, by diverting the flow from Alligator Lake. The overflow line will be located below the visible beach and open only during extreme storm events, estimated to occur once in 10-15 years. The potential exists for pipeline consolidation along the back-beach or Gulf Shore Blvd.

The Preferred Alternative offers the most flexibility with regard to construction phasing and future expansion. For example, if the Alternative 3 south system is constructed first, the opportunity will exist in the future to construct the north system for Alternative 3, upon securing funding and procurement of an easement for use of land. Should land use for the Alternative 3 north system prove difficult to acquire, the City will have the option to convert the system to modify the north system to convey flow south to construct either the Alternative 2 ***or*** Alternative 1 project designs.

Meetings were held with stakeholders to receive input during the development and evaluation of the project alternatives, including the Conservancy and the Water Keepers Alliance as well as the governmental regulatory agencies.

An evaluation of the permits requirement, and consultation with key regulatory agencies, indicates that the regulatory agencies responsible for the Project permits are supportive of the Project.

Seven potential sources of grant funding were identified. The incorporation of water quality treatment into the Project will result in the greatest potential for funding from the State.

The Preferred Alternatives provides a low impact coastal, environmental and stormwater engineering design which provides a unique design that utilizes directionally drilled pipeline and a diffuser system, and pump stations with a filtration and UV treatment system to solve chronic flooding and water quality problems.

8 REFERENCES

AECOM. (2012). *Beach Stormwater Outfalls Hydrologic and Hydraulic Modeling for Existing Conditions.* City of Naples.

AECOM. (2013). *Beach Stormwater Outfalls Alternatives Preliminary Assessment, a Technical Report.* City of Naples.

Baxter. (2009, April 27). *Collier County Heavy Rain-Flood September 29, 2003*. Retrieved from National Weather Service Weather Forecast Office: http://www.srh.noaa.gov/mfl/?n=wet_collier_county

CB&I. (2015, January 12). Attachment 24: Permit Sketches. *Collier County Beach Nourishment Project - JCP Application*. FDEP.

CB&I. (2015, January). Attachment 28: Natural Community Classification. *Collier County Beach Nourishment Project, Joint Coastal Permit Application*. Naples, FDEP.

CB&I. (2015, January 12). Attachment 33a: Effects on the Coastal System. *Collier County Beach Nourishment Project - JCP Application*. FDEP.

CP&E. (2004, June 7). Attachment 2: Beach Profile Equilibration Analysis. *Collier County Beach Renourishment Project - JCP Application*.

CP&E. (2012, November). Attachment 5: Biological Assessment. *Collier County Beach Renourishment Project*. Naples: FDEP.

Division of Water Resources Management. (2015). *Critically Eroded Beaches in Florida.* Tallahassee, FL: FDEP.

Doyle, T. (2009). *Naples Florida Hurricane Information*. Retrieved from Naples Florida Real Estate: http://naplesinsider.com/naplesarea/hurricaneinformation.htm

EPA. (2015b). *State Development of Numerica Criteria for Nitrogen and Phosphorus Pollution*. Retrieved from EPA Laws and Regulations: http://cfpub.epa.gov/wqsits/nnc-development/

FDEP. (2010). *Surface Water Quality Standards Chapter 62-302*.

Grady Minor. (2015). *Stormwater Management Report for Naples Beach Hotel Golf Course.*

Gulfshore Engineering, Inc. (2009). *Conceptual Stormwater Management Analysis.* Collier County.

Humiston and Moore. (2010). *City of Naples Outfall System Coastal Impact Assessment and Management, a Technical Memorandum.* Collier County.

Natinoal Weather Service. (2016). *NWS Miami-South Florida* . Retrieved from National Weather Service Weather Forecast Online: http://www.srh.noaa.gov/mfl/

Rainwater Management. (2016). *Stormfilter Media Filtration*. Retrieved from Rainwater Management Products: http://www.rainwatermanagement.ca/products/stormfilter-media-filtration/

Rocla. (2016). *Downstream Defender*. Retrieved from Water Quality Seperation Products: http://www.rocla.com.au/Downstream-Defender.php

SFWMD. (2014). *SFWMD Environmental Resource Permit Applicant's Handbook, Volume II.*

APPENDIX A

DATA COMPILATION

&

SUPPLEMENTAL INFORMATION

APPENDIX A1

KEY DATA AND RESOURCES

Key Data and Resources Compiled for 30% Design and Report

Author	Date	Title
AECOM	April 2013	City of Naples Beach Outfall Management Evaluation - Beach Stormwater Outfall Alternatives Preliminary Assessment
AECOM	Nov. 2012	City of Naples Beach Outfall Management Evaluation - Beach Stormwater Outfalls Hydrologic and Hydraulic Modeling for Existing Conditions
AECOM	2013	AECOMM SWMM Model Results (5Yr/1hr, 5Yr/1Day & 25Yr/3Day)
AMEC	Sept. 2014	Collier County Floodplain Management Plan
CB&I	Jan. 2015	JCP Application for Beach Re-Nourishment on Behalf of Collier County
City of Naples	Jan. 2015	Cardno Water Quality Testing in Alligator Lake
City of Naples	2007	Upland Elevation Lidar Data (NGVD 29 vertical datum)
City of Naples		Stormwater System GIS Data
City of Naples		Utilities GIS Data
City of Naples		GIS Property, Land Use and Zoning Boundaries
Collier County	2015	Collier County Property Appraiser (Georeferenced) Aerials
Collier County		Beach Nourishment and Maintenance Activities Construction Easements
Collier County		FEMA Designations and Delineations of Flood Zones and Elevations
CPE		Collier County Hardbottom Mapping, Biological Monitoring and Habitat Assessments (2003, 2008, 2009, 2012 and 2015)
CPE		Beach Re-Nourishment Design Reports and Post-Construction Monitoring Reports (2003, 2007, 2009, 2011 and 2015)
DOH		Beach Water Quality Results
ECE	Mar. 2016	Field Data Collection (Dune Vegetation Mapping and Elevations)
ECE	upcoming	Water Quality Sampling and Testing (Benchmark EnviroAnalytical)
ECE & Stantec	Nov. 2015	Field Data Collection (Outfall Invert and Stormwater Conveyance System)
ECE & Stantec	Oct. 2015	Field Data Collection (Stormwater Conveyance Symbol)
FDEP	1978-2015	Beach Offshore Profiles (NAVD 88 (ft) vertical datum)
FDEP		Coastal Construction Line (CCL) and Erosion Control Line (ECL)
Florida Climate Center at FSU		Historic Rainfall Data
Grady Minor	Nov. 2015	Stormwater Management Report for Naples Beach Hotel Golf Course ERP
Humiston & Moore Engineers	Feb. 2010	City of Naples Outfall System Coastal Impact Assessment & Management
Stantec		FLUCCS, NWI and NRCS Soils Maps
USFWS	May 2011	Statewide Programmatic Biological Opinion for USACE for Planning and Sand Placement on Critical Florida Beach Habitats
Weather Underground		Historic Rainfall Data
		Geotechnical Reports for Private Beachfront Homes

H:\Projects_USA\Naples - Outfalls\Reports by ECE\30% Design Report\Appendices\A_Data Compilation\Naples Outfalls 30% Design_Key Resources.docx

APPENDIX A2

SITE PHOTOS

Erickson Consulting Engineers, Inc.

SITE PHOTOS

FOR: **30% Design Report Appendix**

RE: **Existing outfall conditions site photos from 10/27/2015 and 11/05/2015 field work**

OUTFALL #1 – Mansion House Condos

Figure 1 – Outfall #1 Looking East

Figure 2 – Outfall #1 Looking West

Figure 3 – Outfall #1 Looking West

Figure 4 – Outfall #1 Looking South

Figure 5 – Outfall #1 Looking North

Figure 6 – Outfall #1 Looking South

OUTFALL #2 – Naples Beach Hotel and Golf Club

Figure 7 – Outfall #2 Looking East

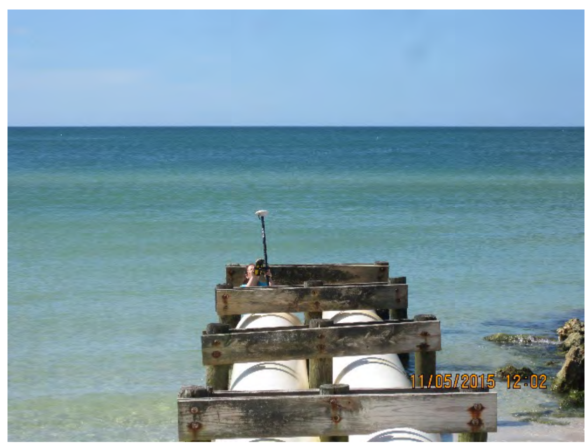


Figure 8 – Outfall #2 Looking West

Figure 9 – Outfall #2 Looking West

Figure 10 – Outfall #2 Looking South

Figure 11 – Outfall #2 Looking North

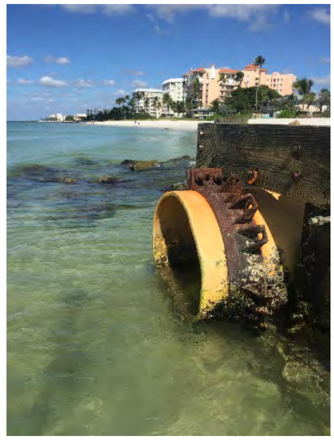


Figure 12 – Outfall #2 Looking North

OUTFALL #3 – 8th Avenue North

Figure 13 – Outfall #3 Looking East

Figure 14 – Outfall #3 Looking West

Figure 15 – Outfall #3 Looking North

Figure 16 – Outfall #3 Looking South

OUTFALL #4 – 7th Avenue North

Figure 17 – Outfall #4 Looking East

Figure 18 – Outfall #4 Looking West

Figure 19 – Outfall #4 Looking Northwest

Figure 20 – Outfall #4 Looking South

Figure 21 – Outfall #4 Looking North

OUTFALL #5 – 6th Avenue North

Figure 22 – Outfall #5 Looking East

Figure 23 – Outfall #5 Looking West

Figure 24 – Outfall #5 Looking Southwest

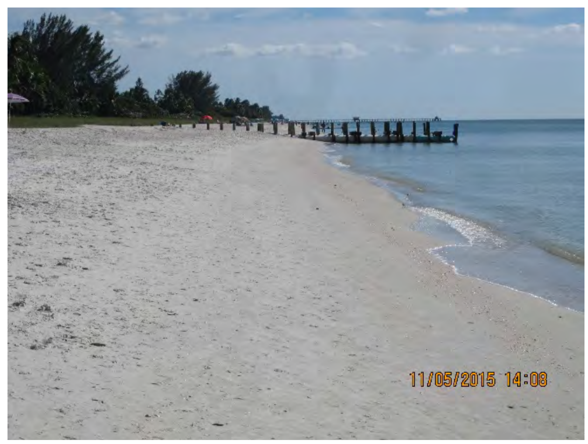


Figure 25 – Outfall #5 Looking South

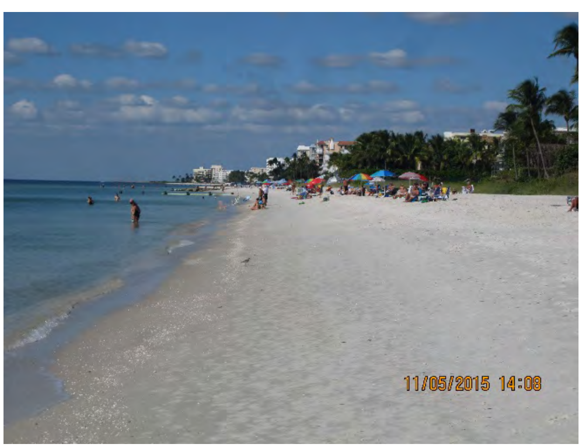


Figure 26 – Outfall #5 Looking North

Figure 27 – Outfall #5 Looking Northwest

Alligator Lake

Figure 28 – Outfall #8 Looking East

Figure 29 – Outfall #8 Looking West

Figure 30 – Outfall #8 Looking North

Figure 31 – Outfall #8 Looking South

OUTFALL #6 – Southlake Drive

Figure 32 – Outfall #6 Looking East

Figure 33 – Outfall #6 Looking West

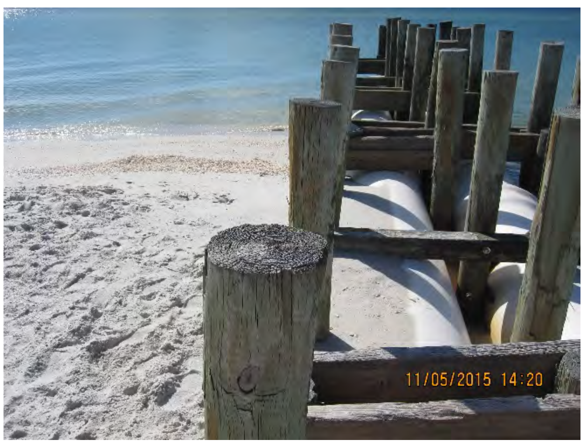


Figure 34 – Outfall #6 Looking West, South Side

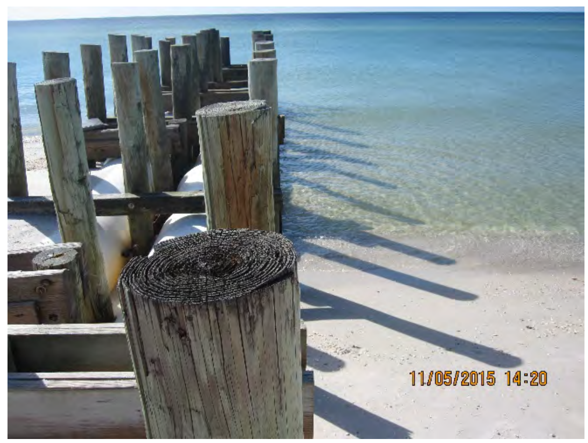


Figure 35 – Outfall #6 Looking West, North Side

Figure 36 – Outfall #6 North-side of North-pipe

Figure 37 – Outfall #6 South-side of South-pipe

Figure 38 – Outfall #6 Looking South

Figure 39 – Outfall #6 Looking North

OUTFALL #7 – 3rd Avenue North

Figure 40 – Outfall #7 Looking East

Figure 41 – Outfall #7 Looking West

Figure 42 – Outfall #7 Looking North

Figure 43 – Outfall #7 Looking South

OUTFALL #8 – 1st Avenue North

Figure 44 – Outfall #8 Looking East

Figure 45 – Outfall #8 Looking West

Figure 46 – Outfall #8 Looking North

Figure 47 – Outfall #8 Looking South

OUTFALL #9 – 1st Avenue South

Figure 48 – Outfall #9 Looking East

Figure 49 – Outfall #9 Looking West

Figure 50 – Outfall #9 Looking West

Figure 51 – Outfall #9 Looking North

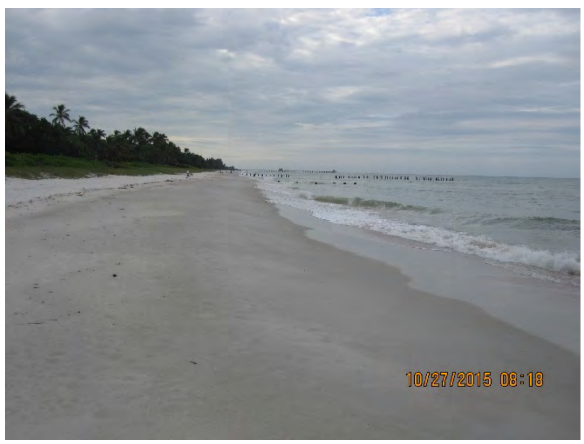


Figure 52 – Outfall #9 Looking South

OUTFALL #10 – 2nd Avenue South

Figure 53 – Outfall #10 Looking East

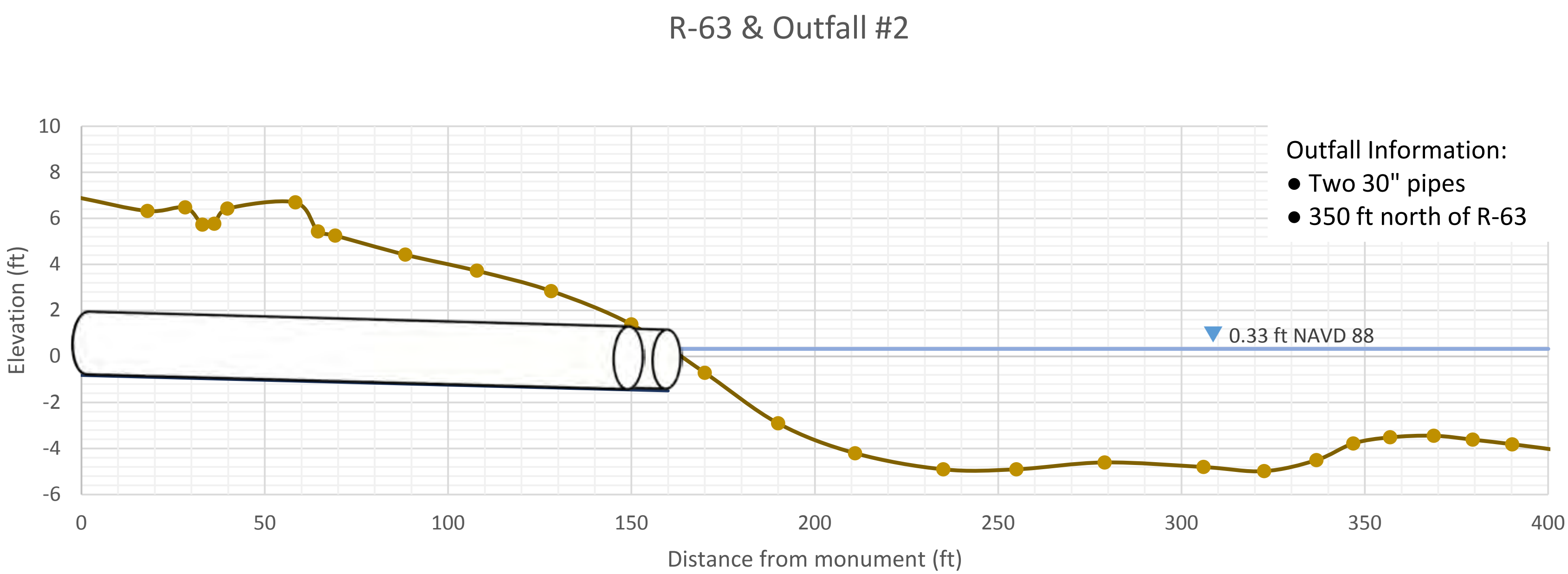
Figure 54 – Outfall #10 Looking West

Figure 55 – Outfall #10 Looking North

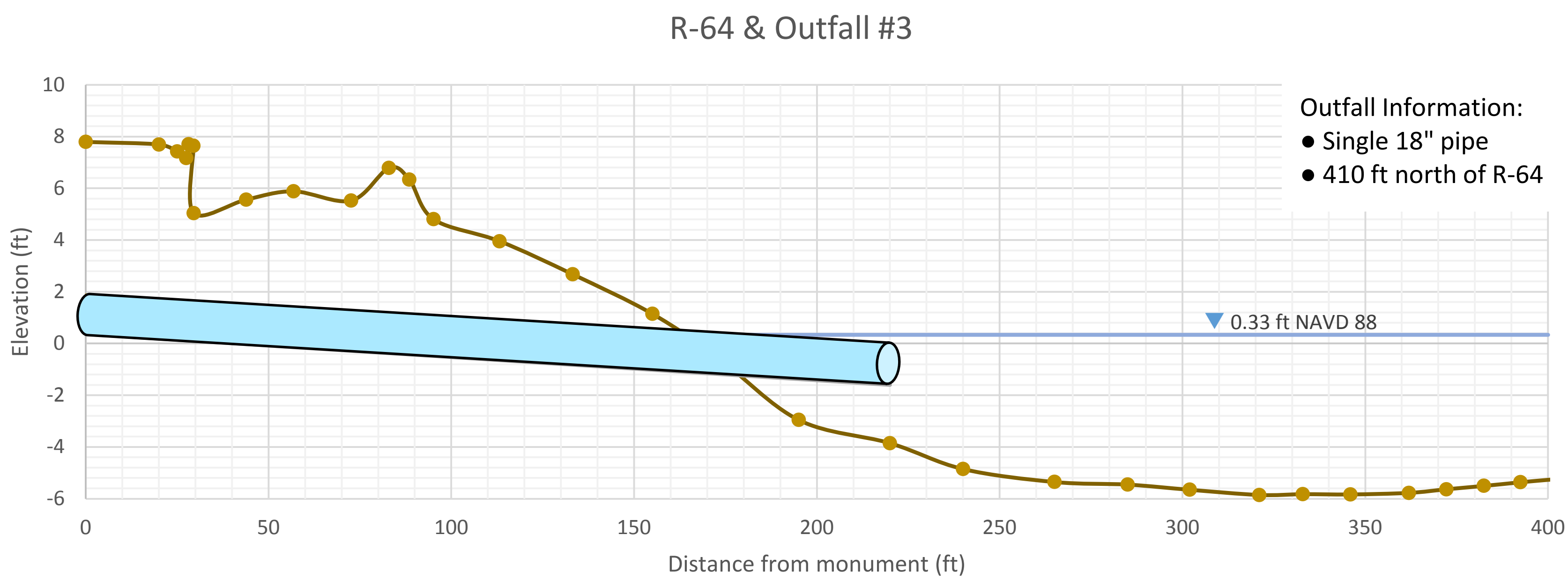
Figure 56 – Outfall #10 Looking South

APPENDIX A3

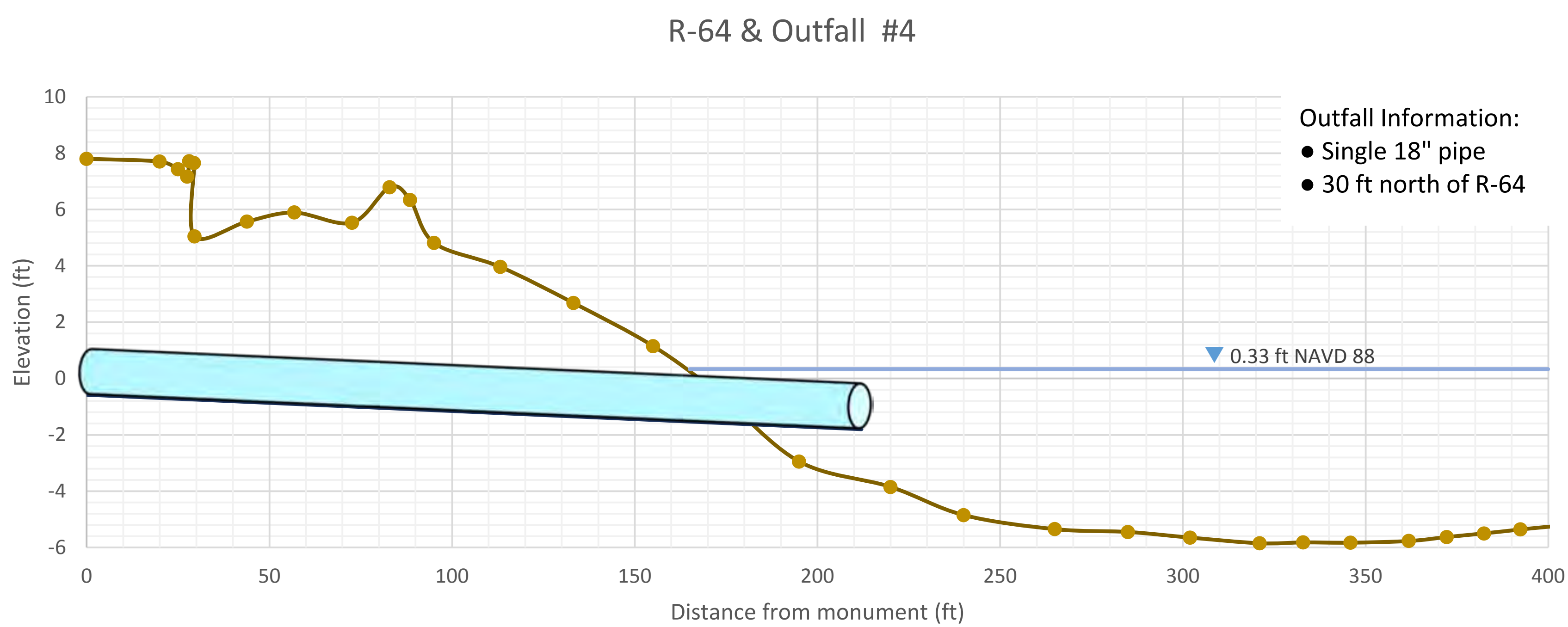
OUTFALL PROFILES


R-63 & Outfall #2
Outfall Information:
● Two 30" pipes
● 350 ft north of R-63
0.33 ft NAVD 88
Elevation (ft)
Distance from monument (ft)
10
8
6
4
2
0
-2
-4
-6
0
50
100
150
200
250
300
350
400

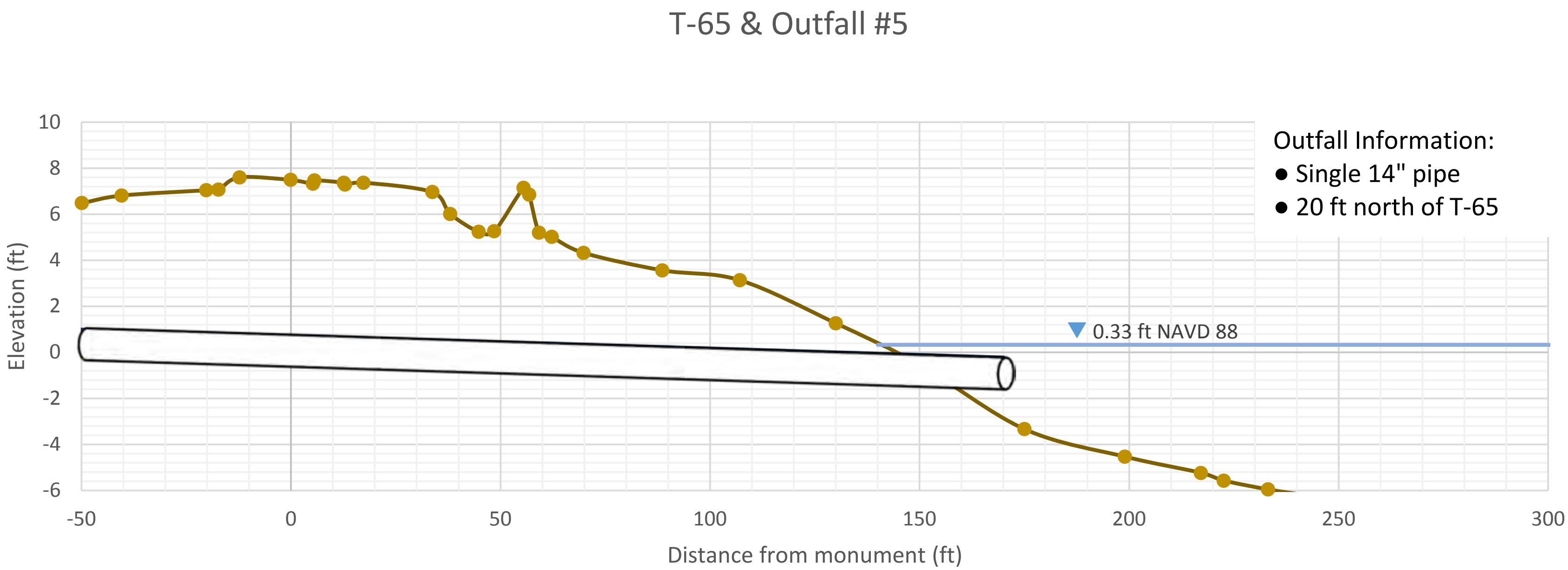

11/05/2015 12:01


R-64 & Outfall #3
Outfall Information:
● Single 18" pipe
● 410 ft north of R-64
0.33 ft NAVD 88
Elevation (ft)
10
8
6
4
2
0
-2
-4
-6
0
50
100
150
200
250
300
350
400
Distance from monument (ft)

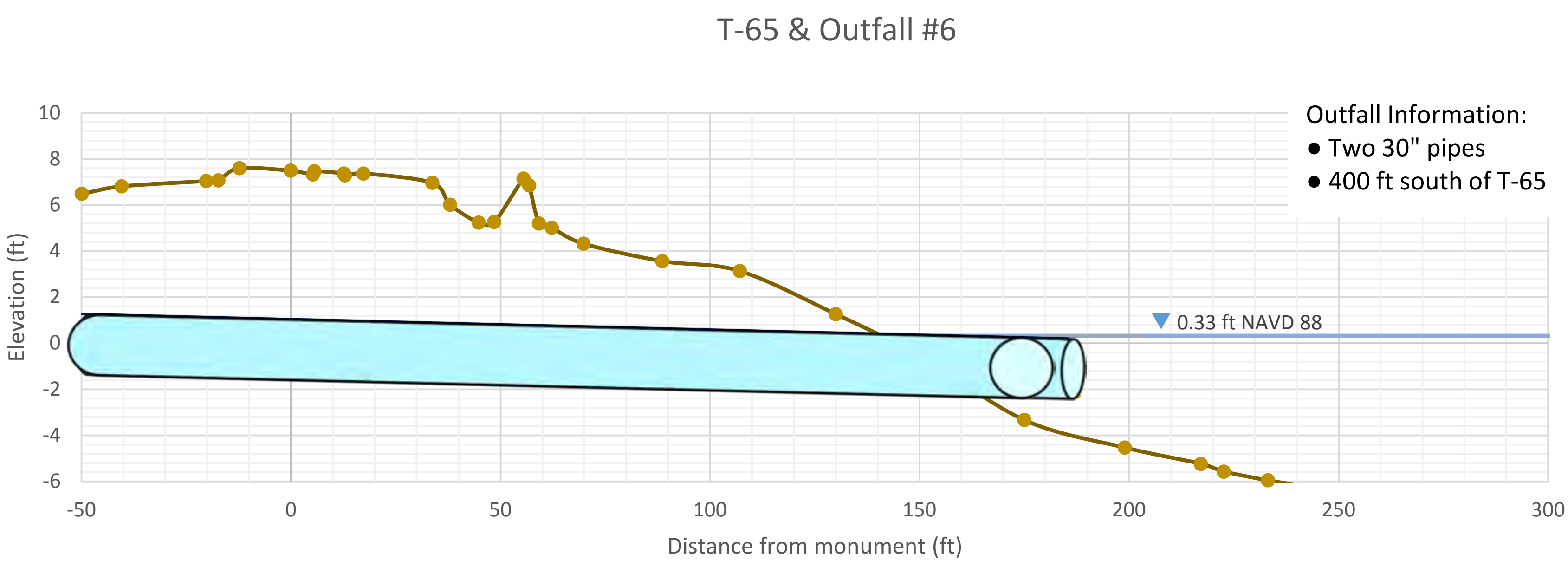

11/05/2015 12:11



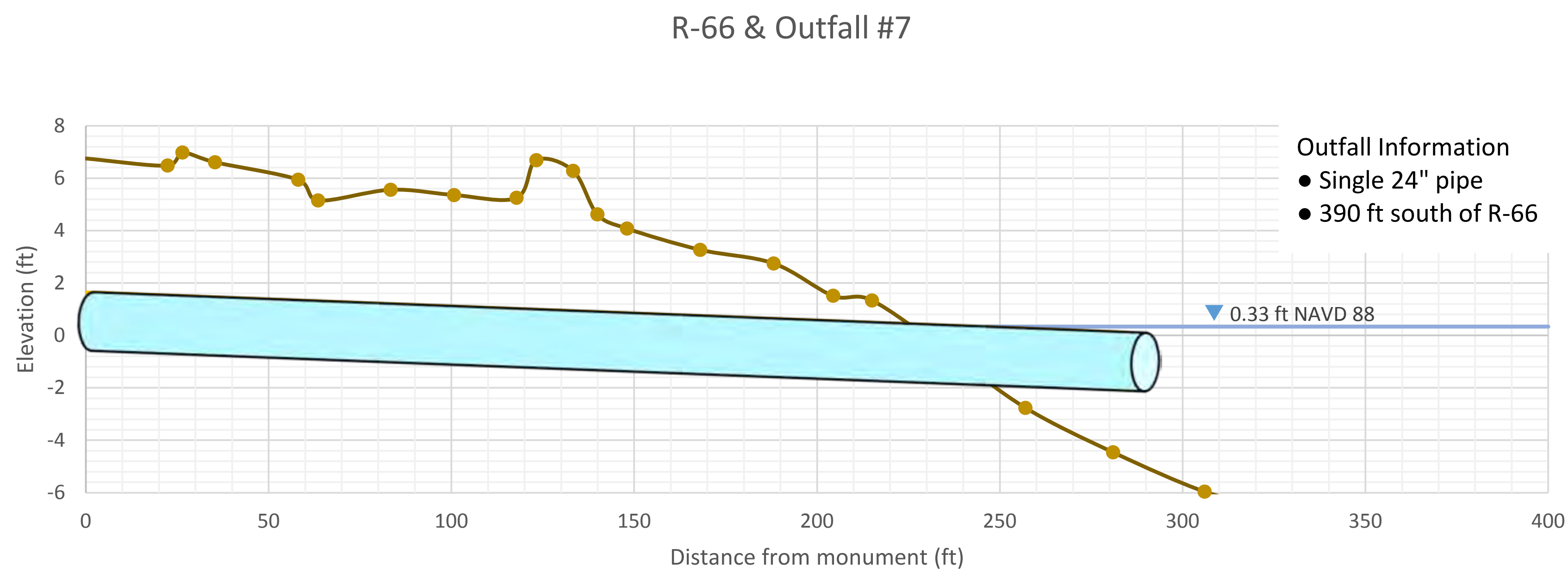
H:\Projects_USA\Naples - Outfalls\Engineer_Working Files\Beach Profiles\Outfalls & Profiles_2016.04.06.docx


T-65 & Outfall #5
Outfall Information:
● Single 14" pipe
● 20 ft north of T-65
0.33 ft NAVD 88
Elevation (ft)
Distance from monument (ft)
10
8
6
4
2
0
-2
-4
-6
-50
0
50
100
150
200
250
300

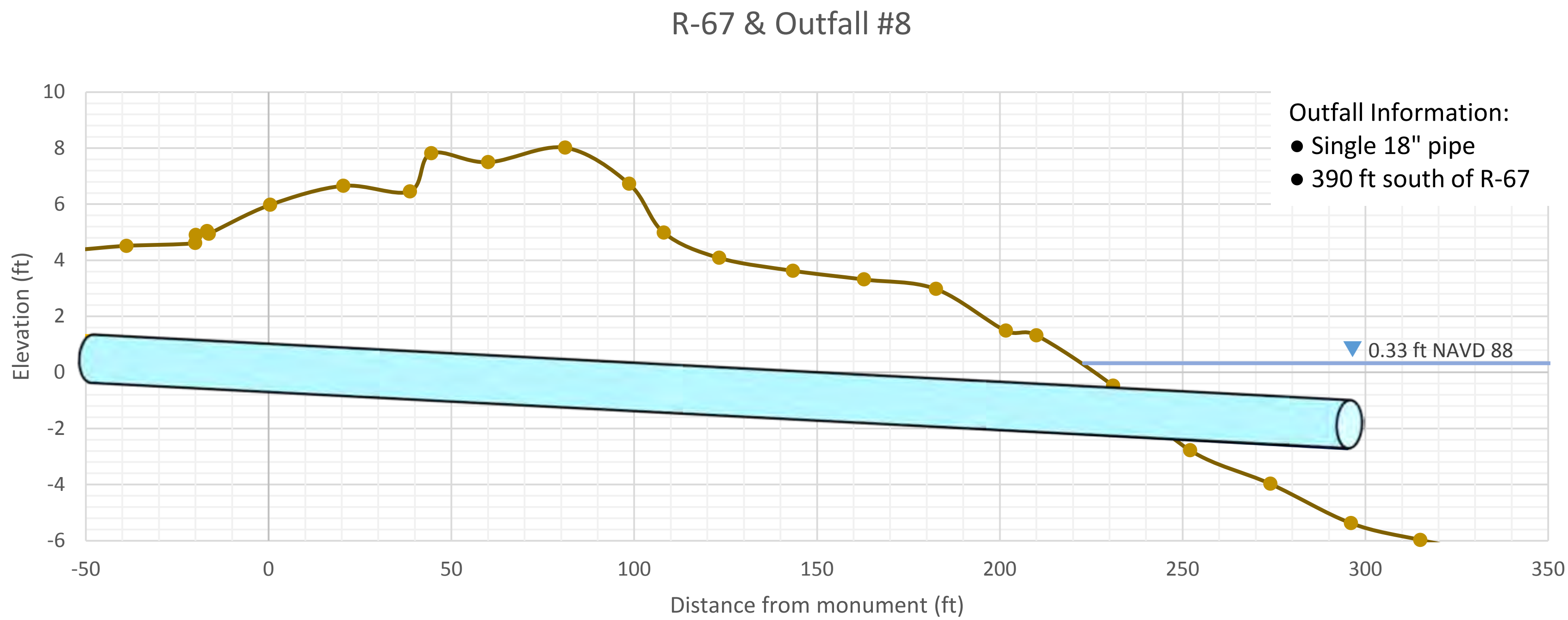

11/05/2015 14:08


T-65 & Outfall #6
Outfall Information:
● Two 30" pipes
● 400 ft south of T-65
0.33 ft NAVD 88
Elevation (ft)
Distance from monument (ft)
10
8
6
4
2
0
-2
-4
-6
-50
0
50
100
150
200
250
300

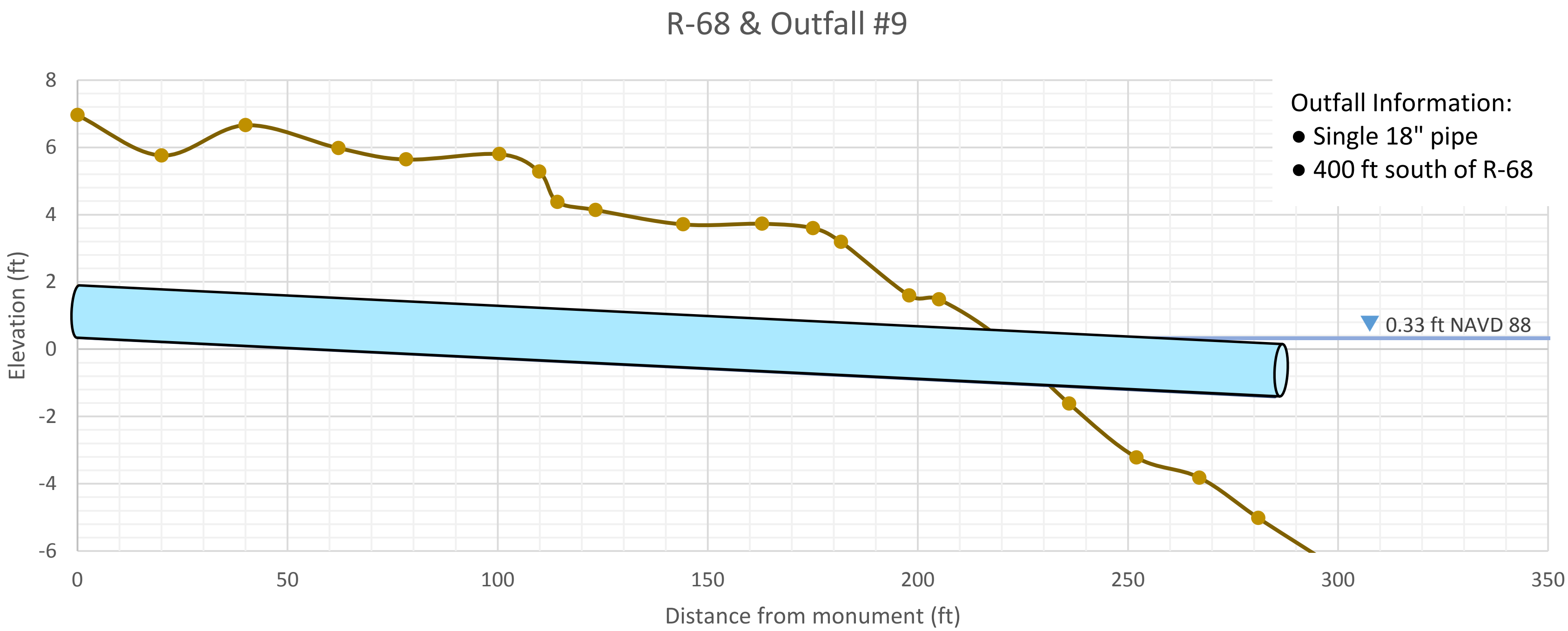

11/05/2015 14:15


R-66 & Outfall #7
Outfall Information
● Single 24" pipe
● 390 ft south of R-66
0.33 ft NAVD 88
Elevation (ft)
8
6
4
2
0
-2
-4
-6
0
50
100
150
200
250
300
350
400
Distance from monument (ft)

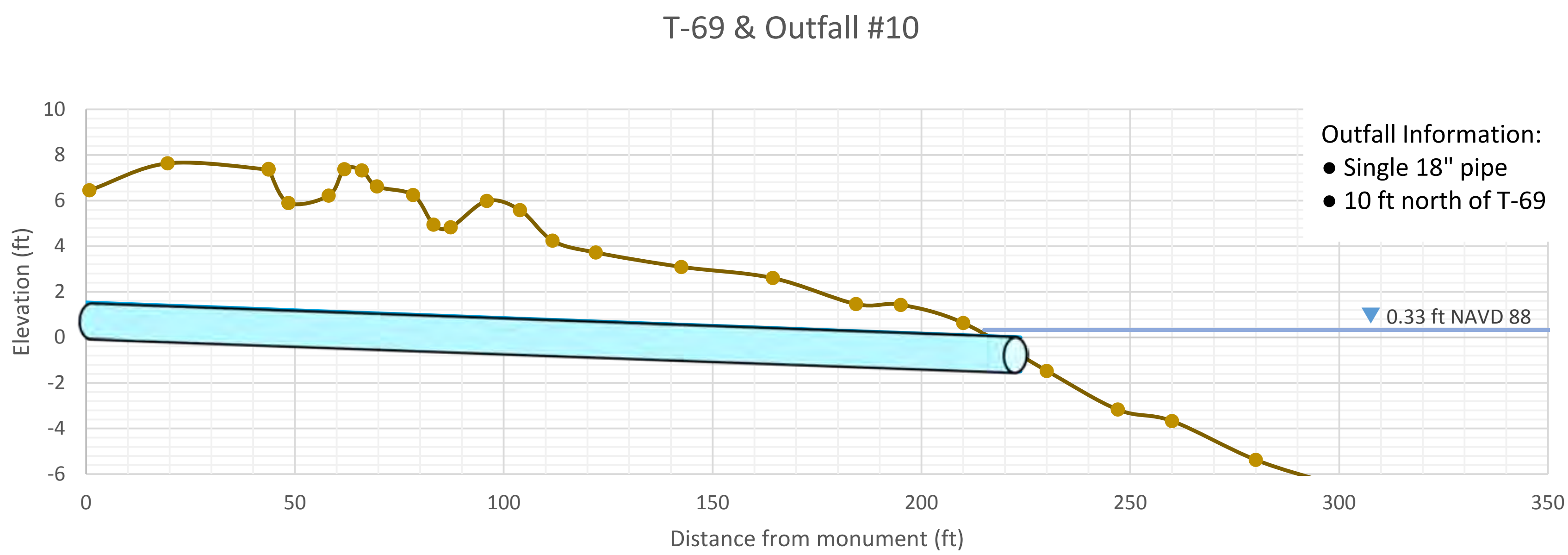

11/05/2015 14:25


R-67 & Outfall #8
Outfall Information:
● Single 18" pipe
● 390 ft south of R-67
0.33 ft NAVD 88
Elevation (ft)
10
8
6
4
2
0
-2
-4
-6
-50
0
50
100
150
200
250
300
350
Distance from monument (ft)

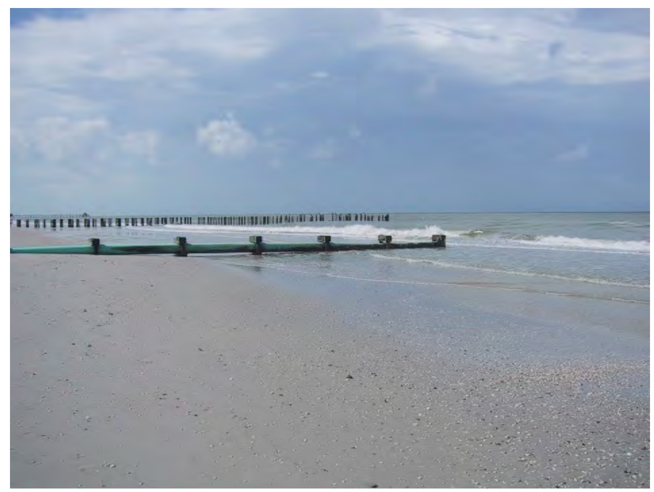

11/05/2015 14:30


R-68 & Outfall #9
Outfall Information:
● Single 18" pipe
● 400 ft south of R-68
0.33 ft NAVD 88
Elevation (ft)
Distance from monument (ft)
8
6
4
2
0
-2
-4
-6
0
50
100
150
200
250
300
350


10/27/2015 08:18

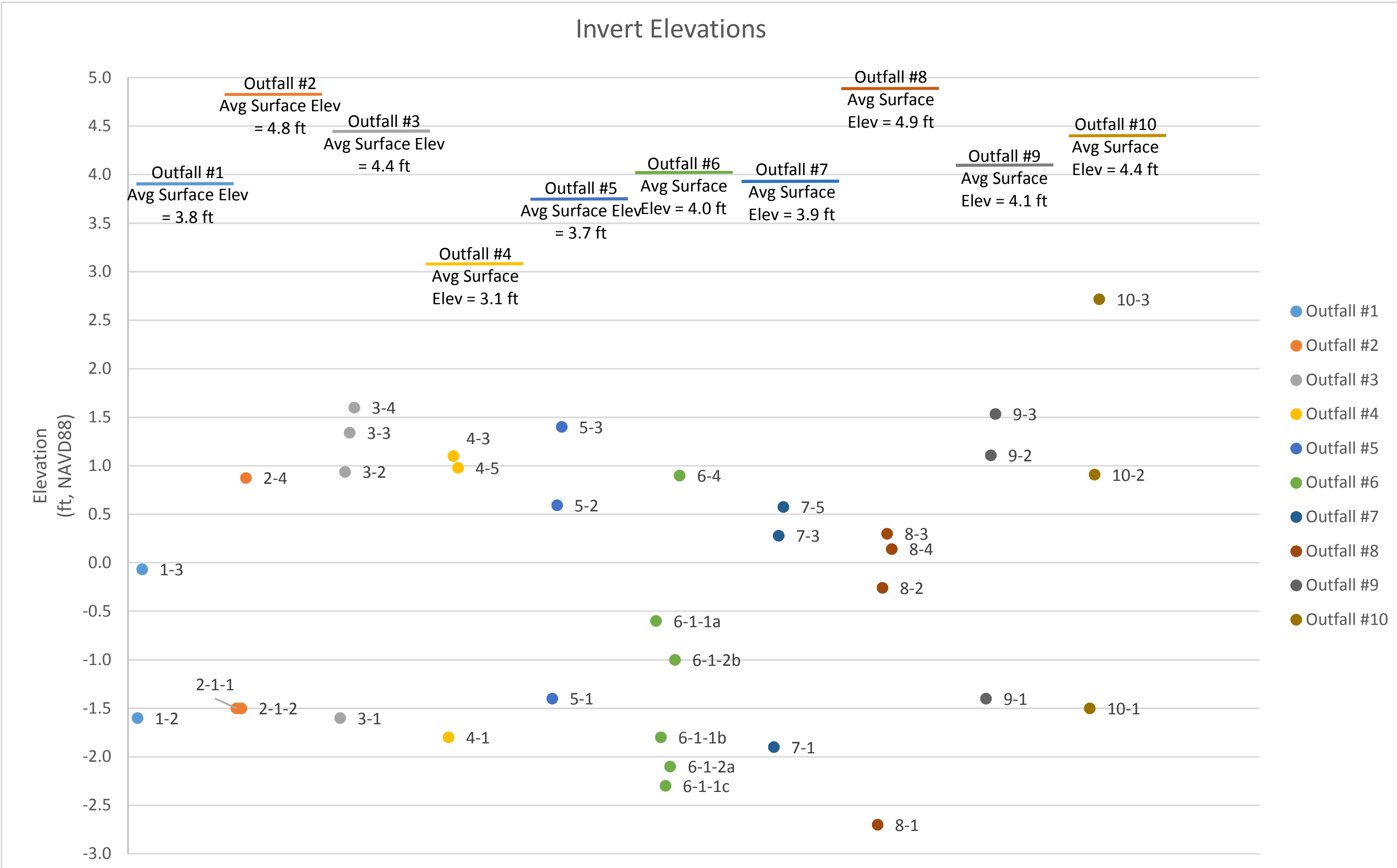

T-69 & Outfall #10
Outfall Information:
● Single 18" pipe
● 10 ft north of T-69
0.33 ft NAVD 88
Elevation (ft)
Distance from monument (ft)
10
8
6
4
2
0
-2
-4
-6
0
50
100
150
200
250
300
350


10/27/2015 07:50

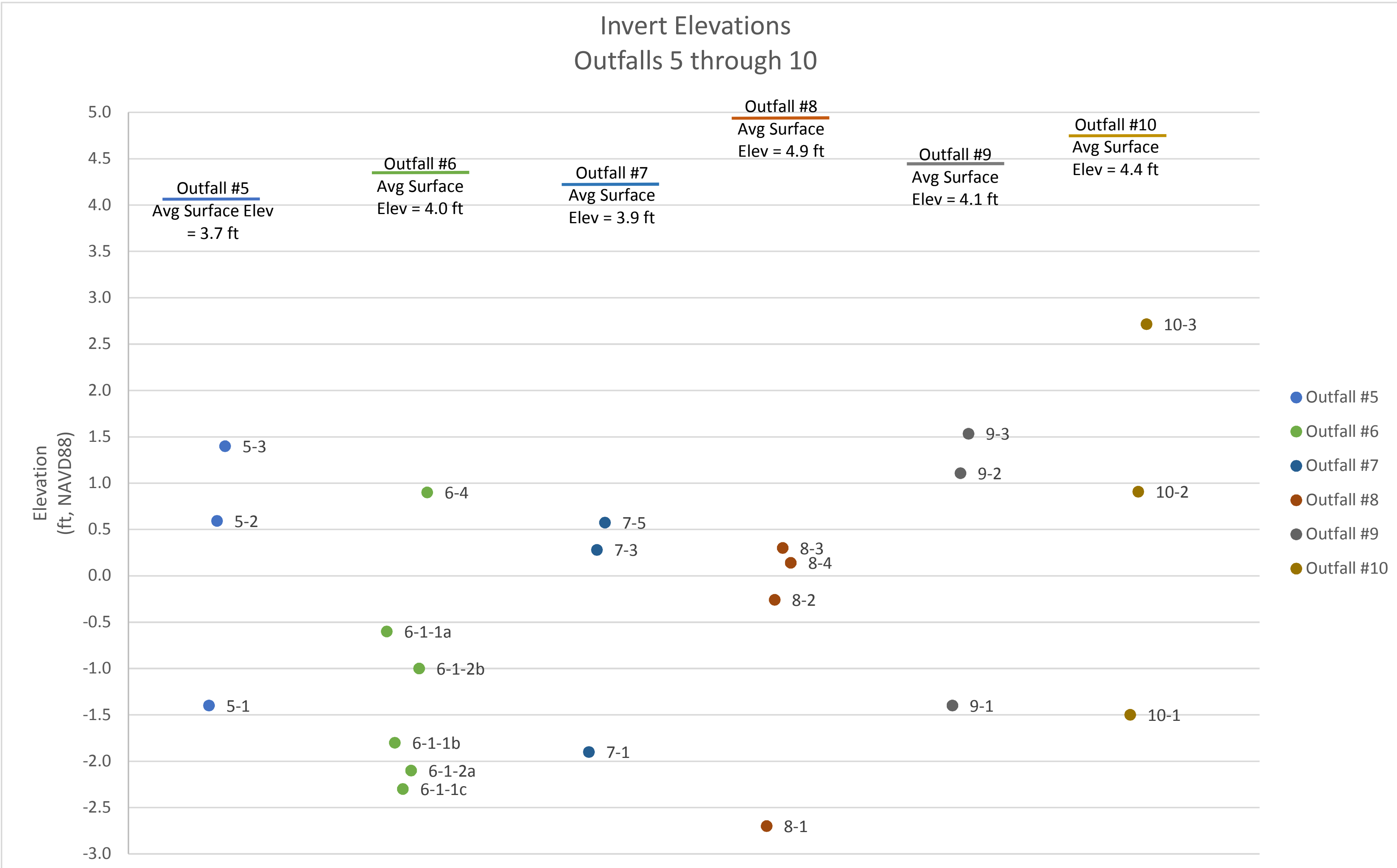


APPENDIX A4

INVERT ELEVATIONS


Invert Elevations
Elevation (ft, NAVD88)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
Outfall #1 Avg Surface Elev = 3.8 ft
Outfall #2 Avg Surface Elev = 4.8 ft
Outfall #3 Avg Surface Elev = 4.4 ft
Outfall #4 Avg Surface Elev = 3.1 ft
Outfall #5 Avg Surface Elev = 3.7 ft
Outfall #6 Avg Surface Elev = 4.0 ft
Outfall #7 Avg Surface Elev = 3.9 ft
Outfall #8 Avg Surface Elev = 4.9 ft
Outfall #9 Avg Surface Elev = 4.1 ft
Outfall #10 Avg Surface Elev = 4.4 ft
1-3
1-2
2-4
2-1-1
2-1-2
3-4
3-3
3-2
3-1
4-3
4-5
4-1
5-3
5-2
5-1
6-4
6-1-1a
6-1-2b
6-1-1b
6-1-2a
6-1-1c
7-5
7-3
7-1
8-3
8-4
8-2
8-1
9-3
9-2
9-1
10-3
10-2
10-1
Outfall #1
Outfall #2
Outfall #3
Outfall #4
Outfall #5
Outfall #6
Outfall #7
Outfall #8
Outfall #9
Outfall #10

Invert Elevations
Outfalls 2 through 5
Elevation
(ft, NAVD88)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
Outfall #2
Avg Surface Elev
= 4.8 ft
Outfall #3
Avg Surface Elev
= 4.4 ft
Outfall #4
Avg Surface
Elev = 3.1 ft
Outfall #5
Avg Surface Elev
= 3.7 ft
2-4
2-1-1
2-1-2
3-4
3-3
3-2
3-1
4-3
4-5
4-1
5-3
5-2
5-1
Outfall #2
Outfall #3
Outfall #4
Outfall #5



Invert Elevations
Outfalls 5 through 10
Elevation (ft, NAVD88)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
-3.0
Outfall #5
Avg Surface Elev = 3.7 ft
Outfall #6
Avg Surface Elev = 4.0 ft
Outfall #7
Avg Surface Elev = 3.9 ft
Outfall #8
Avg Surface Elev = 4.9 ft
Outfall #9
Avg Surface Elev = 4.1 ft
Outfall #10
Avg Surface Elev = 4.4 ft
5-3
5-2
5-1
6-4
6-1-1a
6-1-2b
6-1-1b
6-1-2a
6-1-1c
7-5
7-3
7-1
8-3
8-4
8-2
8-1
9-3
9-2
9-1
10-3
10-2
10-1
Outfall #5
Outfall #6
Outfall #7
Outfall #8
Outfall #9
Outfall #10

APPENDIX B

SIGNIFICANT RAINFALL EVENTS & SUMMARY OF CONDITIONS

Annual Rainfall Comparison
2003-2015

5/3/2016

Year	Annual Rainfall Totals (in)					
	Naples		Ft. Myers[1]	Punta Gorda[1]	Venice[1]	Sarasota
	Naples Municipal Airport[1,2]	Golden Gate High School[3]				
2003	71.1	74.6	70.6	62.9	65.5	79.0
2004	40.2	55.7	61.8	50.1	44.6	60.3
2005	63.4	66.1	74.5	58.0	63.4	56.8
2006	50.2	46.2	56.3	51.1	49.2	57.4
2007	35.0	40.5	47.0	30.0	35.1	46.3
2008	48.3	60.3	60.1	48.8	47.1	47.4
2009	33.9	56.8	39.9	45.4	38.5	46.6
2010	44.6	57.1	53.1	54.5	45.0	59.7
2011	38.2	55.8	65.8	47.1	40.8	46.1
2012	37.9	52.1	49.6	56.3	53.1	57.5
2013	49.3	64.5	53.8	66.9	54.4	67.8
2014	50.7	60.4	42.3	54.8	41.5	66.2
2015	38.1	-	57.3	49.9	47.9	60.9
Avg. Annual Rainfall (2003 - 2015)	**46.2**	**57.5**	**56.3**	**52.0**	**48.1**	**57.8**

Data Source(s):

1. https://www.ncdc.noaa.gov/cdo-web/
   - Naples Municipal Airport Station
   - Ft. Myers Field Airport Station
   - Punta Gorda Airport Station
   - Venice Utilities Dept Station
   - Myakka River State Park Station
2. http://www.weatherunderground.com/history - Naples Municipal Airport Station
3. http://climatecenter.fsu.edu/ - Golden Gate High School Station

Approximately 13 events from January 2003 through February 2016 where the total rainfall (spanning consecutive days) exceeded 4 inches. Table 3 below summarizes these events based on the Naples Municipal Airport Station.

Multiple Day Events Exceeding 4 Inches (Source: Naples Municipal Airport Gauge)

Event Reference No.	Year	Month	Day	Rainfall (in)	Description of Event
1	2003	6	21	3.15	
			22	1.36	
			23	0.14	
			24	0.78	
			Total	5.43	
2	2003	8	13	0.95	
			14	0.57	
			15	3.38	
			Total	4.90	
3	2003	9	24	0.84	On September 29, 2003 a stalled cold front over central Florida and a tropical disturbance in the southwest Caribbean collided, resulting in a 4 to 8 inch event (Collier County). By evening, the rainfall ended. Late day, on September 30, 2003, street and yard flooding subsided. (source: http://www.srh.noaa.gov/mfl/?n=wet_collier_county)
			25	2.03	
			26	0.06	
			27	0.22	
			28	6.95	
			Total	10.1	

(Table Continued on Next Page)

Multiple Day Events Exceeding 4 Inches (Source: Naples Municipal Airport Gauge) (Cont.)

Event Reference No.	Year	Month	Day	Rainfall (in)	Description of Event
4	2005	5	30	0.75	Tropical Storm Arlene produced a record breaking wet June in Naples. This storm entered the Gulf on June 10, 2005. (source: http://www.srh.noaa.gov/images/mfl/news/2005WeatherSummary.pdf)
			31	2.27	
		6	1	2.34	
			2	2.22	
			3	0.98	
			4	0.1	
			5	0	
			6	0.22	
			7	0.19	
			8	0.31	
			9	2.36	
			10	2.81	
			11	0.79	
			Total	15.34	
5	2005	9	28	2.27	Hurricane Rita resulted in tropical storm force winds over Collier County on late September 25, 2005. The two events noted here proceed Hurricane Rita. (source: http://www.srh.noaa.gov/images/mfl/news/2005WeatherSummary.pdf)
			29	0.37	
			30	0.55	
		10	1	0.02	
			2	0.17	
			3	0.1	
			4	0.25	
			5	0.28	
			6	2.73	
			7	0.25	
			8	0.22	
			9	0.72	
			10	0.06	
			11	1.3	
			Total	9.29	

(Table Continued on Next Page)

Multiple Day Events Exceeding 4 Inches (Source: Naples Municipal Airport Gauge) (Cont.)

Event Reference No.	Year	Month	Day	Rainfall (in)	Description of Event
6	2005	10	22	0.55	The 2005 annual maximum corresponds with Hurricane Wilma which hit Naples on October 24, 2005. (source: http://naplesinsider.com/naplesarea/hurricaneinformation.htm)
			23	6.14	
			Total	6.69	
7	2006	6	30	2.55	
		7	1	0.43	
			2	0.51	
			3	1.39	
			Total	4.88	
8	2010	6	26	2.25	
			27	1.11	
			28	0.4	
			29	0.75	
			30	0.95	
		7	1	T	
			2	2.58	
			3	0.02	
			4	0.27	
			5	0.59	
			Total	8.92	
9	2013	6	30	0.69	
		7	1	2.24	
			2	0.17	
			3	0.08	
			4	0.2	
			5	0.83	
			Total	4.21	

(Table Continued on Next Page)

Multiple Day Events Exceeding 4 Inches (Source: Naples Municipal Airport Gauge) (Cont.)

Event Reference No.	Year	Month	Day	Rainfall (in)	Description of Event
10	2013	7	13	0.71	
			14	3.41	
			Total	4.12	
11	2013	9	15	0.97	NOAA reported flooding and lighting in the Naples area September 6th through 7th, 2013 and that approximately 6-10 inches fell in approximately 4 hours. This event proceeds that event, which was not registered by our referenced stations. (source: http://www.srh.noaa.gov/images/mfl/news/2013YearlySummary.pdf)
			16	0.22	
			17	2.19	
			18	0.79	
			Total	4.17	
12	2014	8	3	0.3	On August 4, 2014 a band of heavy rain hit Naples resulting in 6 to 7 inches of rain within approximately 4 hours. (source: http://www.weather.gov/miami)
			4	6.73	
			Total	7.03	
13	2016	1	25	0.21	January 2014 produced record rainfall totals for Naples. This anomaly of record rainfall can be attributed to a strong El Niño pattern. (source: http://www.fox4now.com/news/january-rainfall-breaks-records-in-southwest-florida)
			27	3.5	
			28	0.96	
			Total	4.67	

Notes:

1. Cells highlighted in light orange indicate significant daily even during each period.
2. There were no hurricanes or tropical storms that hit the Naples area in 2003, 2006, 2007, 2009, 2010, 2011, 2012, 2013 and 2014. (source: http://naplesinsider.com/naplesarea/hurricaneinformation.htm)
3. If the event description cell is blank, note that there were not significant event descriptions during that particular time period found per online research.

APPENDIX C

COASTAL CONTROL LINES AND EASEMENTS

DESIGNED BC | DRAWN JC | CHECKED KE

DATE: 04-29-2016

JOB NO. 15-304

SCALE: AS NOTED

NAPLES BEACH RESTORATION &
WATER QUALITY IMPROVEMENT PROJECT

APPENDIX C
COASTAL CONTROL LINES AND EASEMENTS

Erickson Consulting Engineers, Inc.
7201 Delainey Court
Sarasota, FL 32420
(941) 373-6460

SHEET 1 OF 3

Z:\CADD_Graphics\US Projects\15-304_Naples Outfalls\Exhibits\Appendix C_CCCL and Easements.dwg May 24, 2016-5:21pm

LEGEND

- AREA OF INTEREST
- CCCL (COASTAL CONSTRUCTION LINE)
- CCSL (COLLIER COUNTY SETBACK LINE)
- ECL (EROSION CONTROL LINE)

NOTES:

1. AERIAL IMAGE 2015 (CITY OF NAPLES).

DESIGNED	DRAWN	CHECKED
BC	JC	KE

DATE: 04-29-2016
JOB NO. 15-304
SCALE: AS NOTED

NAPLES BEACH RESTORATION &
WATER QUALITY IMPROVEMENT PROJECT

APPENDIX C
COASTAL CONTROL LINES AND EASEMENTS

Erickson Consulting Engineers, Inc.
7201 Delainey Court
Sarasota, FL 32420
(941) 373-6460

SHEET 2 OF 3

Z:\CADD_Graphics\US Projects\15-304_Naples Outfalls\Exhibits\Appendix C_CCCL and Easements.dwg May 24, 2016-5:20pm

Z:\CADD_Graphics\US Projects\15-304_Naples Outfalls\Exhibits\Appendix C_CCCL and Easements.dwg May 24, 2016-5:19pm

DESIGNED	DRAWN	CHECKED
BC	JC	KE

DATE: 04-29-2016
JOB NO. 15-304
SCALE: AS NOTED

NAPLES BEACH RESTORATION & WATER QUALITY IMPROVEMENT PROJECT

APPENDIX C
COASTAL CONTROL LINES AND EASEMENTS

Erickson Consulting Engineers, Inc.
7201 Delainey Court
Sarasota, FL 32420
(941) 373-6460

SHEET 3 OF 3

APPENDIX D

COASTAL PROCESSES

SUPPLEMENTAL INFORMATION

APPENDIX D1

LINEAR REGRESSION

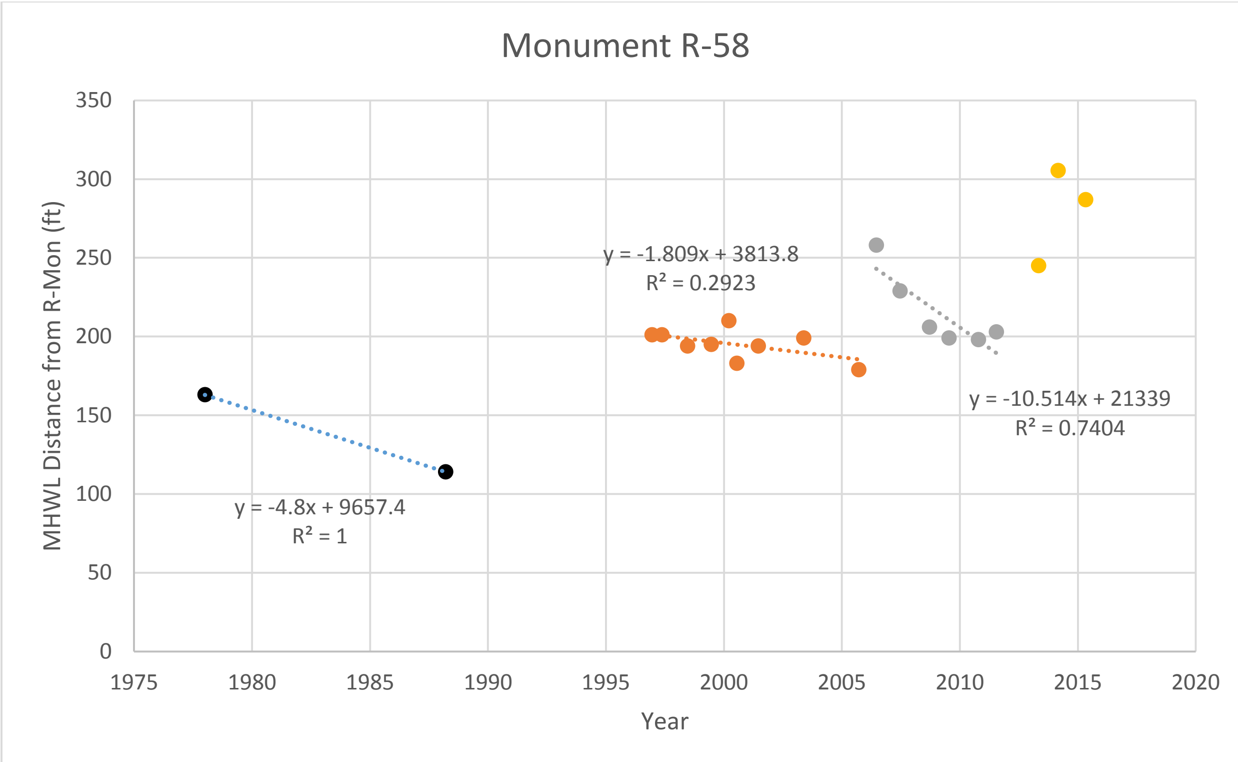
Linear Regression

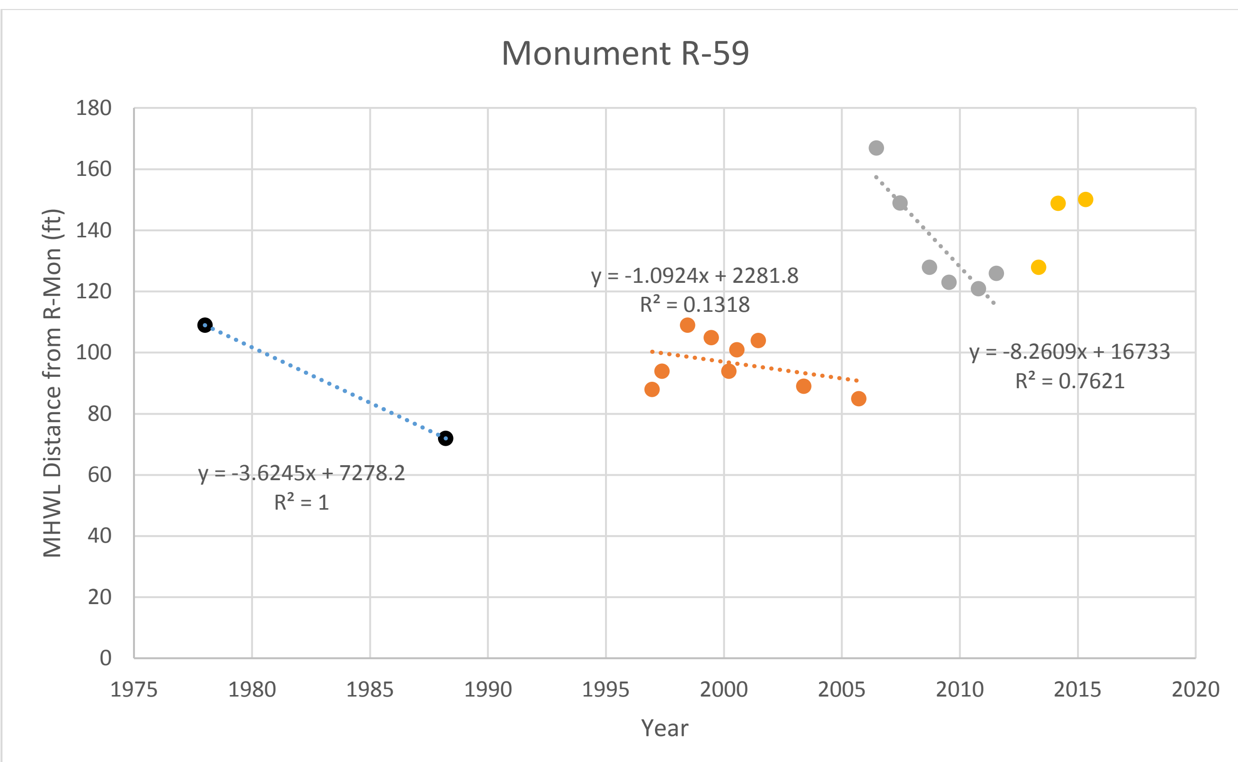
Monument	Approx Distance to Downdrift (South) Outfall (ft)	Outfall #	Linear Regression Historic Erosion Rate (ft/yr)			
			1978-1988	1996-2006	2006-2011	2006-2013
R-57	North		-3.2	4.5	1.8	5.5
R-58	North		-4.8	-1.8	-10.5	-2.6
R-59	North		-3.6	-1.1	-8.3	-5.3
R-60	250	1	-5.9	-7.0	0.0	0.1
R-61	1680	2	-6.5	-3.0	3.6	15.0
T-62	660	2	-2.4	-5.6	-4.9	-1.0
T-63	520	3	-4.9	-2.0	-4.9	-6.1
R-64	0	4	-7.6	-0.3	-1.6	-1.8
T-65	0/370	5/6	-4.9	-5.4	-4.4	-4.4
R-66	380	7	-3.6	-0.2	-5.1	-2.8
T-67	370	8	-2.4	1.3	-6.8	-2.3
R-68	390	9	-3.0	-1.7	-0.4	0.2
T-69	0	10	-2.0	-3.9	-3.3	-4.7
R-70	South		-2.1	-3.6	-7.8	-4.0
R-71	South		1.0	-6.6	-8.6	-5.7
R-72	South		-0.1	-6.1	-8.0	-7.6

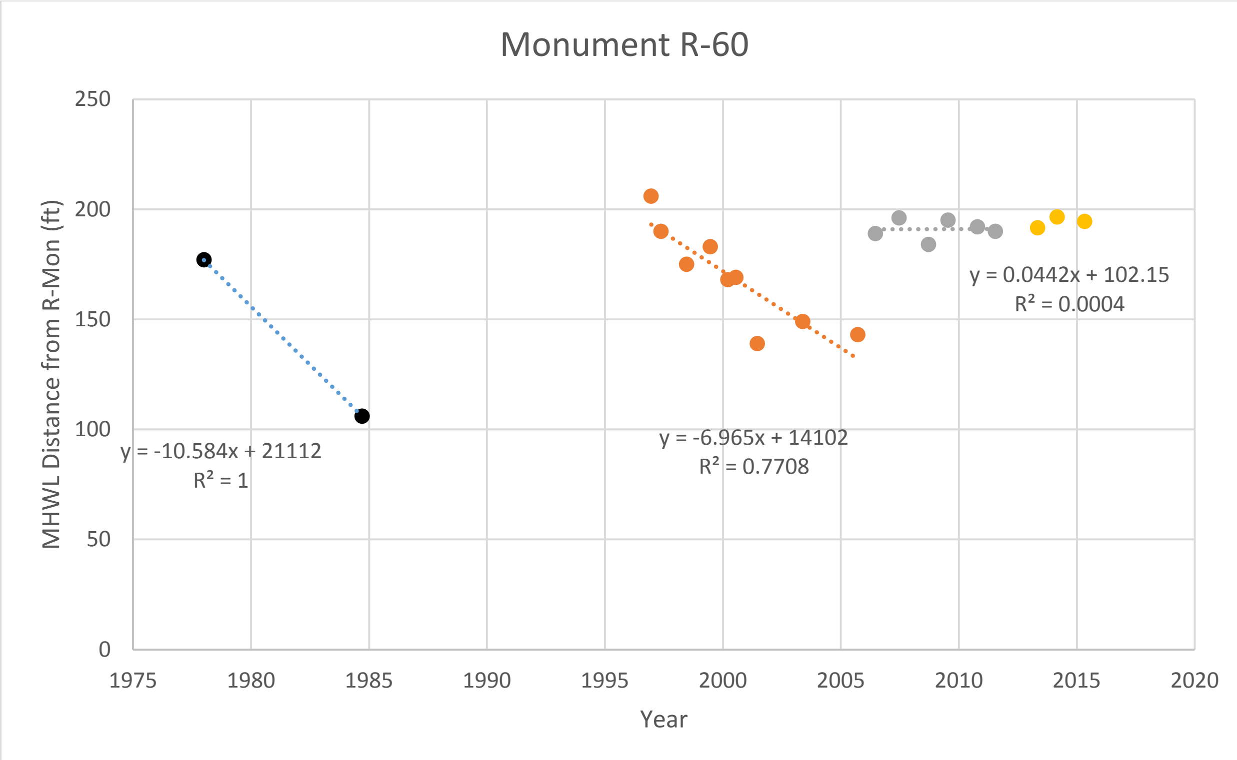
Notes:

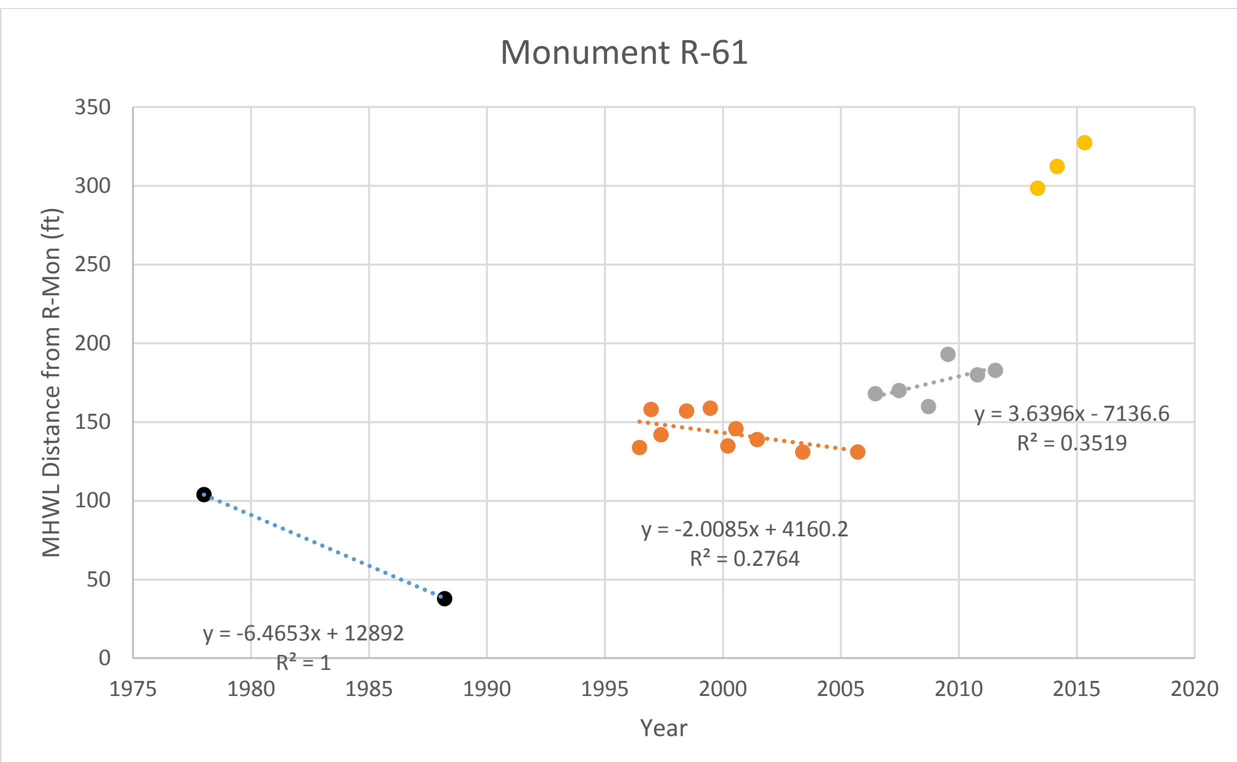
(1) Historic Erosion Rates are based on a linear regression analysis.

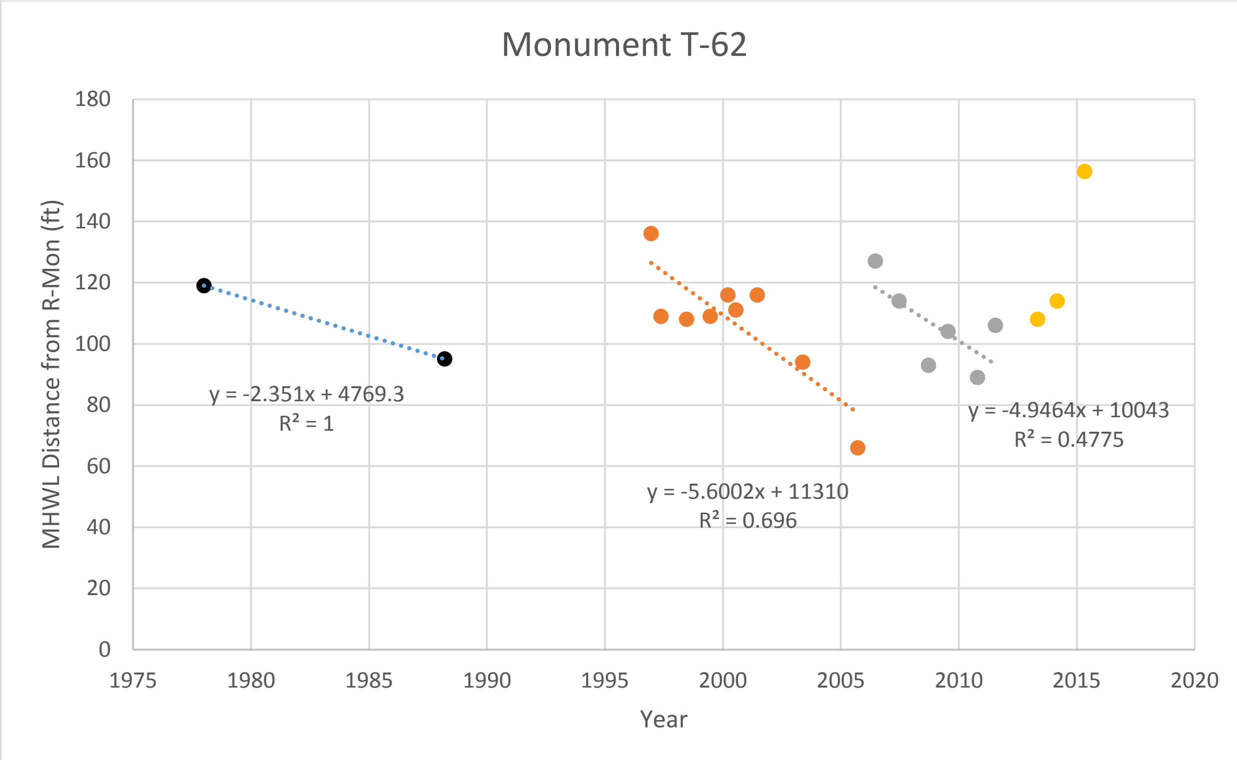
(2) Highlighted Cells represent reaches receiving nourishment during analysis period

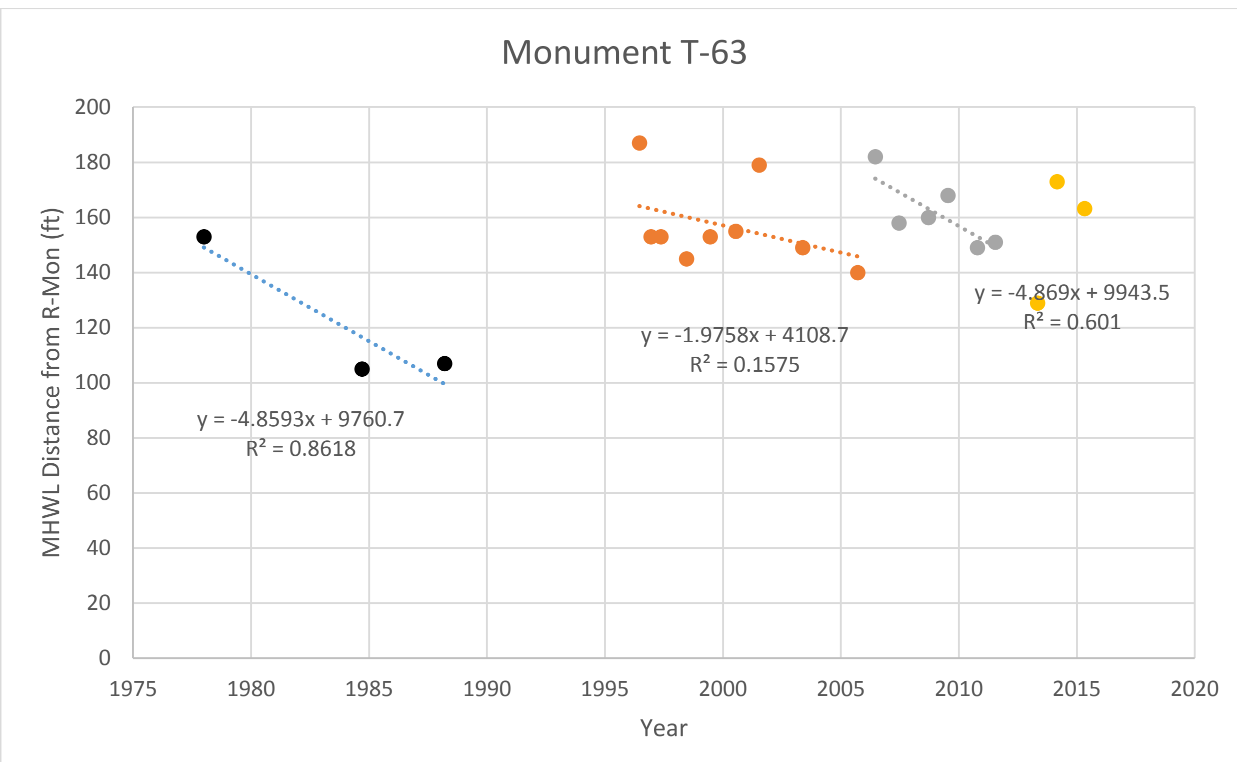

Monument R-58
MHWL Distance from R-Mon (ft)
Year
y = -1.809x + 3813.8
R² = 0.2923
y = -10.514x + 21339
R² = 0.7404
y = -4.8x + 9657.4
R² = 1

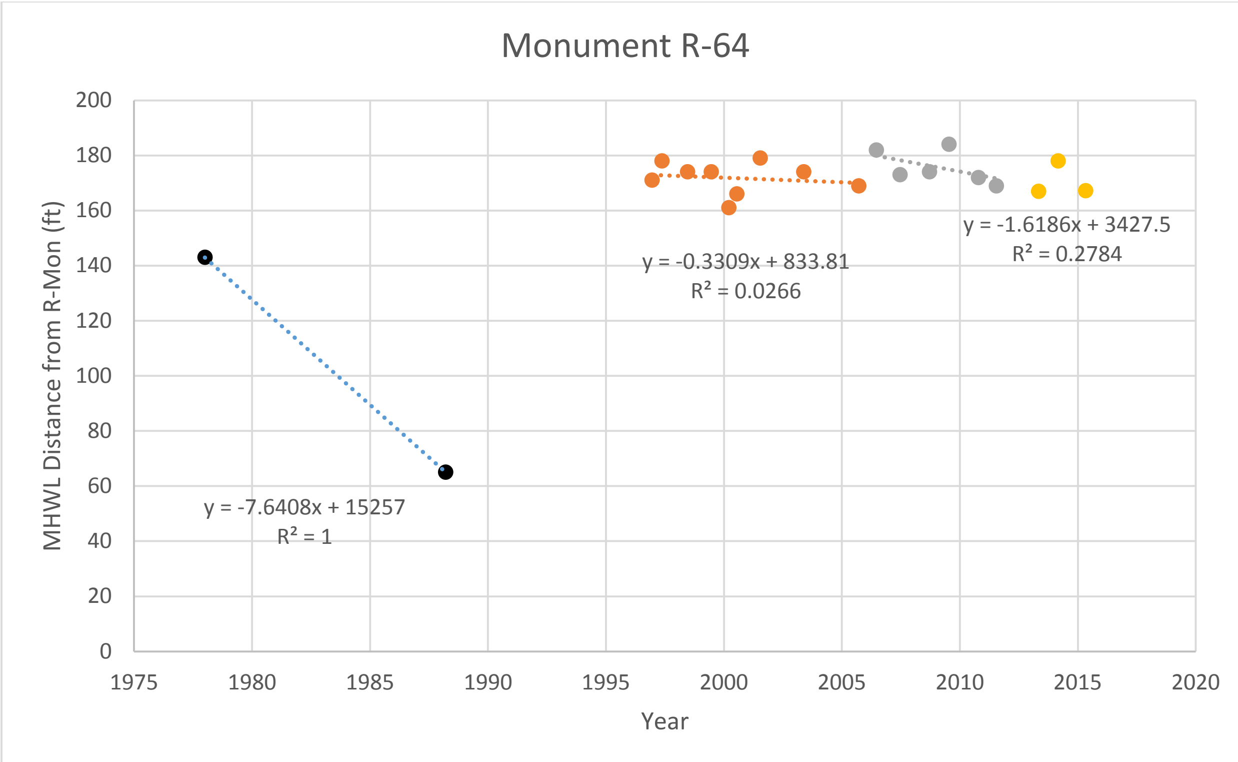

Monument R-59
MHWL Distance from R-Mon (ft)
Year
y = -1.0924x + 2281.8
R² = 0.1318
y = -8.2609x + 16733
R² = 0.7621
y = -3.6245x + 7278.2
R² = 1

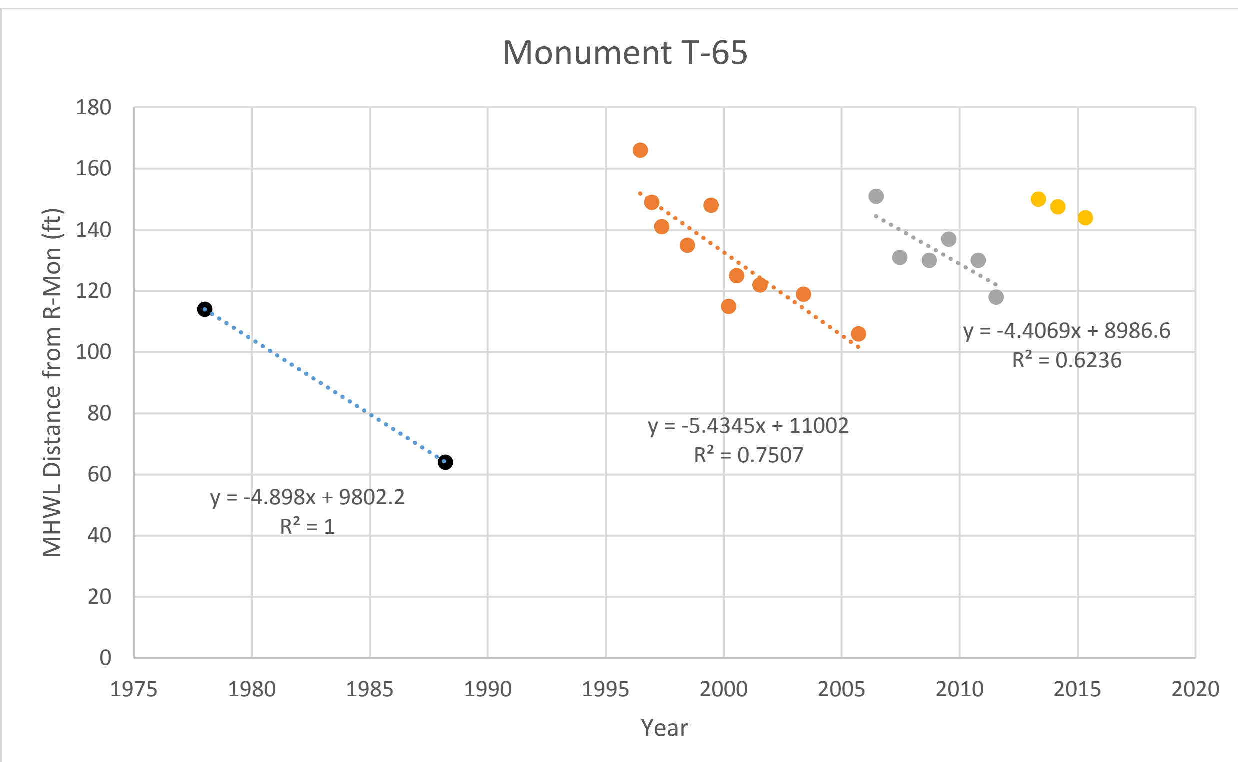

Monument R-60
MHWL Distance from R-Mon (ft)
Year
y = -10.584x + 21112
R² = 1
y = -6.965x + 14102
R² = 0.7708
y = 0.0442x + 102.15
R² = 0.0004

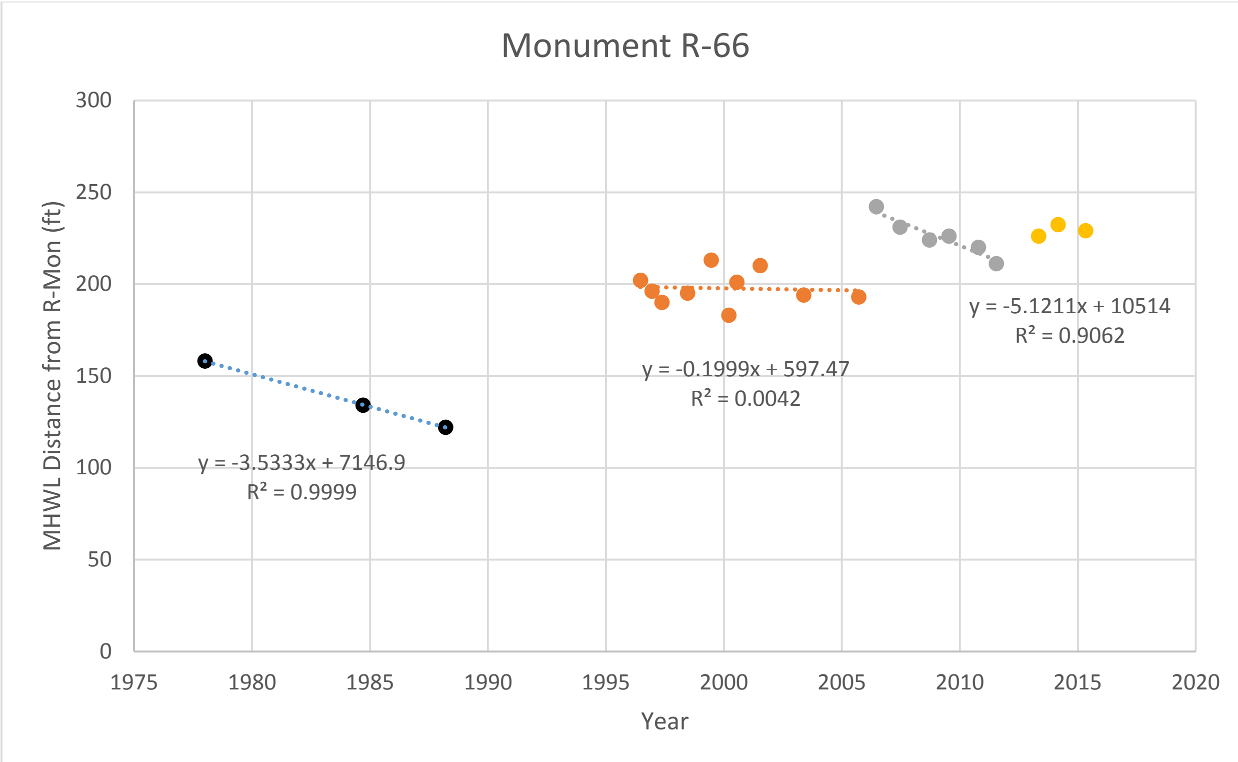

Monument R-61
MHWL Distance from R-Mon (ft)
Year
y = -6.4653x + 12892
R² = 1
y = -2.0085x + 4160.2
R² = 0.2764
y = 3.6396x - 7136.6
R² = 0.3519

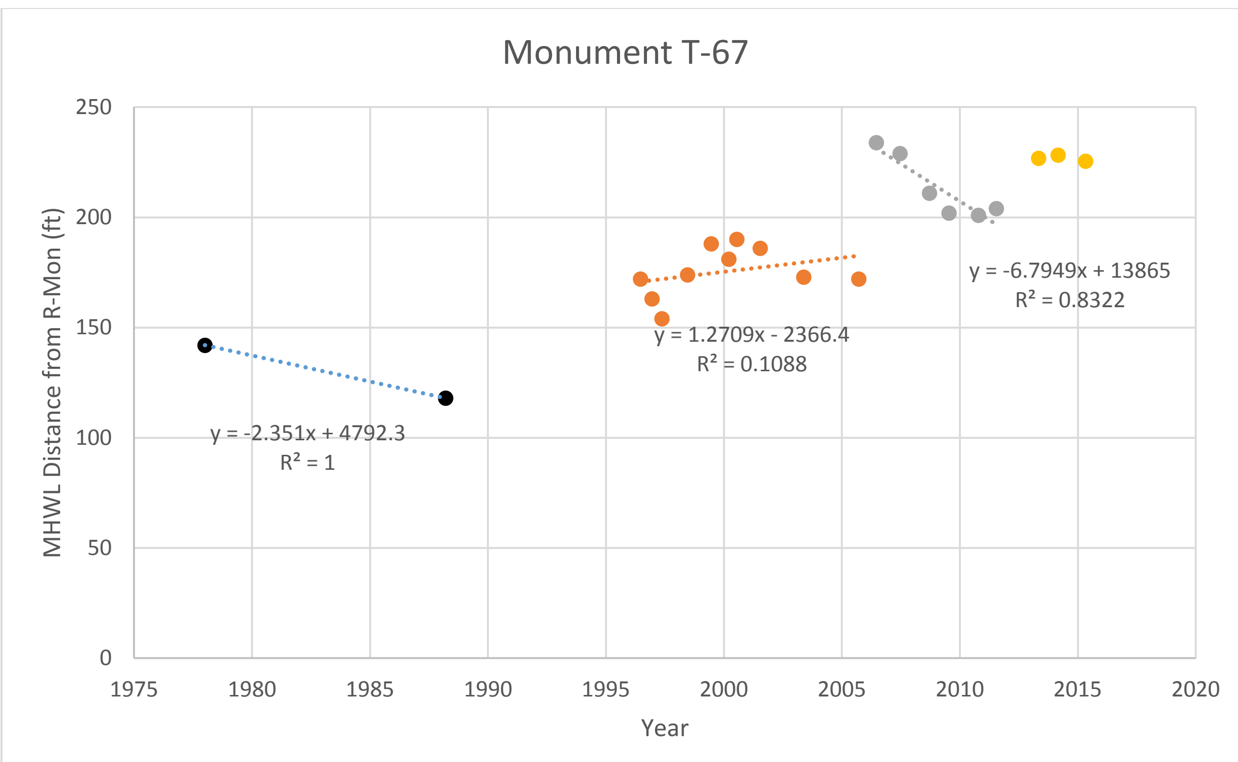

Monument T-62
MHWL Distance from R-Mon (ft)
Year
y = -2.351x + 4769.3
R² = 1
y = -5.6002x + 11310
R² = 0.696
y = -4.9464x + 10043
R² = 0.4775

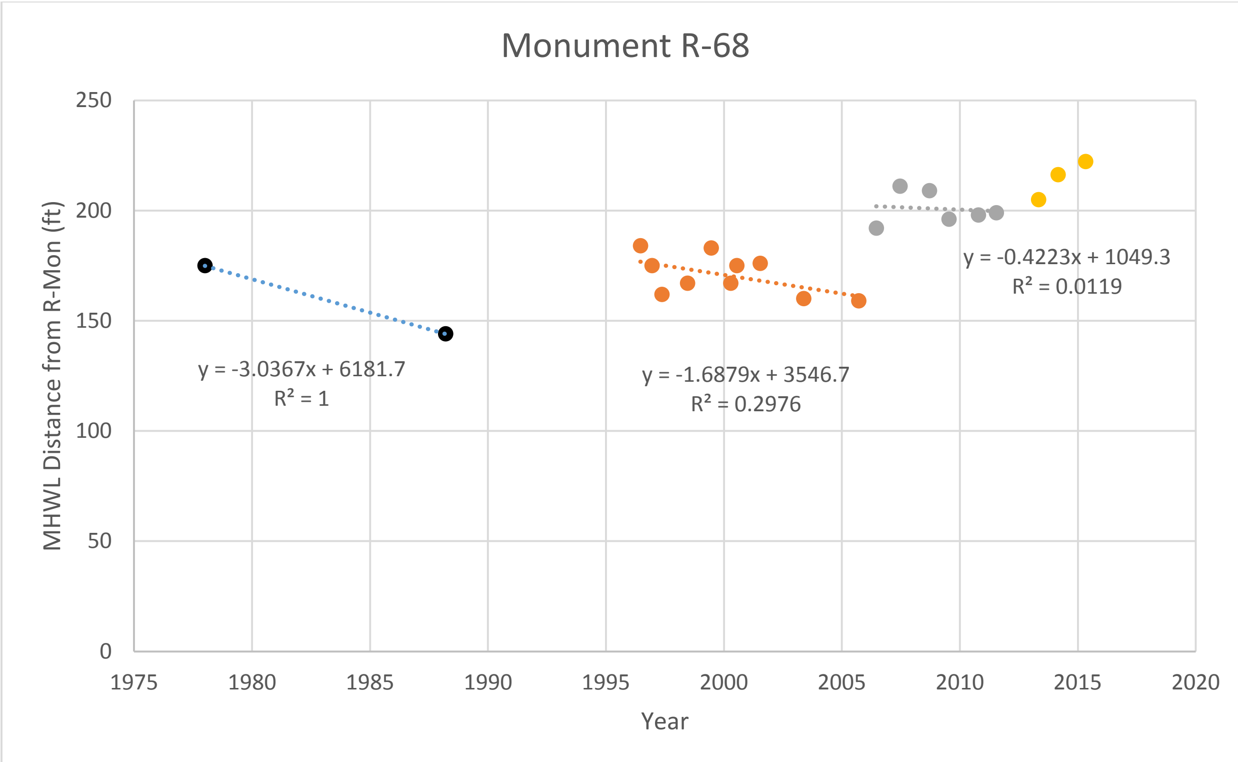

Monument T-63
MHWL Distance from R-Mon (ft)
Year
y = -4.8593x + 9760.7
R² = 0.8618
y = -1.9758x + 4108.7
R² = 0.1575
y = -4.869x + 9943.5
R² = 0.601

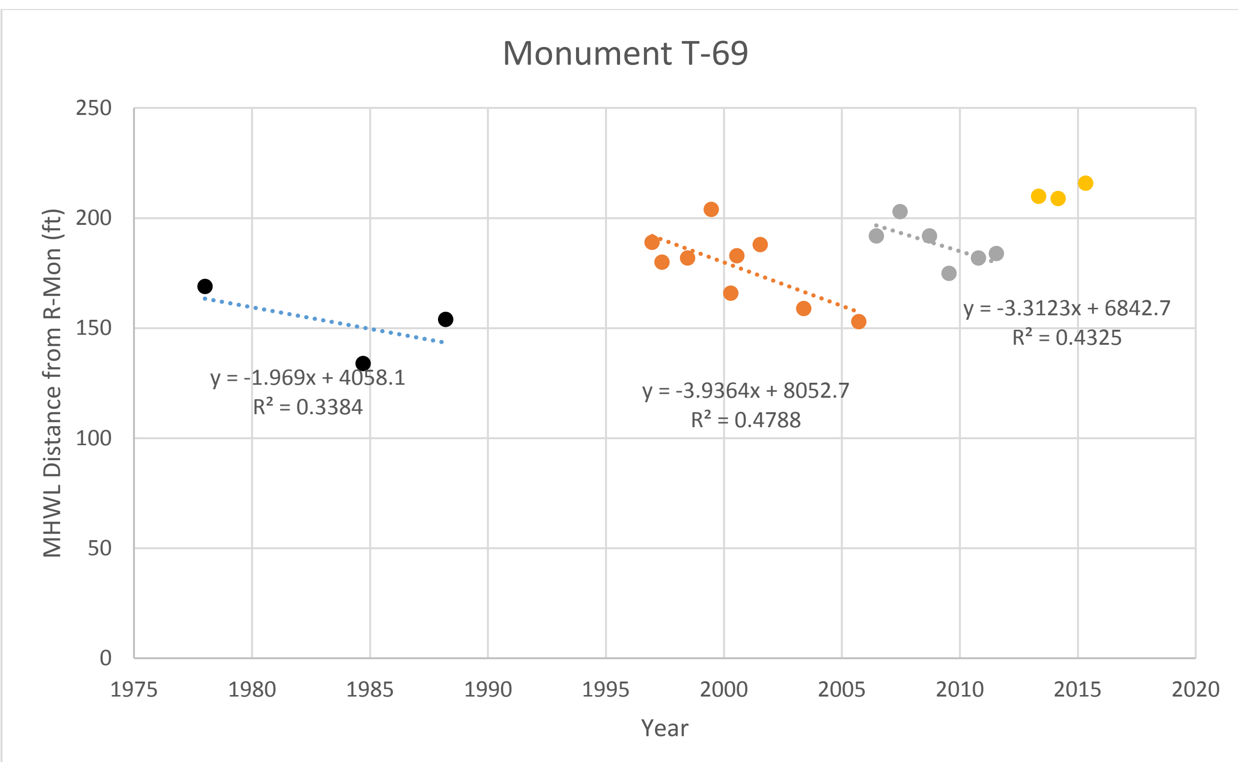

Monument R-64
MHWL Distance from R-Mon (ft)
Year
y = -7.6408x + 15257
R² = 1
y = -0.3309x + 833.81
R² = 0.0266
y = -1.6186x + 3427.5
R² = 0.2784

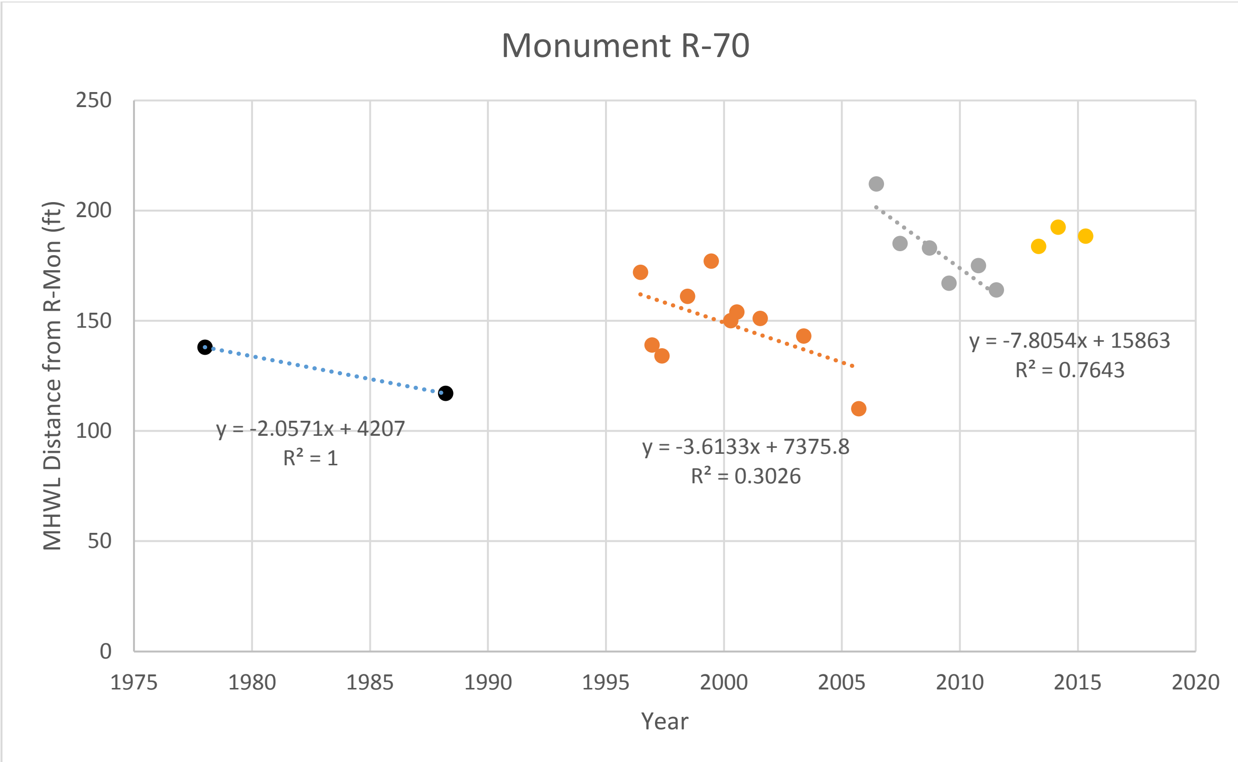

Monument T-65
MHWL Distance from R-Mon (ft)
Year
y = -4.898x + 9802.2
R² = 1
y = -5.4345x + 11002
R² = 0.7507
y = -4.4069x + 8986.6
R² = 0.6236

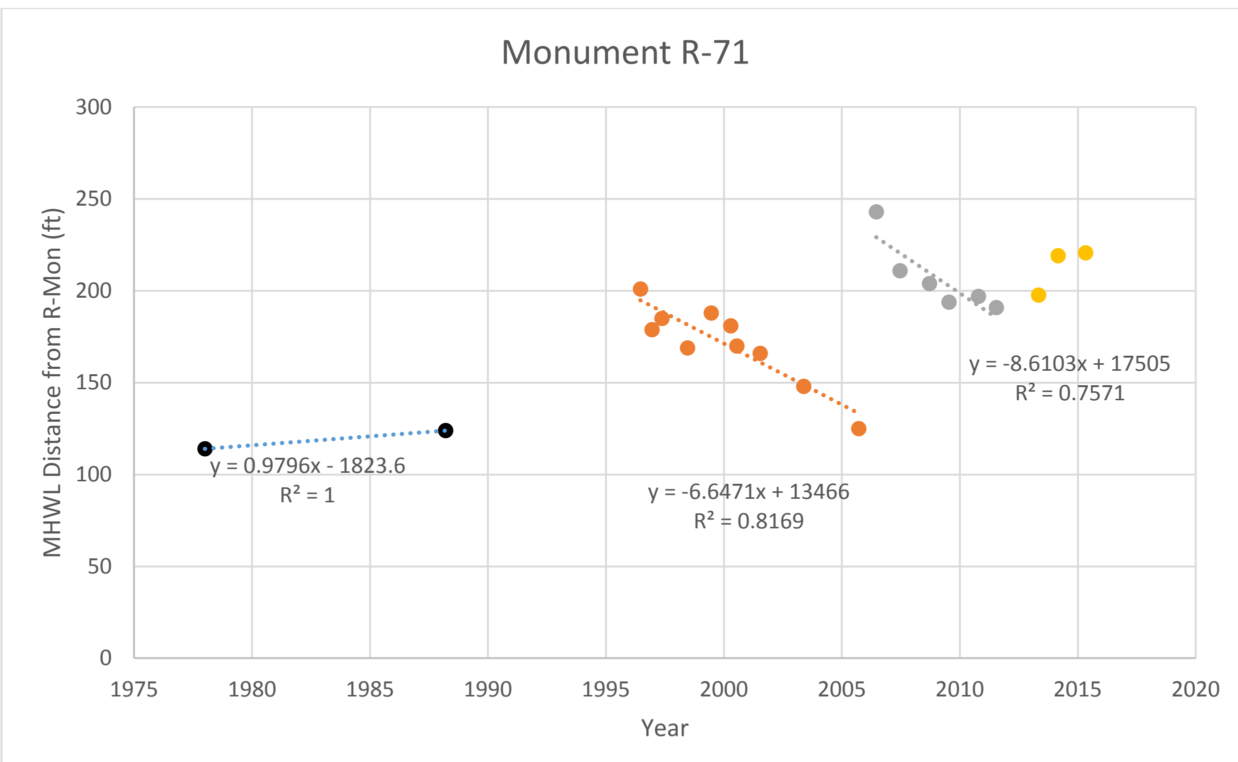

Monument R-66
MHWL Distance from R-Mon (ft)
Year
y = -3.5333x + 7146.9
R² = 0.9999
y = -0.1999x + 597.47
R² = 0.0042
y = -5.1211x + 10514
R² = 0.9062

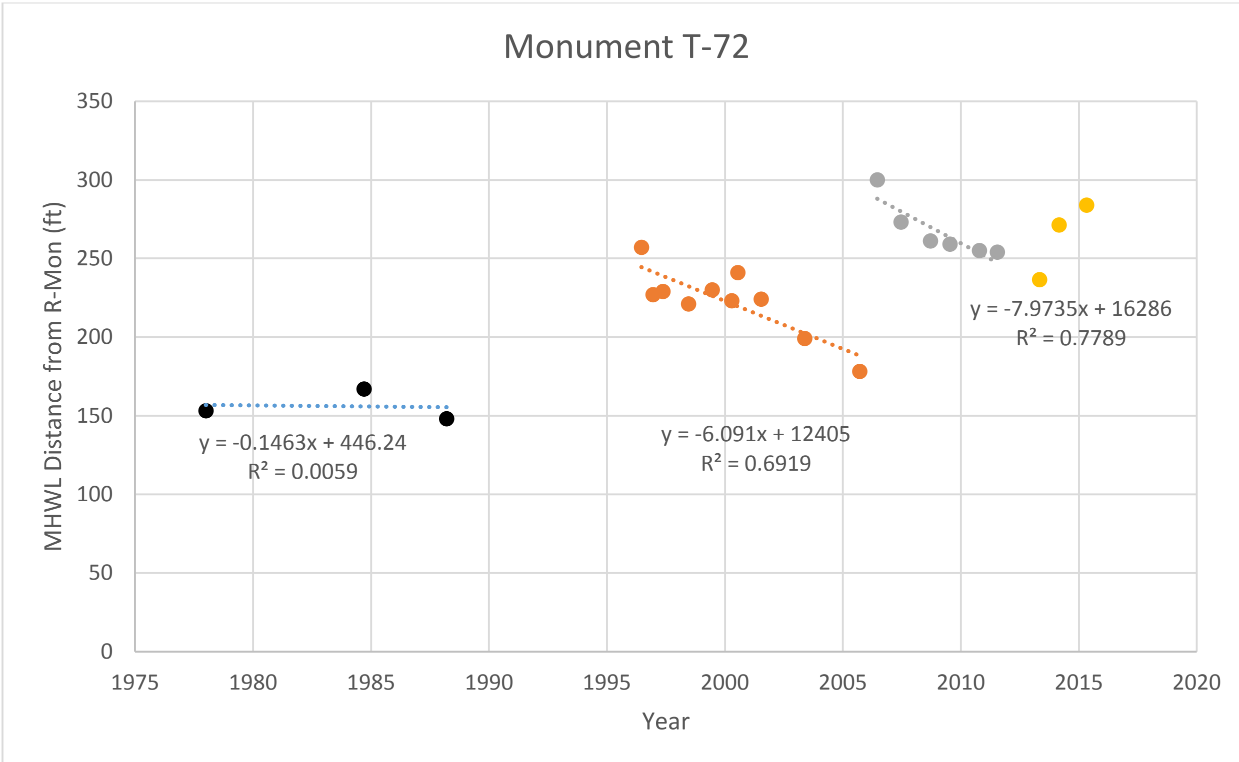

Monument T-67
MHWL Distance from R-Mon (ft)
Year
y = -2.351x + 4792.3
R² = 1
y = 1.2709x - 2366.4
R² = 0.1088
y = -6.7949x + 13865
R² = 0.8322


Monument R-68
250
200
150
100
50
0
MHWL Distance from R-Mon (ft)
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year
y = -3.0367x + 6181.7
R² = 1
y = -1.6879x + 3546.7
R² = 0.2976
y = -0.4223x + 1049.3
R² = 0.0119


Monument T-69
250
200
150
100
50
0
MHWL Distance from R-Mon (ft)
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year
y = -1.969x + 4058.1
R² = 0.3384
y = -3.9364x + 8052.7
R² = 0.4788
y = -3.3123x + 6842.7
R² = 0.4325


Monument R-70
MHWL Distance from R-Mon (ft)
Year
y = -2.0571x + 4207
R² = 1
y = -3.6133x + 7375.8
R² = 0.3026
y = -7.8054x + 15863
R² = 0.7643
250
200
150
100
50
0
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020


Monument R-71
MHWL Distance from R-Mon (ft)
Year
y = 0.9796x - 1823.6
R² = 1
y = -6.6471x + 13466
R² = 0.8169
y = -8.6103x + 17505
R² = 0.7571
300
250
200
150
100
50
0
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

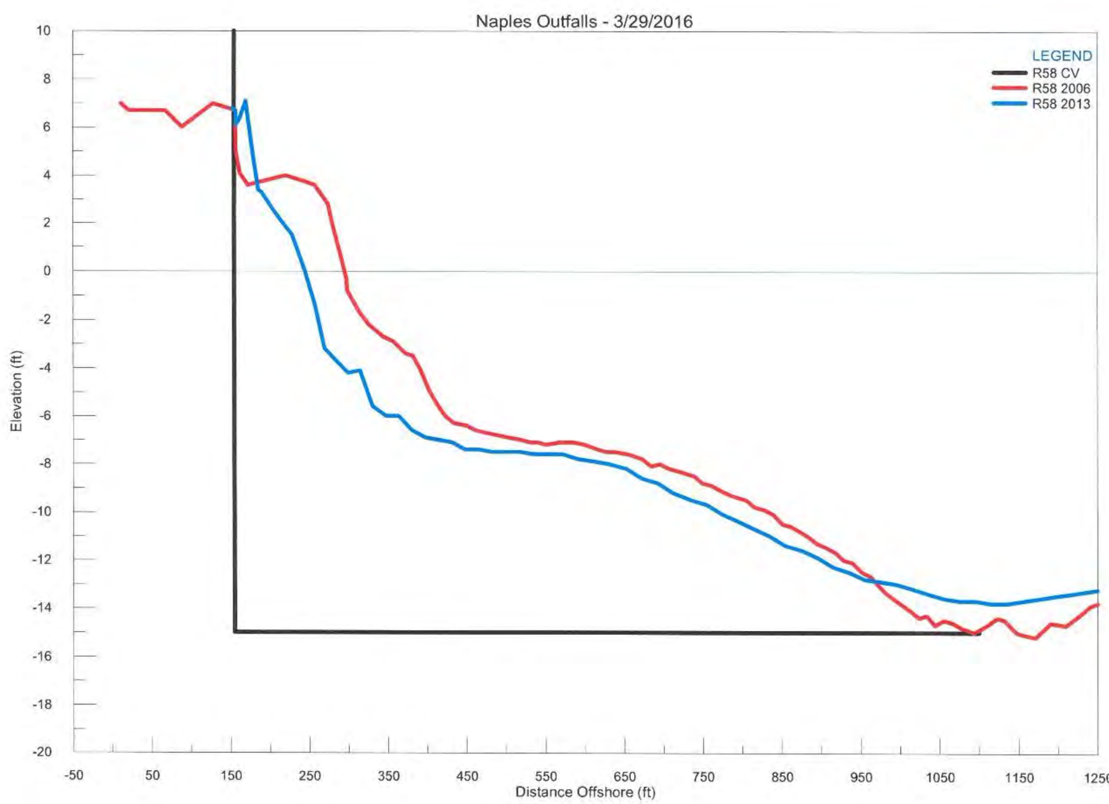

Monument T-72
MHWL Distance from R-Mon (ft)
Year
y = -0.1463x + 446.24
R² = 0.0059
y = -6.091x + 12405
R² = 0.6919
y = -7.9735x + 16286
R² = 0.7789

APPENDIX D2

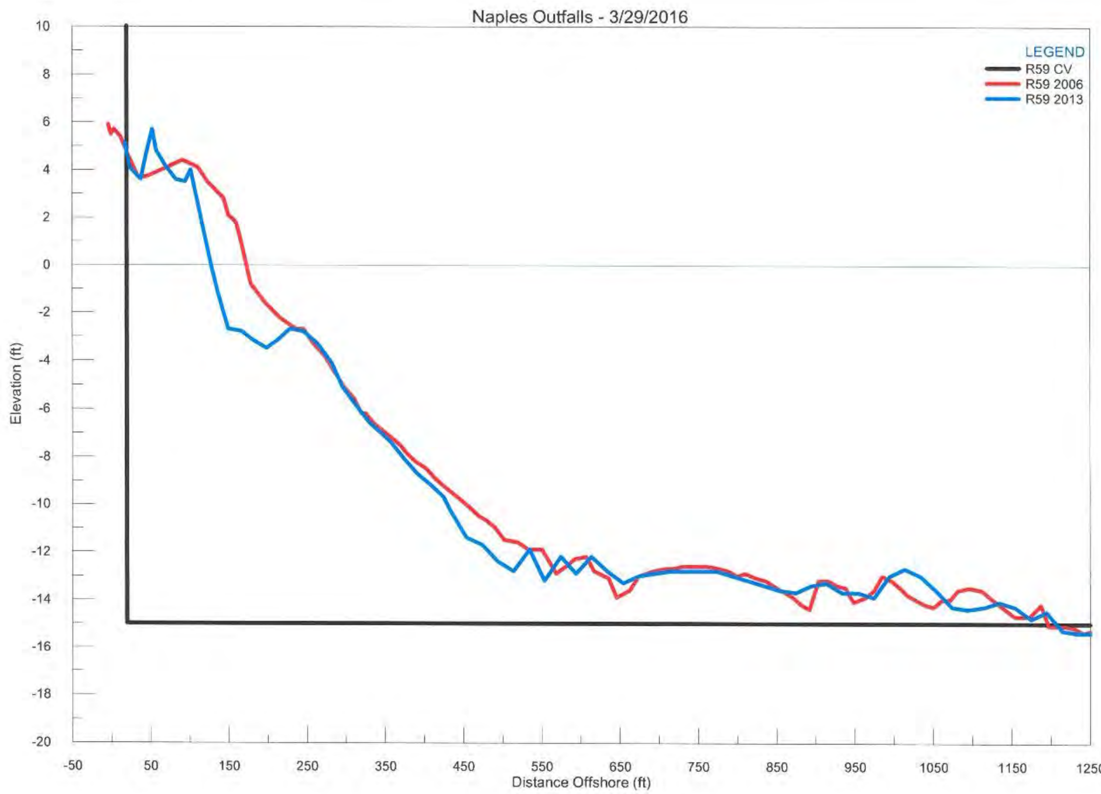
BEACH PROFILE COMPAIRSON PLOTS: EROSION VOLUME ANALYSIS

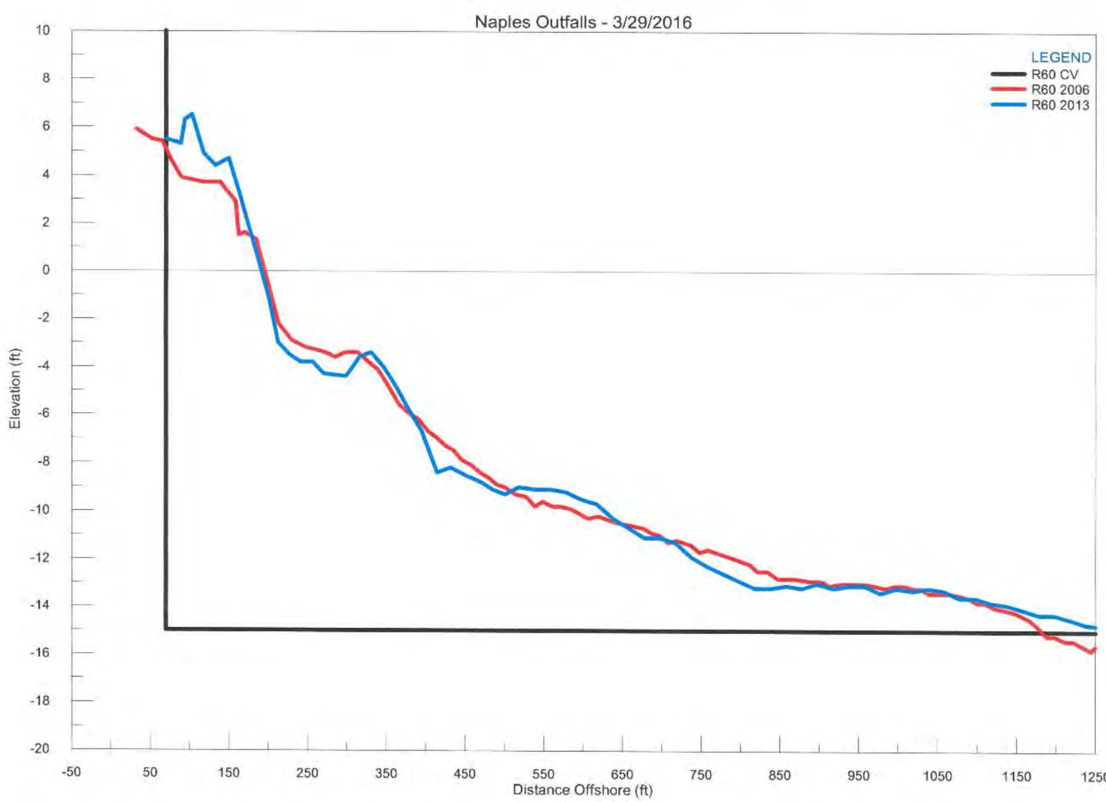
Erosion Volume (2006 to 2013)

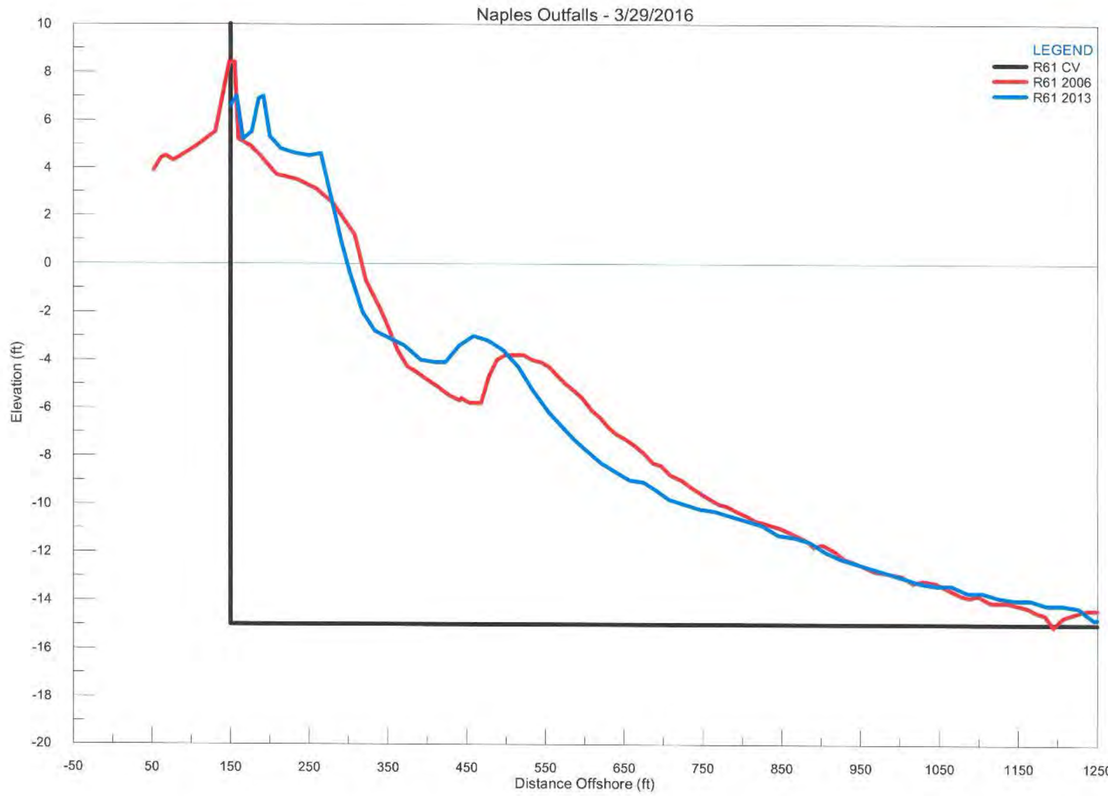
Volume calculations were permformed in BMAP by comparing each profile to the CV and removing volume above +4ft NAVD to discount wind driven erosion and dune variability.

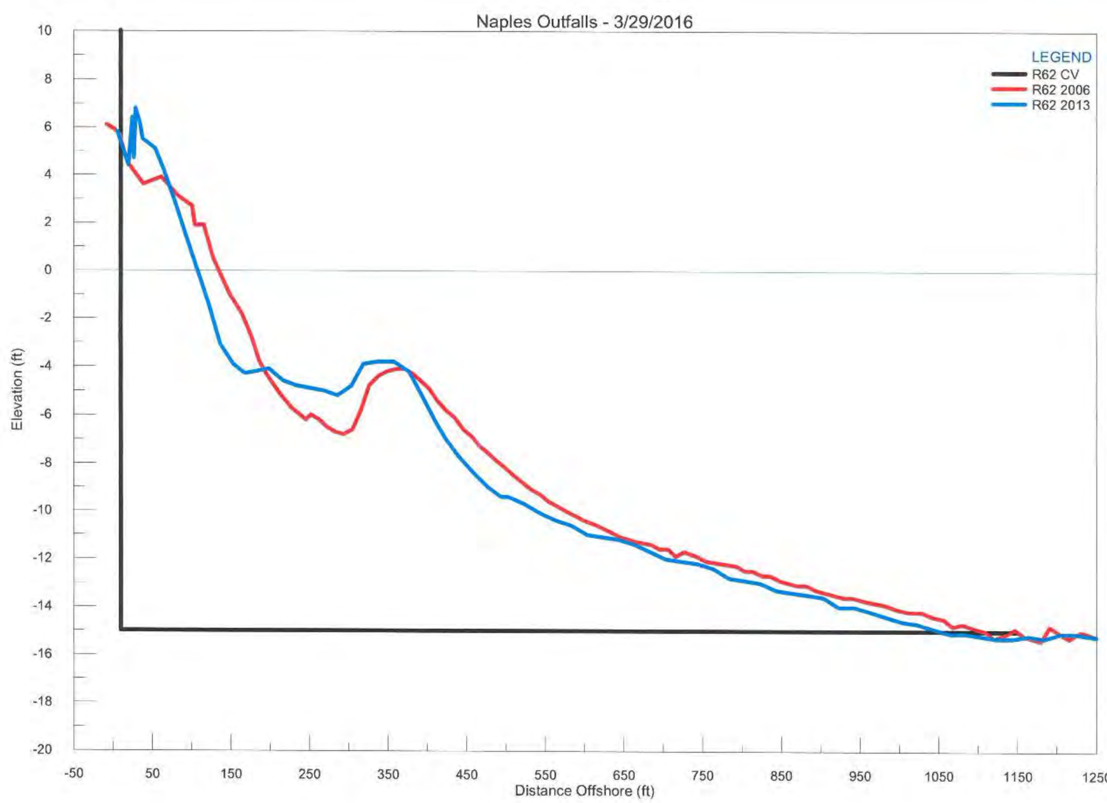


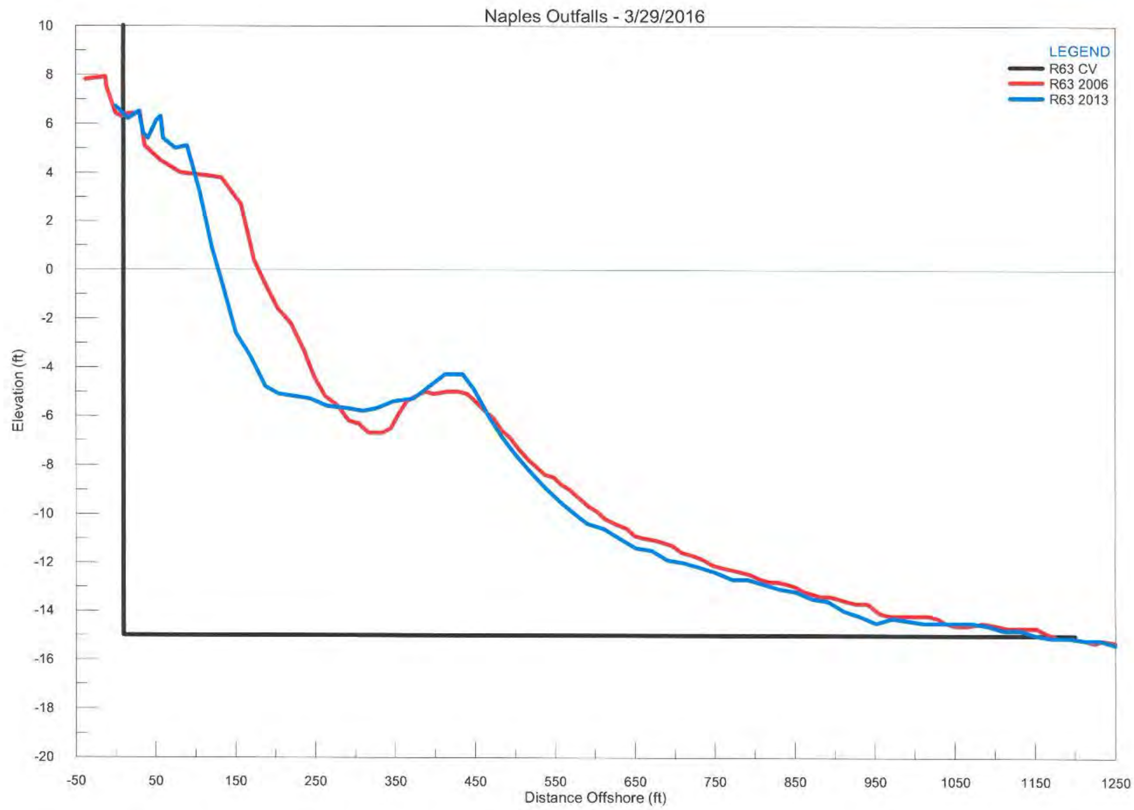
Naples Outfalls: Coastal Processes
Profiles for Erosion Volume Computation

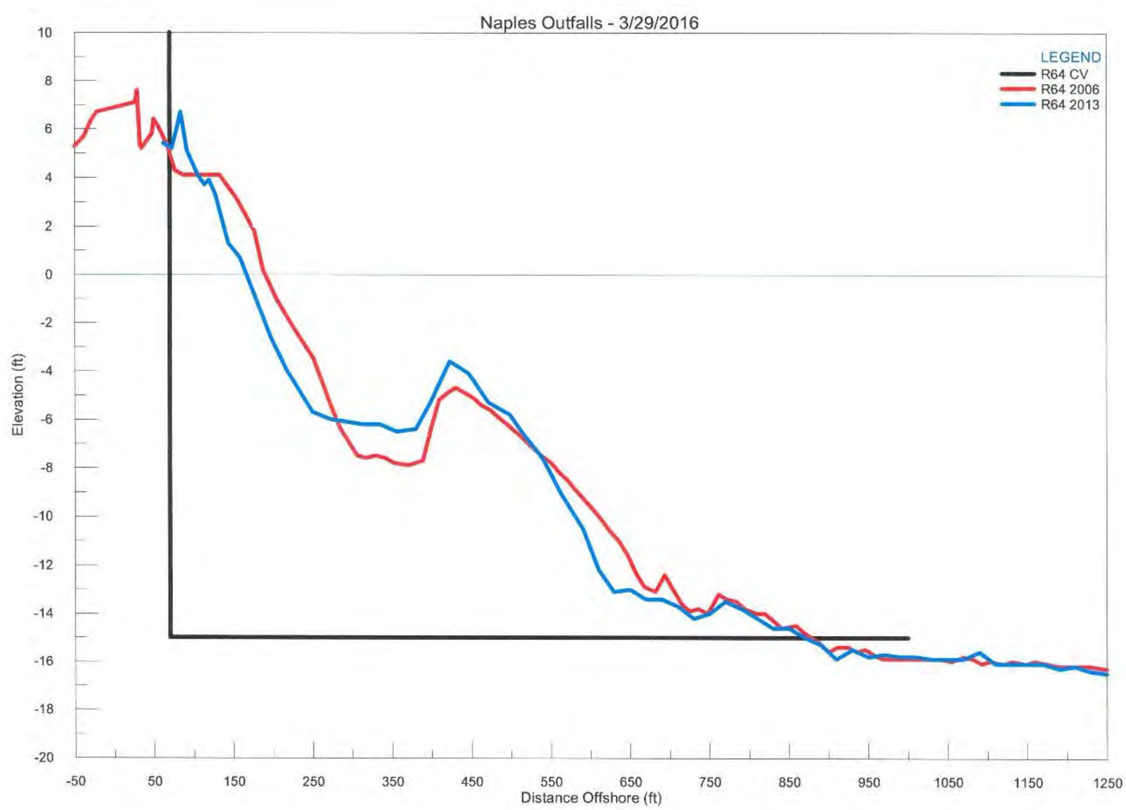


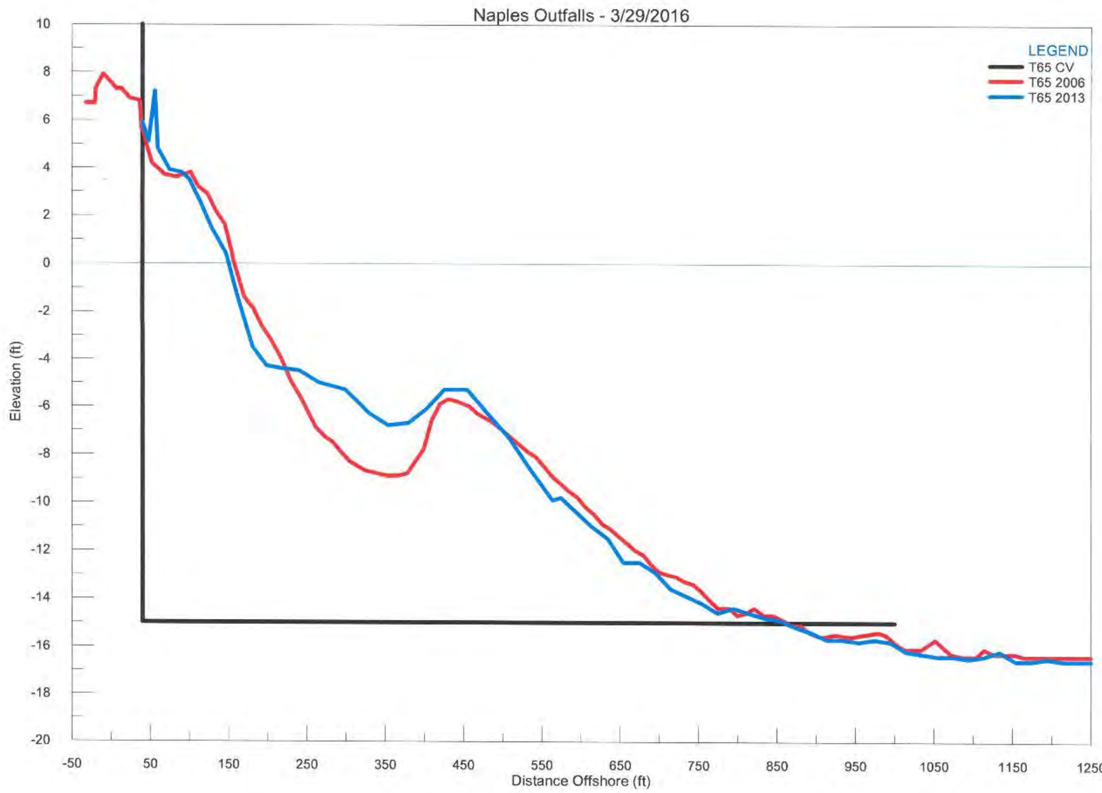


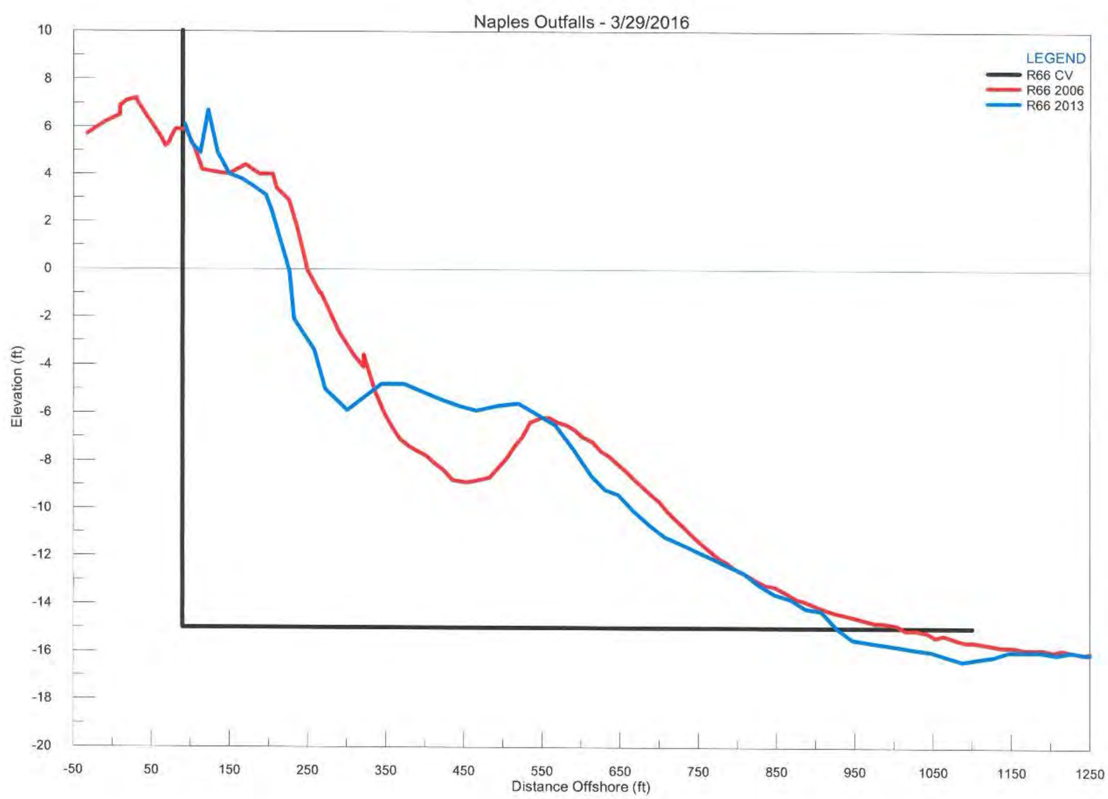

Naples Outfalls - 3/29/2016
LEGEND
R61 CV
R61 2006
R61 2013
Elevation (ft)
Distance Offshore (ft)
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-50
50
150
250
350
450
550
650
750
850
950
1050
1150
1250

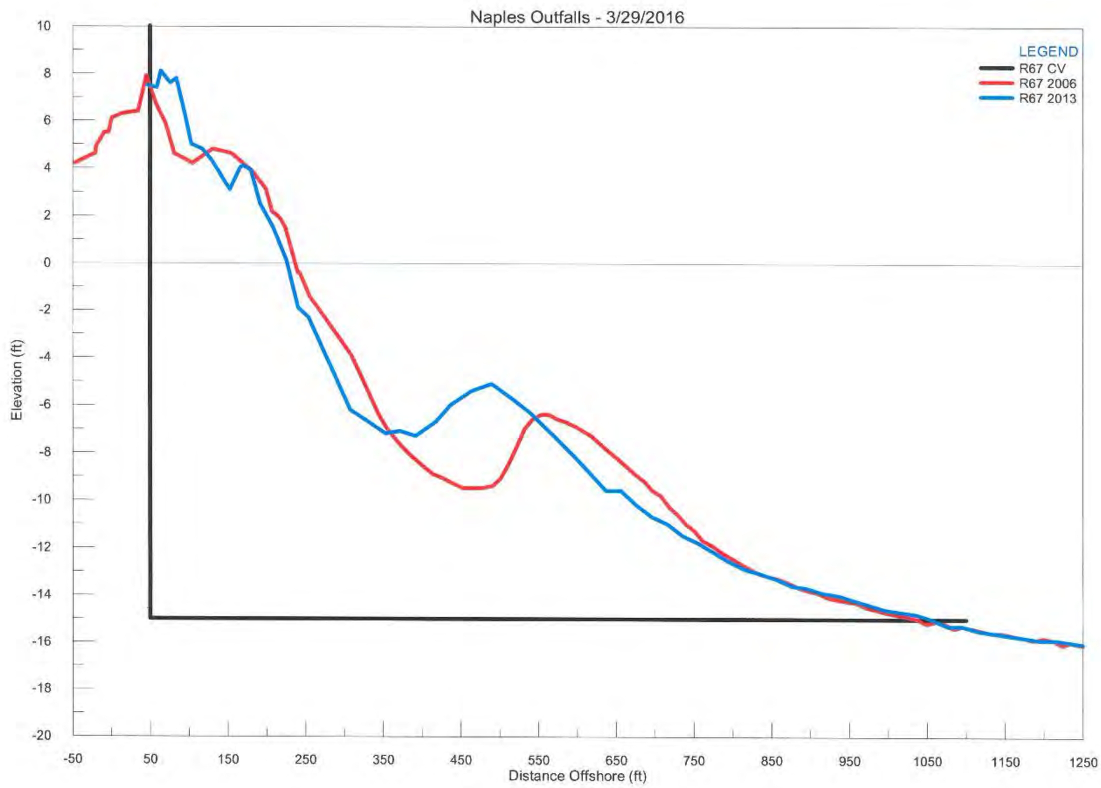

Naples Outfalls - 3/29/2016
LEGEND
R62 CV
R62 2006
R62 2013
Elevation (ft)
Distance Offshore (ft)
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-50
50
150
250
350
450
550
650
750
850
950
1050
1150
1250

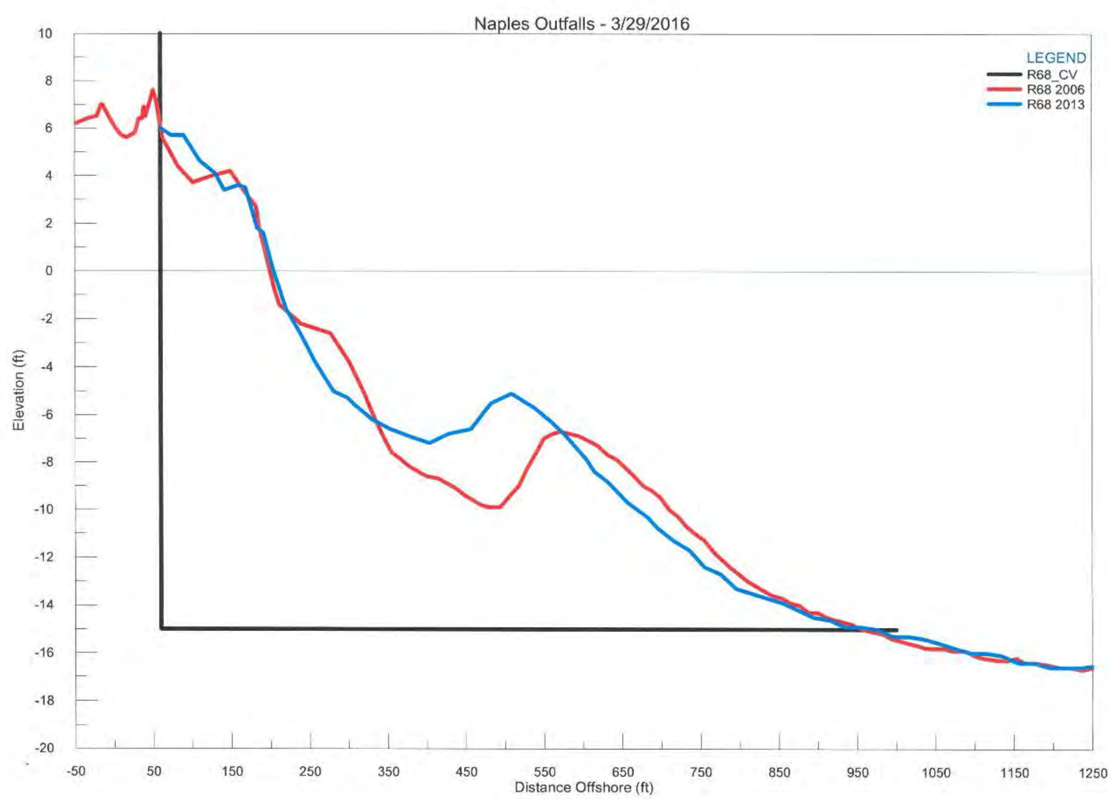

Naples Outfalls - 3/29/2016
LEGEND
R63 CV
R63 2006
R63 2013
Elevation (ft)
Distance Offshore (ft)
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-50
50
150
250
350
450
550
650
750
850
950
1050
1150
1250

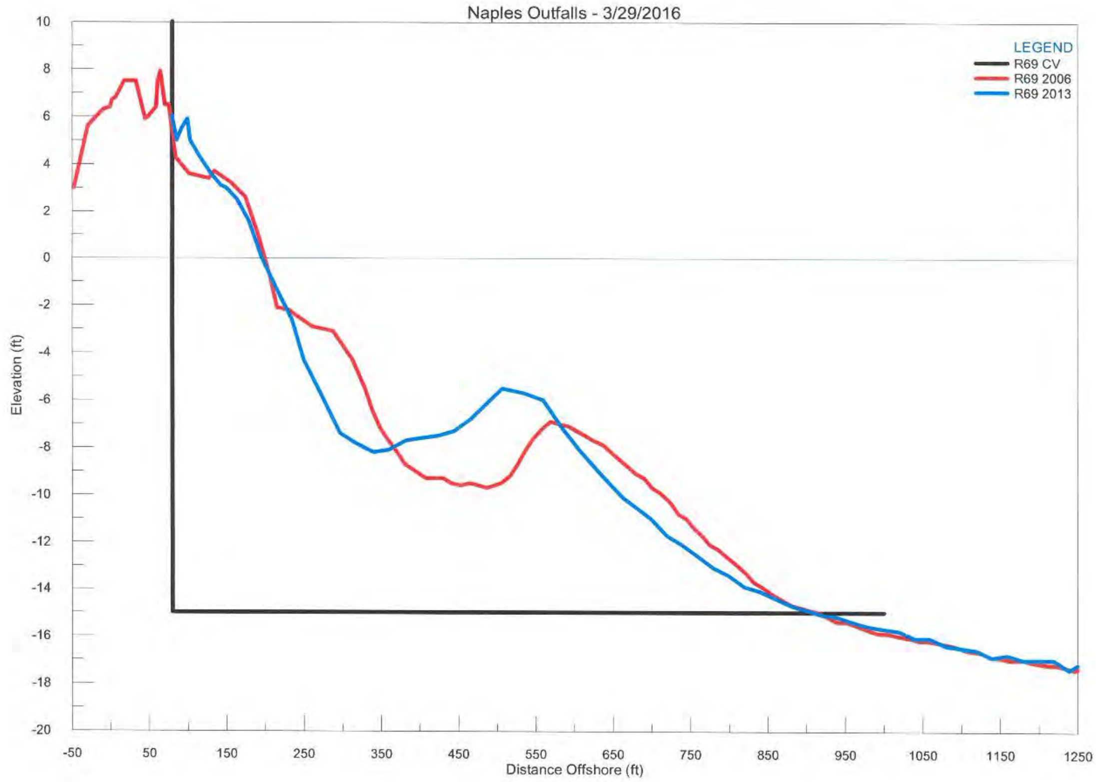

Naples Outfalls - 3/29/2016
LEGEND
R64 CV
R64 2006
R64 2013
Elevation (ft)
Distance Offshore (ft)
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-50
50
150
250
350
450
550
650
750
850
950
1050
1150
1250

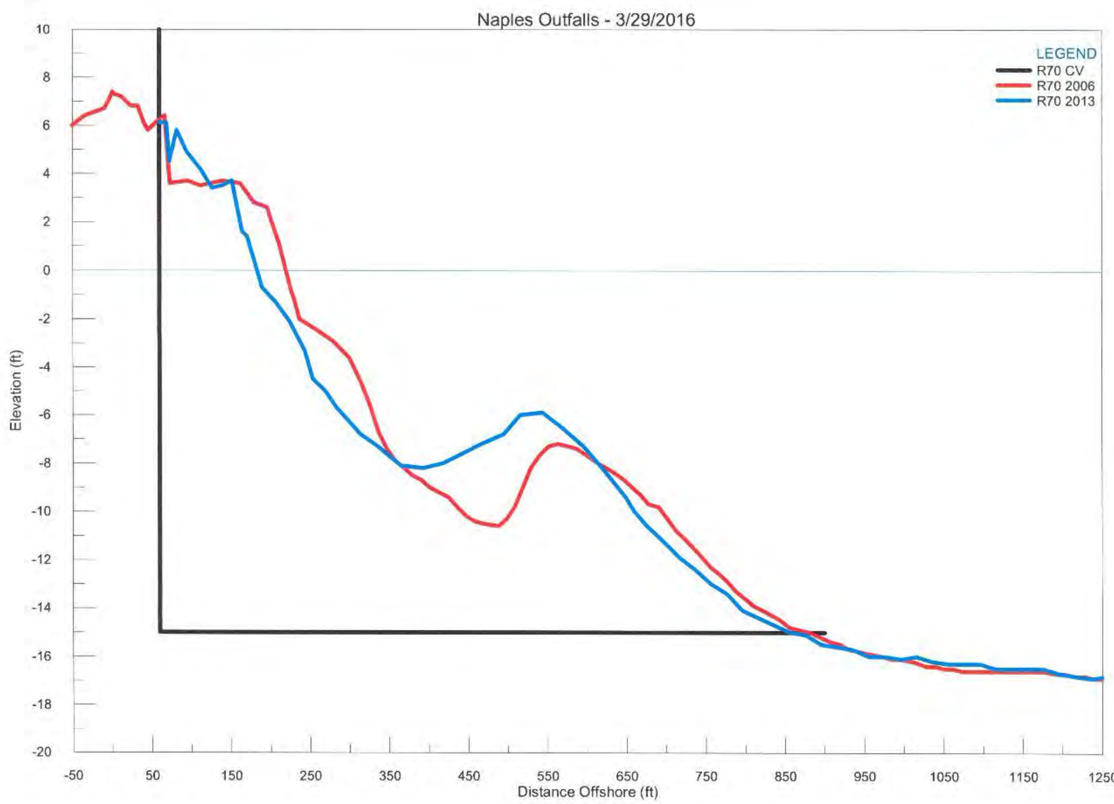

Naples Outfalls - 3/29/2016
LEGEND
T65 CV
T65 2006
T65 2013
Elevation (ft)
Distance Offshore (ft)
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-50
50
150
250
350
450
550
650
750
850
950
1050
1150
1250

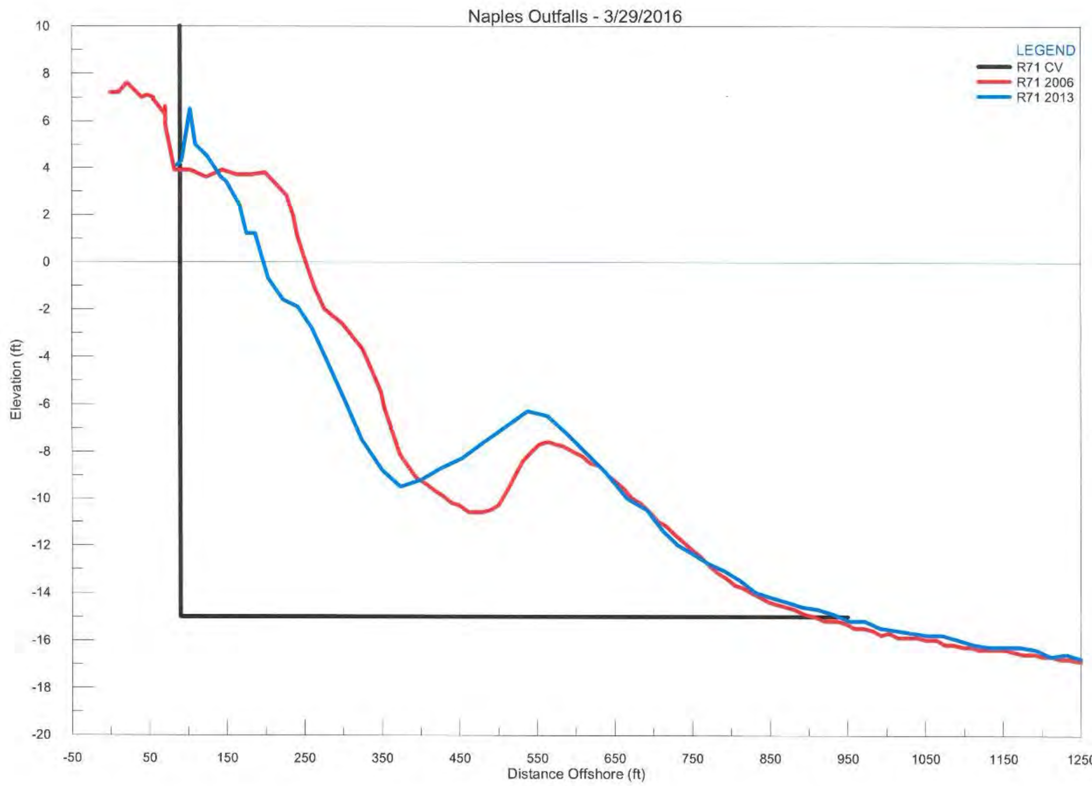

Naples Outfalls - 3/29/2016
LEGEND
R66 CV
R66 2006
R66 2013
Elevation (ft)
Distance Offshore (ft)
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-50
50
150
250
350
450
550
650
750
850
950
1050
1150
1250

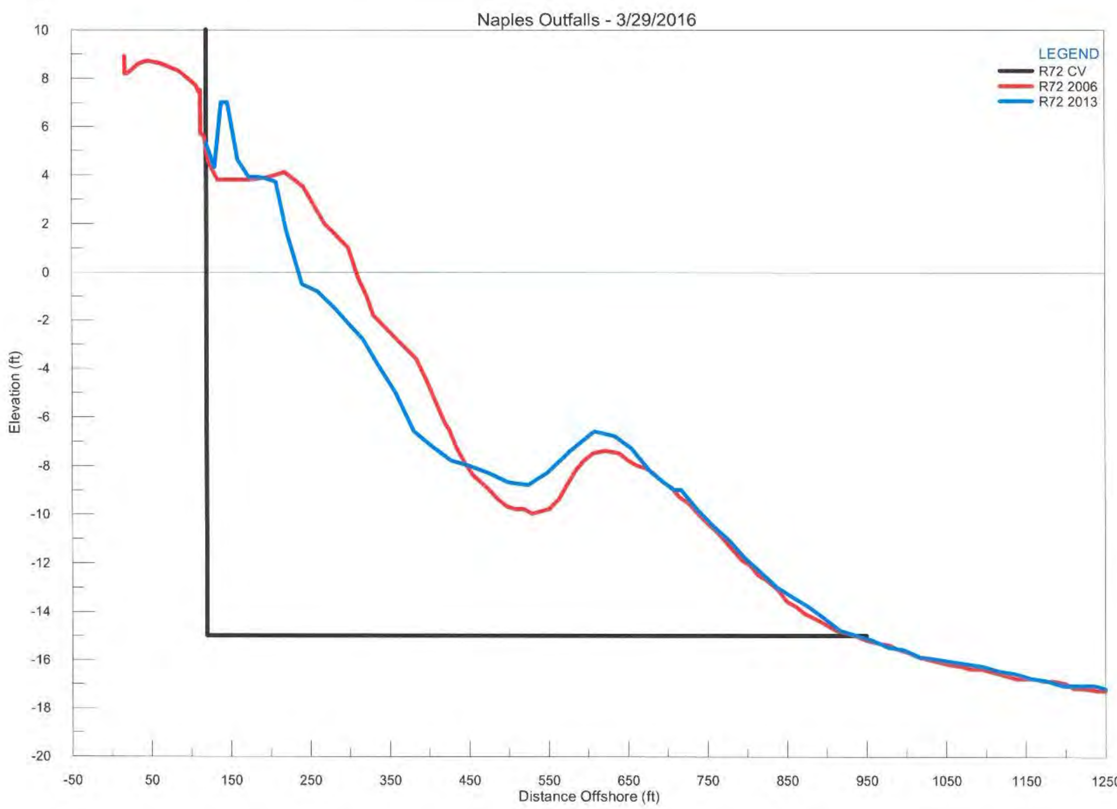

Naples Outfalls - 3/29/2016
LEGEND
R67 CV
R67 2006
R67 2013
Elevation (ft)
Distance Offshore (ft)
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-50
50
150
250
350
450
550
650
750
850
950
1050
1150
1250


Naples Outfalls - 3/29/2016
LEGEND
R68_CV
R68 2006
R68 2013
Elevation (ft)
Distance Offshore (ft)
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-50
50
150
250
350
450
550
650
750
850
950
1050
1150
1250


Naples Outfalls - 3/29/2016
LEGEND
R69 CV
R69 2006
R69 2013
Elevation (ft)
Distance Offshore (ft)
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-50
50
150
250
350
450
550
650
750
850
950
1050
1150
1250

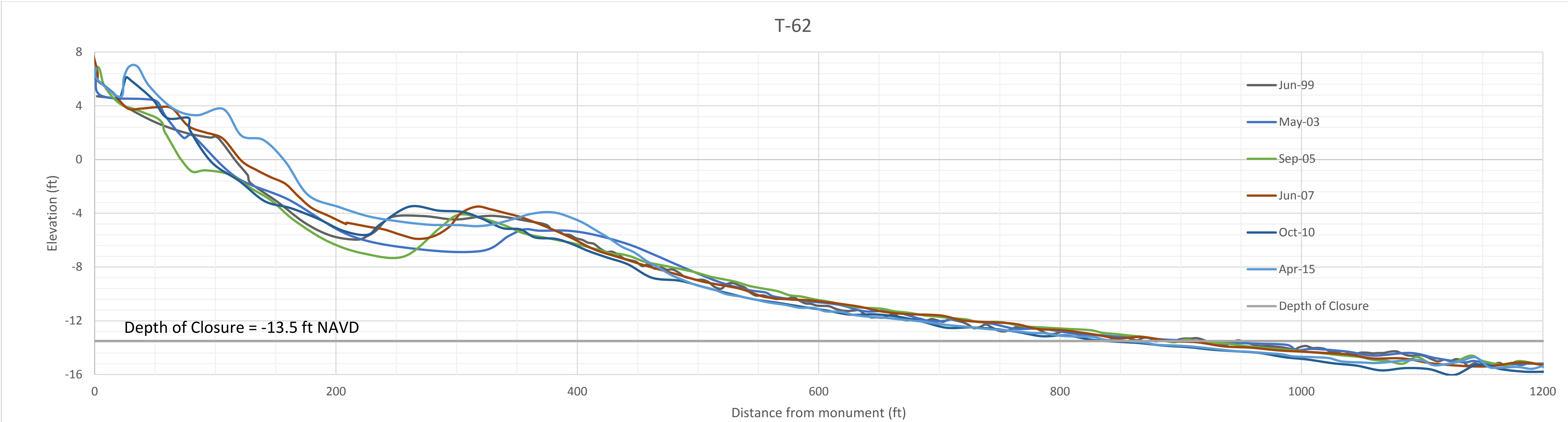

Naples Outfalls - 3/29/2016
LEGEND
R70 CV
R70 2006
R70 2013
Elevation (ft)
Distance Offshore (ft)
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-50
50
150
250
350
450
550
650
750
850
950
1050
1150
1250

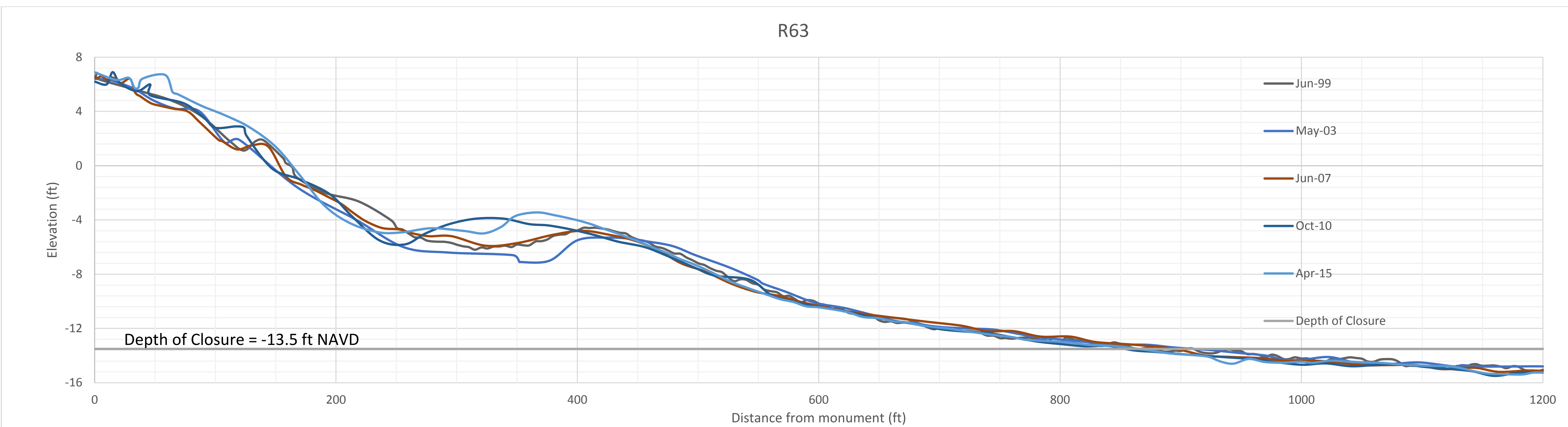

Naples Outfalls - 3/29/2016
LEGEND
R71 CV
R71 2006
R71 2013
Elevation (ft)
Distance Offshore (ft)
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-50
50
150
250
350
450
550
650
750
850
950
1050
1150
1250

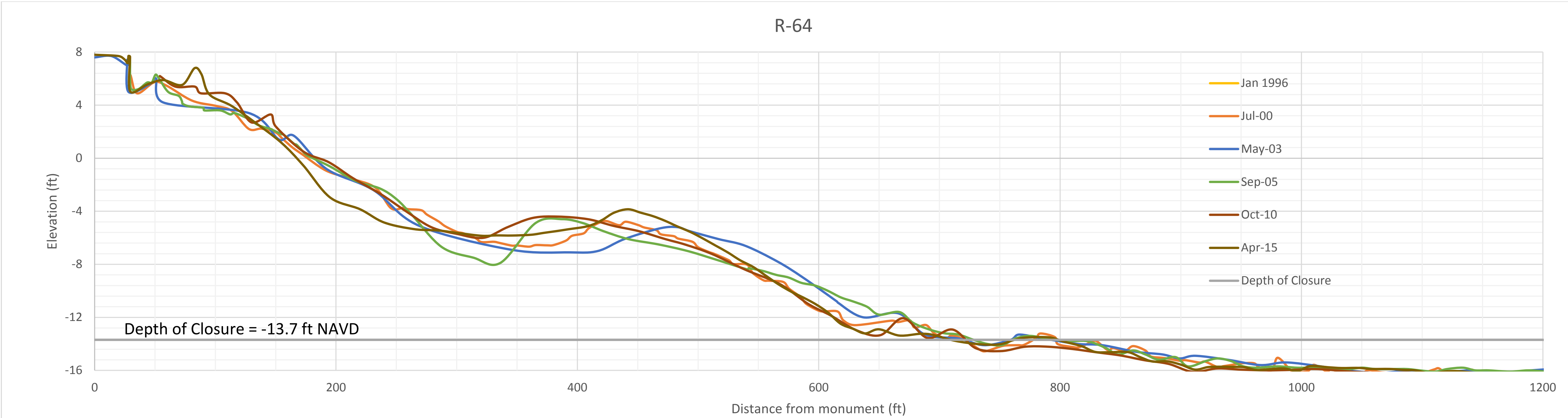

Naples Outfalls - 3/29/2016
LEGEND
R72 CV
R72 2006
R72 2013
Elevation (ft)
Distance Offshore (ft)
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-50
50
150
250
350
450
550
650
750
850
950
1050
1150
1250

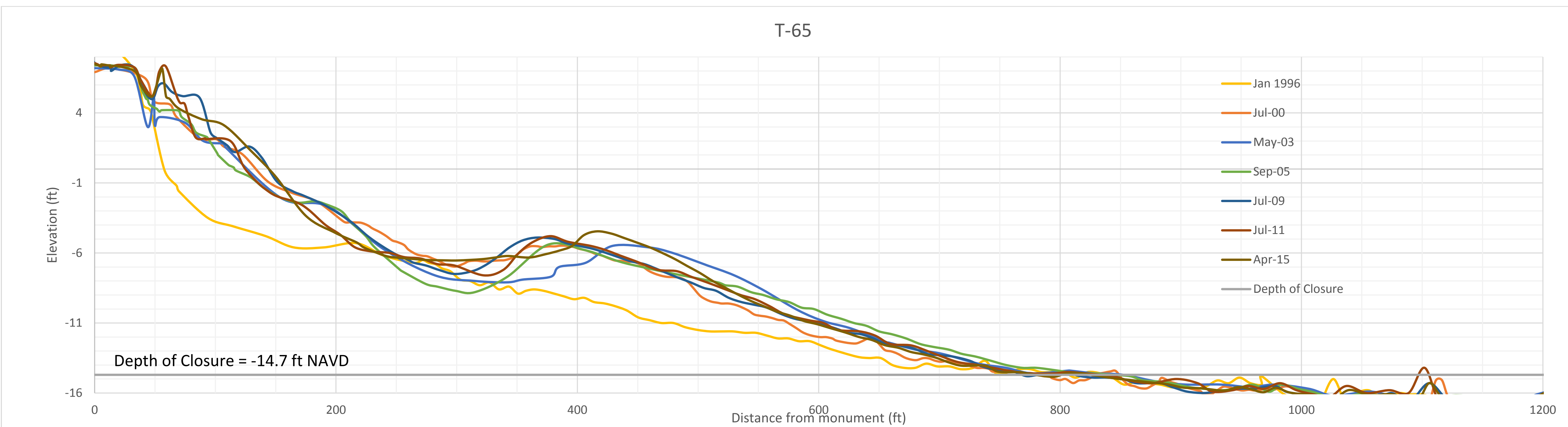
APPENDIX D3

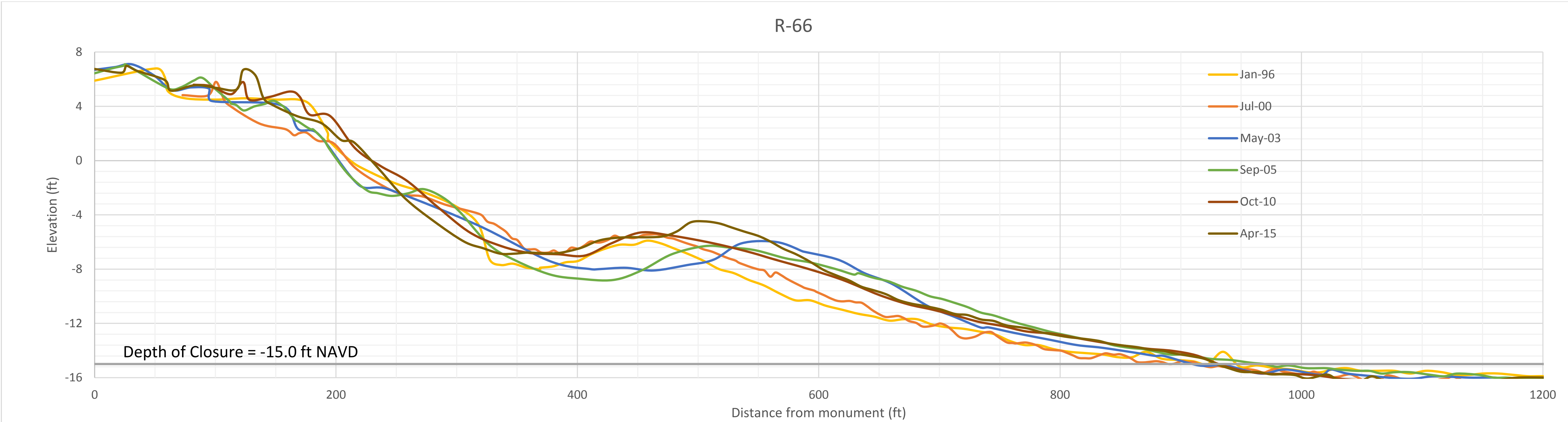
DEPTH OF CLOSURE

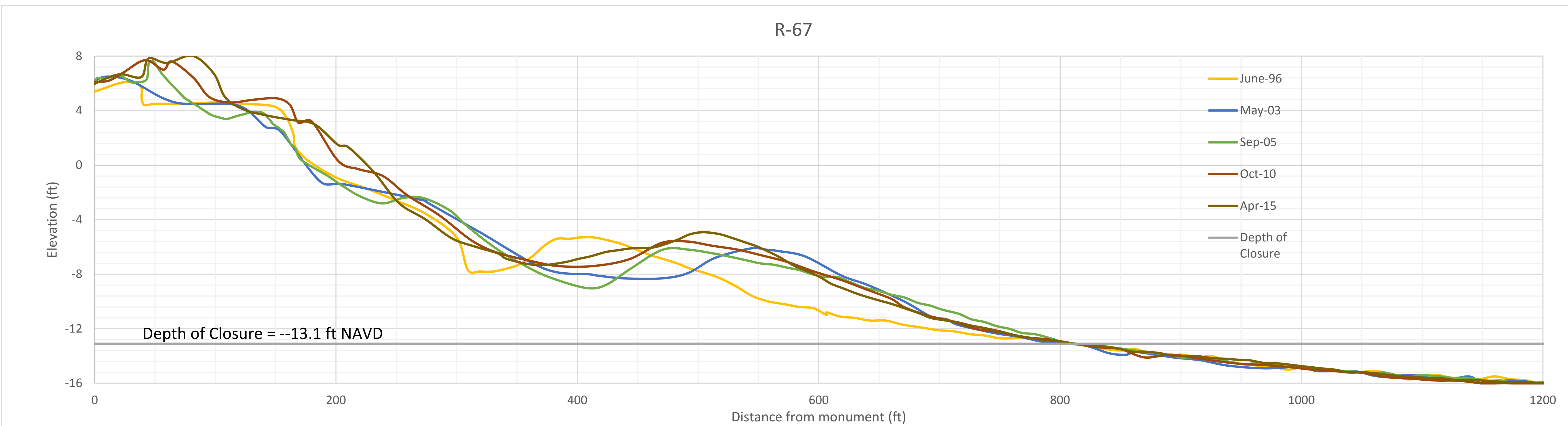

T-62
Elevation (ft)
Distance from monument (ft)
8
4
0
-4
-8
-12
-16
0
200
400
600
800
1000
1200
Depth of Closure = -13.5 ft NAVD
Jun-99
May-03
Sep-05
Jun-07
Oct-10
Apr-15
Depth of Closure


R63
Elevation (ft)
Distance from monument (ft)
8
4
0
-4
-8
-12
-16
0
200
400
600
800
1000
1200
Depth of Closure = -13.5 ft NAVD
Jun-99
May-03
Jun-07
Oct-10
Apr-15
Depth of Closure


R-64
8
4
0
-4
-8
-12
-16
Elevation (ft)
0
200
400
600
800
1000
1200
Distance from monument (ft)
Jan 1996
Jul-00
May-03
Sep-05
Oct-10
Apr-15
Depth of Closure
Depth of Closure = -13.7 ft NAVD


T-65
4
-1
-6
-11
-16
Elevation (ft)
0
200
400
600
800
1000
1200
Distance from monument (ft)
Jan 1996
Jul-00
May-03
Sep-05
Jul-09
Jul-11
Apr-15
Depth of Closure
Depth of Closure = -14.7 ft NAVD


R-66
Elevation (ft)
Distance from monument (ft)
Depth of Closure = -15.0 ft NAVD
Jan-96
Jul-00
May-03
Sep-05
Oct-10
Apr-15


R-67
Elevation (ft)
Distance from monument (ft)
Depth of Closure = --13.1 ft NAVD
June-96
May-03
Sep-05
Oct-10
Apr-15
Depth of Closure

APPENDIX E

WATER QUALITY

APPENDIX E1

WATER QUALITY TESTING PROTOCOL

CITY OF NAPLES, FLORIDA
WATER QUALITY MONITORING PROTOCOL
FOR FIELD SAMPLING AND LABORATORY TESTING
(for Enterococci, Fecal Coliform and Nitrate/Nitrite)

Project Description

Currently, the City of Naples Drainage Basin II system collects stormwater and discharges via ten (10) beach outfalls located within the swash zone. These outfalls are located between FDEP R-Monuments R-60 and R-69, south of Doctor's Pass. Of the ten (10) stormwater outfalls, the City of Naples currently maintains nine (9) of them. The northern-most outfall (#1), located just south of R-60, is private.

Currently, flooding of local roads is common during high tides and heavy rain events. In addition, there is significant concern by the public as to the contamination of water discharged to the beach. Erickson Consulting Engineers, Inc. (ECE) was contracted by the City of Naples to determine the feasibility of siting a stormwater pump station(s) in a location that would receive all or a portion of the stormwater within Drainage Basin II, consolidate the nine publically owned outfalls and discharge the collected stormwater through an offshore gulf discharge pipeline(s).

One of the primary objectives of the project is to improve water quality by minimizing bacterial and nutrient discharges to the Gulf.

Historic Water Quality Data

The State of Florida Department of Health (DOH) periodically tests shoreline water quality and issues beach closure notifications as necessary. Three areas near and within the project area are regularly monitored by the DOH for bacteria: (1) Doctor's Pass (north of the pass and north of the project area); (2) Lowdermilk Beach Park (within the project area, between Outfall #s 1 and 2, near R-61); and (3) Naples Pier (south of the project area). See Table 1 and Figure 1 below for DOH sampling locations. Historically, no beach closures have been issued for the City of Naples beaches.

Table 1. DOH Sampling Locations

Sampling Location	Location (WGS 84)		General Location Relative to Project
	Latitude	Longitude	
Doctor's Pass	26° 10' 41" N	81° 48' 54" W	North
Lowdermilk Park Beach	26° 09' 44" N	81° 48' 40" W	Within
Naples Pier	26° 07' 54" N	81° 48' 24" W	South

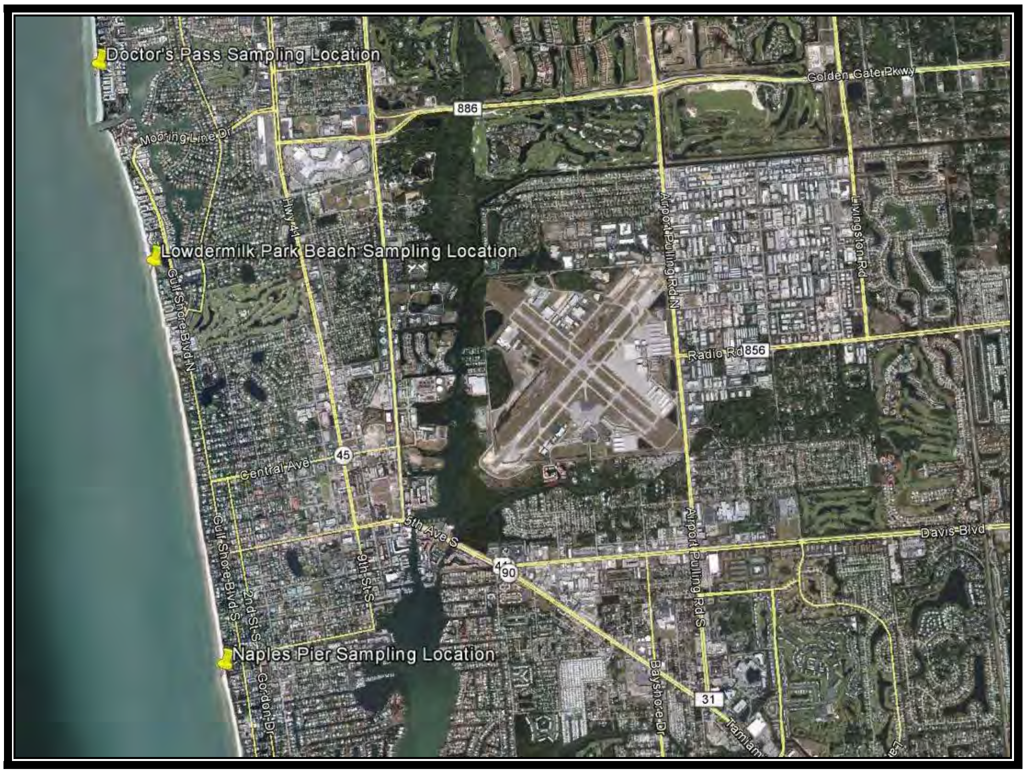


Figure 1: DOH Sampling Locations

Sampling Program

The goal of the water quality sampling program is to identify and quantify the types and concentrations of pollutants that presently discharge through the City's beach outfall pipes (#2-10). Alternative treatment methods will be investigated and evaluated during the 60% design and permitting phases of the Project.

The objectives of the water quality sampling protocol include:

1. Strategically siting the sampling locations for overall geographic location to estimate and quantify the sub-basin contribution and concentrations for outfalls characterized by high discharge rates;

2. Timing the sampling to capture the "worst case conditions" for an approximate 0.5" or greater rainfall event;
3. Following established standard methods for sampling and testing to measure pollutants of concern and gather related key baseline and physical information; and
4. Utilizing adaptive management to assess the sampling and testing results to incorporate feedback loops that may result in siting and protocol changes; and
5. Gaining an understanding of variability and levels of water quality impacts to the Gulf associated with stormwater at these outfalls and opportunities to reduce levels of pollutants.

Sampling will be conducted at the following outfalls (Table 1 and Figure 1):

Table 1. Water Quality Sampling Locations

Outfall #	Location	Characteristics
Outfall 2	R-63, north of 8th Avenue North at the Naples Beach Hotel & Golf Club	High discharge rate (84 cfs), golf course drainage/influence, geographic location
Outfall 4	R-64, 7th Avenue North	Geographic and spatial contribution from sub-basin
Outfall 6	R-65, Between 4th & 6th Avenue North and west of South Lake Drive	High discharge rates (82.3 cfs), geographic location and spatial contribution from sub-basin
Outfall 7	Between R-66 & R-67, 3rd Avenue North	Geographic location and spatial contribution from sub-basin
Outfall 8	R-67, 1st Avenue North	High discharge rate and spatial contribution from sub-basin
Outfall 10	R-69, 2nd Avenue South	Geographic location (Project's south limit)

Testing for the following will be performed by Benchmark EnviroAnalytical Inc.

- Turbidity
- Fecal Coliform
- Enterococci
- TKN
- Nitrate-Nitrite
- Total Phosphorous

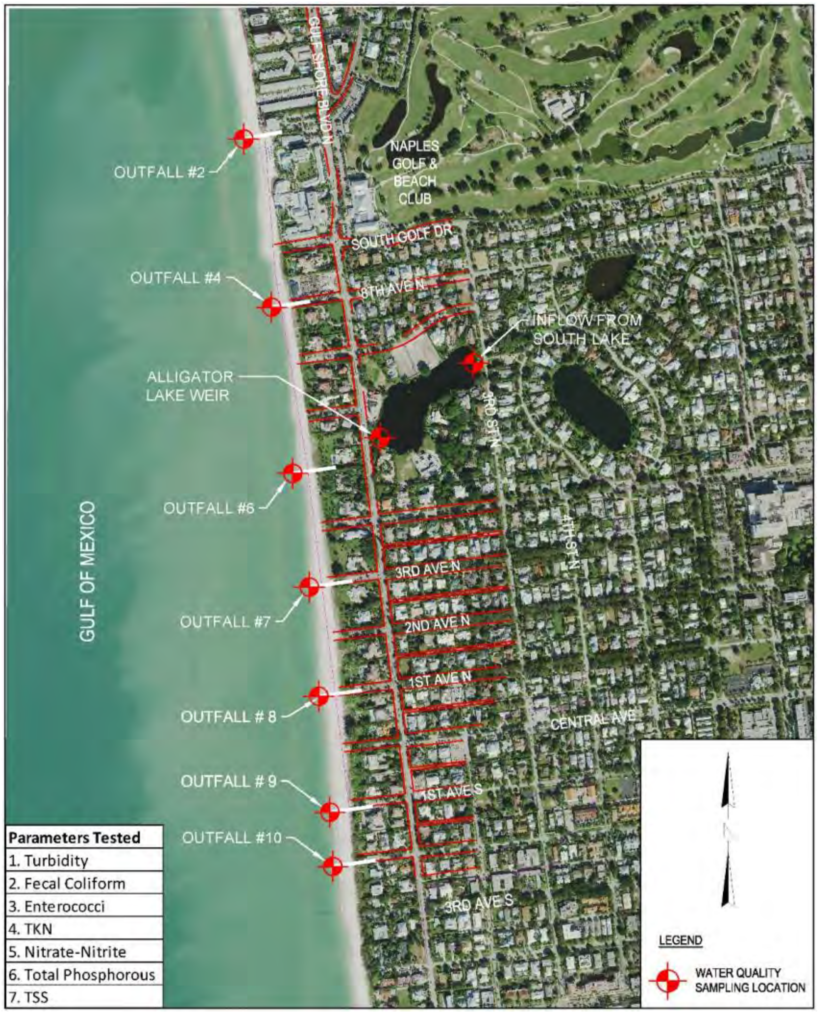


Figure 1. Water Quality Sampling Locations

The sampling methods were developed to maximize the following conditions that contribute to higher pollutant loads, and thus strive to meet the following criteria:

- Minimal to no rainfall in the area for 7 days
- A rainfall event of at least 0.5” occurring in an 8 hour period
- Safe conditions for sampling (e.g. daylight, no lightning strikes nearby, low waves)

Additional considerations include the preference to conduct the sampling during an onshore wind from the north to avoid upwelling and collection of samples at low tide where a discharge plume is visible.

The water samples are collected at each of the identified outfalls immediately after (within 1-2 hours) a rain event when the outfalls are discharging at or near peak velocity. Sampling will occur at the seaward terminus of the outfall. The goal of the timing is to capture the worst case conditions that would result in contamination near to shore and thus not allow for significant diffusion/dispersion.

At Outfalls #2 and #6 (highest flow rates), additional testing approximately 2-3 hours after the initial testing helps to determine the magnitude of reduction in loading occurring over time.

Additional considerations include:

- Samples taken during an onshore wind from the north are preferable to avoid upwelling. Therefore all samples should be taken at 11 am or later.
- Similar to the protocol followed by the State of Florida Department of Health, samples will be taken in approximately 3 ft of water at a depth approximately 1-2 ft below the water surface.
- Samples from stagnant waters at each location shall be avoided.
- For at least one of the four possible sampling events, grab samples will be collected after five (5) significant rainfall events producing a cumulative excess of two (2) inches of rainfall within the outfall project area.

Once the above criteria has been met, ECE will collect samples at each of the identified outfalls immediately after (within 1 hour of) the rain event as the outfalls are discharging at a high velocity. Sampling will occur at the seaward terminus of the outfall. The goal of this timing is to capture the worst case scenario that would keep contamination close to shore and that would not allow for diffusion/dispersion.

For outfalls #2 and #6 (highest flow rates), additional testing will be performed approximately 2-3 hours after the initial testing to determine the magnitude of reduction in loading occurring over time.

Additional testing upstream of the outfall may be conducted at the discretion of the Engineer.

Sampling Methods

Water quality sampling will initially be conducted at the seaward terminus of each outfall for bacteria (Enterococci by EPA 1600 and Fecal Coliform by SM9222D and nutrients (Nitrate/Nitrite).

Sampling methods will follow FDEP standard operating procedures per DEP-SOP-001/01, Rule 62-160.800 F.A.C., which identify requirements for applicable field collection, quality control and record keeping. SOP subsections FS 2005 – Bacteriological Sampling and method FS 2110 – Surface Water Sampling Techniques will be used for sample collection techniques. See Attachment B for FS 2005 and FS 2110 and all F.A.C. rules identified herein.

All samples will be stored on ice and transported, with appropriate chain of custody forms, for delivery to the contract analytical laboratory within the appropriate hold times, as identified in DEP-SOP-001/01.

Water quality samples will be collected from fixed stations, as identified in Table 2.

Table 2. Sample Station Locations

Outfall	Description	Approximate Latitude WGS 84 (degrees)	Approximate Longitude WGS 84 (degrees)
2	Naples Beach Hotel & Golf Club	26.1439	-81.8063
4	7th Avenue North	26.1436	-81.8082
6	Between 4th & 6th Avenue North & west of South Lake Drive	26.1449	-81.8066
8	1st Avenue North	26.1493	-81.8072
10	2nd Avenue South	26.1493	-81.8071

Laboratory Testing Procedures

Samples will be immediately stored on ice and transported to the contract laboratory, with appropriate chain of custody forms within the required 6 hour hold time, as identified in DEP-SOP-001/01. Testing will be conducted by a NELAP certified laboratory for quantifying fecal coliform by SM9222D and enterococci by EPA 1600. Laboratories used for testing identified herein must hold certification from the Department of Health – Environmental Laboratory Certification Program as required under Rule 62-160.300 F.A.C.

The initial study will use dilutions which encompass the maximum contamination limits and cover up to maximum concentrations of 20,000 CFU per 100 mL of sample. If very high concentrations (i.e. >20,000 CFU/100 mL) are encountered, the dilutions will be extended to cover maximum concentrations of 1,000,000 CFU/100 mL sample. The analytical limits of the study are outlined in Table 3 below.

Table 3. Summary Description of the Test Study

		SAMPLE DILUTION	MATRIX	MDL	MAX. COUNT	EXCEEDANCE LIMIT
PARAMETER	METHOD	ML / 100 ML		CFU / 100 ML	CFU / 100 ML	CFU / 100 ML
FECAL COLIFORM	SM9222D	1	SW	100	20000	400
		10	SW	10	2000	400
ENTERO-COCCI	EPA 1600	1	SW	100	20000	70
		10	SW	10	2000	70

Data QA/QC and Data Management

All field notes and laboratory reports will be reviewed for Quality Control. The QA/QC officer is responsible for the review and validation of the data collected. Specific activities include:

- Confirm correct information is shown on chain-of-custody forms;
- Verify that holding times were met for all parameters; and,
- Verify that appropriate analytical methods were used for all parameters.

Reporting

Field measurements and observations will be recorded on standardized field data sheets (Attachment C) for each site and will consist of the following: Date and time of sampling; Station ID; persons sampling; water temperature (degree C); dissolved oxygen saturation (%); dissolved oxygen (mg/l); specific conductance (mmhos/cm); salinity (ppt); and flow rate. Weather condition data will consist of daily and antecedent rainfall (in.), cloud cover (%), air temperature (degree C), wind direction (degree) and speed (mph), wave direction (degree) and height (ft) and current direction (degree) and magnitude (fps).

Physical characteristics such as shoreline description, water color, clarity and odor, bottom description, sediment description and erosion will be identified in the field. The field data will also include biological observations as they apply to water quality and flow such as aquatic and shoreline vegetation, bird rookeries, red tide, algae blooms, fish invertebrate and wildlife species.

Photographs will be taken at each sample site during each event. Additional photos will be taken to record any unusual or out of the ordinary conditions. Actual sample photos will be taken, as needed, to record any unique or unusual characteristics. All photos will be properly labeled and saved in the appropriate project file.

Data must be submitted in a standardized electronic format, as identified by Southwest Forida Water Management District (SWFWMD) and in accordance with Rule 62-40.540, F.A.C. The data must also include the required data elements set forth in Rules 62-160.240 and 62-160-340 F.A.C.

Final reporting shall include a detailed description of the sampling program methods and procedures as well as tabular and graphical summaries of water quality data.

Adaptive Management

The purpose of adaptive management is to incorporate feedback loops that will result in protocol changes as needed to ensure pertinent data and information is collected to assist in the analysis and design of water quality issues and treatment.

In development of the additional sample locations and/or times under adaptive management, ECE will considered the following:

- Spring and neap tidal conditions to discern what effect tidal conditions may have on the presence of contaminants at the outfalls;
- Pollutant sources;
- Shore birds feeding on schooling fish/nesting shore birds;
- Stagnant water within upstream stormwater system;
- Previous upstream water quality test results and sample locations (pump stations and lakes).

APPENDIX E2

WATER QUALITY FINDINGS

NAPLES BEACH RESTORATION AND WATER QUALITY IMPROVEMENT PROJECT WATER QUALITY DATA

	Parameters	May 4, 2016	June 7, 2016			July 21, 2016		June 6, 2017		
		Turbidity	Total Suspended Solids (TSS)	Salinity (Gulf Approx = 36 ppt)	Copper (State Limit = 3.7 UG/L)	Total Suspended Solids (TSS)	Salinity (Gulf Approx = 36 ppt)	Total Suspended Solids (TSS)	Salinity (Gulf Approx = 36 ppt)	Copper (State Limit = 3.7 UG/L)
	Sample Description	(NTU)	(mg/L)	(ppt)	(ug/L)	(mg/L)	(ppt)	(mg/L)	(ppt)	(ug/L)
Outfall #2	At Outfall	35.0	-	-		-	-	-	-	-
	50 ft Down Current	-	-	-	-	25.0	31.3	-	-	-
	100 ft Down Current	-	-	-	-	34.8	31.9	-	-	-
Outfall #4	At Outfall	26.0	-	-	-	-	-	50.0	35.2	-
	50 ft Down Current	-	-	-	-	-	-	57.0	38.9	-
	100 ft Down Current	-	-	-	-	-	-	50.0	38.6	-
Outfall #6	At Outfall	8.9	33.0	12.1	1.8	-	-	226.0	19.8	-
	50 ft Down Current	-	133.0	31.6	0.272[3]	93.3	31.8	149.0	38.0	-
	100 ft Down Current	-	95.7	33.1	0.272[3]	51.7	31.5	173.0	38.1	-
Alligator Lake	Weir Structure	4.3	11.3	4.1	1.2	29.7	4.3	2.0	6.1	0.7
	Shoreline	-	49.7	3.9	3.4	-	-	-	-	-
	South Lake Outlets	-	-	-	-	-	-	6.5	5.3	0.3
Outfall #7	At Outfall	72.0	-	-	-	-	-	20.0	2.5	2.7
	50 ft Down Current	-	-	-	-	39.2	31.2	92.9	36.0	-
	100 ft Down Current	-	-	-	-	46.8	31.8	60.8	37.0	-
Outfall #8	At Outfall	61.0	-	-	-	-	-	30.5	31.8	-
	50 ft Down Current	-	-	-	-	32.3	32.4	10.7	34.2	-
	100 ft Down Current	-	-	-	-	31.8	34.5	11.0	35.2	-
Outfall #9	At Outfall	-	-	-	-	-	-	10616[2]	35.5	-
	50 ft Down Current	-	-	-		-	-	-	-	-
	100 ft Down Current	-	-	-		-	-	-	-	-
Outfall #10	At Outfall	38.0	-	-	-	-	-	883[2]	39.0	-
	50 ft Down Current	-	-	-	-	23.8	31.9	-	-	-
	100 ft Down Current	-	-	-	-	53.2	33.1	-	-	-

1. Data Collected by ECE on: May 4th, 2016; June 7th, 2016; July 21st, 2016; June 6th, 2017.
2. High Suspended Solids due to wave action mixing beach related debris and sediments during collection.
3. Copper (CU) low and out of range due to high salinity levels
4. The conversion from conductivity to salinity was completed using the following website: http://www.chemiasoft.com/chemd/salinity_calculator
5. The approximate salinity of the Gulf of Mexico (36 ppt) was obtained from the following website: hhttps://www.britannica.com/science/salinity

NAPLES BEACH RESTORATION AND WATER QUALITY IMPROVEMENT PROJECT: WATER QUALITY DATA

	Parameters	May 4, 2016			June 7, 2016			July 21, 2016			June 6, 2017		
		Enterococci (State Limit = 70/100 ML)	Fecal Coliform (State Limit = 400/100 ML)	Turbidity	Enterococci (State Limit = 70/100 ML)	Fecal Coliform (State Limit = 400/100 ML)	Salinity (Gulf Approx = 36 ppt)	Enterococci (State Limit = 70/100 ML)	Fecal Coliform (State Limit = 400/100 ML)	Salinity (Gulf Approx = 36 ppt)	Enterococci (State Limit = 70/100 ML)	Fecal Coliform (State Limit = 400/100 ML)	Salinity (Gulf Approx = 36 ppt)
	Sample Description	(#/100 ML)	(#/100 ML)	(NTU)	(#/100 ML)	(#/100 ML)	(ppt)	(#/100 ML)	(#/100 ML)	(ppt)	(#/100 ML)	(#/100 ML)	(ppt)
Outfall #2	At Outfall	1600	180	35.0	-	-	-			-	-	-	-
	50 ft Down Current	-	-	-	-	-	-	70	10	31.3	-	-	-
	100 ft Down Current	-	-	-	-	-	-	10	20	31.9	-	-	-
Outfall #4	At Outfall	22000	140	26.0	-	-	-			-	1700	12000	35.2
	50 ft Down Current	-	-	-	-	-	-			-	140	80	38.9
	100 ft Down Current	-	-	-	-	-	-			-	120	120	38.6
Outfall #6	At Outfall	19000	10	8.9	170	390	12.1			-	8600	4300	19.8
	50 ft Down Current	-	-	-	30	40	31.6	60	10	31.8	460	110	38.0
	100 ft Down Current	-	-	-	20	120	33.1	100	10	31.5	440	230	38.1
Alligator Lake	Weir Structure	300	10	4.3	460	190	4.1	580	4500	4.3	2900	900	6.1
	Shoreline	-	-	-	190	910	3.9			-	-	-	-
	South Lake Outlets	-	-	-	-	-	-			-	3600	1100	5.3
Outfall #7	At Outfall	6600	3600	72.0	-	-	-			-	52000	8000	2.5
	50 ft Down Current	-	-	-	-	-	-	20	10	31.2	2100	140	36.0
	100 ft Down Current	-	-	-	-	-	-	10	10	31.8	980	70	37.0
Outfall #8	At Outfall	38000	2400	61.0	-	-	-			-	41000	8400	31.8
	50 ft Down Current	-	-	-	-	-	-	30	10	32.4	270	60	34.2
	100 ft Down Current	-	-	-	-	-	-	10	10	34.5	190	100	35.2
Outfall #9	At Outfall	-	-	-	-	-	-			-	400	50	35.5
	50 ft Down Current	-	-	-	-	-	-			-	-	-	-
	100 ft Down Current	-	-	-	-	-	-			-	-	-	-
Outfall #10	At Outfall	4400	140	38.0	-	-	-			-	10	10	39.0
	50 ft Down Current	-	-	-	-	-	-	10	20	31.9	-	-	-
	100 ft Down Current	-	-	-	-	-	-	20	10	33.1	-	-	-

1. Data Collected by ECE on: May 4th, 2016; June 7th, 2016; July 21st, 2016; June 6th, 2017.
2. The conversion from conductivity to salinity was completed using the following website: http://www.chemiasoft.com/chemd/salinity_calculator
3. The approximate salinity of the Gulf of Mexico (36 ppt) was obtained from the following website: hhttps://www.britannica.com/science/salinity

NAPLES BEACH RESTORATION AND WATER QUALITY IMPROVEMENT PROJECT: WATER QUALITY DATA

	Parameters	May 4, 2016						July 21, 2016						June 6, 2017					
		Total Kjeldahl Nitrogen (TKN)	Nitrate+ Nitrite as N	Nitrate Nitrogen	Nitrite Nitrogen	Total Phosphorus as P	Salinity (Gulf Approx = 36 ppt)	Total Kjeldahl Nitrogen (TKN)	Total Nitrogen	Nitrate+ Nitrite as N	Nitrate Nitrogen	Nitrite Nitrogen	Salinity (Gulf Approx = 36 ppt)	Total Kjeldahl Nitrogen (TKN)	Total Nitrogen	Nitrate+ Nitrite as N	Nitrate Nitrogen	Nitrite Nitrogen	Salinity (Gulf Approx = 36 ppt)
	Sample Description	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(ppt)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(ppt)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(ppt)
Outfall #2	**At Outfall**	2.840	0.024	0.020	0.004	0.380	-	-	-	-	-	-	-	-	-	-	-	-	-
	50 ft Down Current	-	-	-	-	-	-	1.090	1.100	0.011	0.007	0.004	31.3	-	-	-	-	-	-
	100 ft Down Current	-	-	-	-	-	-	1.020	1.140	0.116	0.111	0.005	31.9	-	-	-	-	-	-
Outfall #4	**At Outfall**	0.872	0.148	0.138	0.010	0.029	-	-	-	-	-	-	-	0.714	0.765	0.051	0.046	0.005	35.2
	50 ft Down Current	-	-	-	-	-	-	-	-	-	-	-	-	0.615	0.635	0.020	0.020	0.002	38.9
	100 ft Down Current	-	-	-	-	-	-	-	-	-	-	-	-	0.692	0.781	0.089	0.089	0.002	38.6
Outfall #6	**At Outfall**	1.370	0.056	0.045	0.011	0.159	12.100	-	-	-	-	-	-	0.836	0.922	0.086	0.077	0.009	19.8
	50 ft Down Current	-	-	-	-	-	31.600	1.150	1.230	0.083	0.076	0.007	31.8	0.761	0.808	0.047	0.042	0.005	38.0
	100 ft Down Current	-	-	-	-	-	33.100	1.390	1.420	0.048	0.033	0.015	31.5	0.686	0.715	0.029	0.026	0.003	38.1
Alligator Lake	**Weir Structure**	1.540	0.011	0.004	0.013	0.112	4.100	1.800	1.820	0.018	0.004	0.029	4.3	1.430	1.500	0.069	0.061	0.008	6.1
	Shoreline	-	-	-	-	-	3.900	-	-	-	-	-	-	-	-	-	-	-	-
	South Lake Outlets	-	-	-	-	-	-	-	-	-	-	-	-	1.460	1.550	0.086	0.078	0.002	5.3
Outfall #7	**At Outfall**	1.160	0.028	0.022	0.006	0.255	-	-	-	-	-	-	-	1.070	1.240	0.169	0.162	0.007	2.5
	50 ft Down Current	-	-	-	-	-	-	1.110	1.160	0.051	0.046	0.005	31.2	0.689	0.719	0.030	0.030	0.002	36.0
	100 ft Down Current	-	-	-	-	-	-	1.190	1.220	0.032	0.023	0.009	31.8	0.674	0.694	0.020	0.016	0.004	37.0
Outfall #8	**At Outfall**	1.040	0.070	0.062	0.008	0.174	-	-	-	-	-	-	-	0.728	0.851	0.123	0.120	0.003	31.8
	50 ft Down Current	-	-	-	-	-	-	1.140	1.250	0.110	0.100	0.010	32.4	0.692	0.713	0.021	0.014	0.007	34.2
	100 ft Down Current	-	-	-	-	-	-	1.040	1.060	0.017	0.010	0.007	34.5	0.668	0.719	0.051	0.051	0.002	35.2
Outfall #9	**At Outfall**	-	-	-	-	-	-	-	-	-	-	-	-	0.742	0.810	0.068	0.061	0.007	35.5
	50 ft Down Current	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	100 ft Down Current	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Outfall #10	**At Outfall**	0.773	0.009	0.005	0.004	0.054	-	-	-	-	-	-	-	0.642	0.657	0.015	0.015	0.002	39.0
	50 ft Down Current	-	-	-	-	-	-	1.060	1.170	0.107	0.097	0.010	31.9	-	-	-	-	-	-
	100 ft Down Current	-	-	-	-		-	1.100	1.110	0.010	0.005	0.005	33.1	-	-	-	-	-	-

1. Data Collected by ECE on: May 4th, 2016; July 21st, 2016; June 6th, 2017.

2. The conversion from conductivity to salinity was completed using the following website: http://www.chemiasoft.com/chemd/salinity_calculator

3. The approximate salinity of the Gulf of Mexico (36 ppt) was obtained from the following website: hhttps://www.britannica.com/science/salinity

APPENDIX F

ALTERNATIVES EVALUATION MATRIX

City of Naples Beach Restoration and Water Quality Improvement Project: Opportunities and Sensitivities Evaluation

Description		Alterative 1		Alterative 2		Alternative 3	
		Benefits	Challenges	Benefits	Challenges	Benefits	Challenges
Technical							
Meets Project Objectives (15%)	**Reduce Erosion Rates & Improve Lateral Beach Access**	• 7 of 9 Outfalls (3-5;7-10) removed • City contribution at outfall 2 re-routed to reduce discharge (eliminates 1 pipe) • Outfall 6 overflow for low-frequency events only • Remove Outfall 6 from visible beach	• Outfall 2 pipe remain to convey Gulf Club Discharge (1 pipe remains) • Outfall 6 remains for low-frequency events	• 7 of 9 outfalls (3-5;7-10) removed • City contribution at outfall 2 re-routed to reduce discharge (eliminate 1 pipe) • Outfall 6 overflow for low-frequency events only • Remove Outfall 6 from visible beach	• Outfall 2 pipe remain to convey Gulf Club Discharge (1 pipe remains) • Outfall 6 overflow for low-frequency events only	• 8 of 9 outfalls removed (2-5;7-10) • Outfall 6 overflow for low-frequency events only • Outfall 6 removed from visible beach • Reduced size of Outfall 6 overflow pipes compared to Alts 1 & 2	• Overflow from Outfall 6 during low-frequency events
	Reduce Flooding	• Eliminates gravity/staging & create positive flow • Consolidates 6 outfalls (3-8) for discharge offshore • Consolidates discharge for 3 outfalls (2-City Contribution, 9, 10) with re-routing to Moorings Bay and Basin III (Naples Bay)	• Outfall 2 pipe remains to convey Gulf Club Discharge (1 pipe remains)	• Eliminates gravity/staging & create positive flow • Consolidates 9 outfalls (2-City to 10) for discharge offshore • City contribution at Outfall 2 consolidated & discharged offshore	• Outfall 2 pipe remain to convey Gulf Club Discharge (1 pipe remains)	• Eliminate gravity/staging & create positive flow • Consolidates 9 outfalls (2 to 10) for discharge offshore • Private Beach Club portion of Outfall 2 is consolidated & discharged offshore • Reduced water volume of Outfall 6 overflow compared to Alts 1 & 2	
	Improve Water Quality	• Consolidates & filters discharge for 6 outfalls (3-8)	• Discharge from 3 outfalls (2, 9 and 10) re-routed out of Basin 2 (Moorings Bay & Naples Bay)	• Consolidates & filters discharge for all outfalls (private Golf Club at Outfall 2 remains)	• Private Beach Club portion of Outfall 2 to remain	• Consolidates & filters discharge for all outfalls	
	Reduce Environmental Impacts	• Outfalls (except Outfall 2) removed from visible beach increasing/enhancing habitat for sea turtles & shorebirds • Reduced impacts to upland & nearshore (2 offshore pipelines, reduced pipeline length) compared to Alts 2 & 3 • Filters discharge for 6 outfalls (3-8)		• Outfalls (except Outfall 2) removed from visible beach increasing/enhancing habitat for sea turtles& shorebirds • Filters discharge for all outfalls (private Golf Club at Outfall 2 remains)	• Higher impacts to upland & nearshore (4 offshore pipelines, increased pipeline length) compared to Alt 1 • Offshore discharge pipes are closer together than Alt 3 affecting the mixing zone	• All outfalls removed from visible beach increasing/enhancing habitat for sea turtles& shorebirds • Lower impacts to upland & nearshore compared to Alt 2 as offshore discharge pipes are separated by considerable distance; and one of the pump stations is landward of Gulf Shore Blvd (GSB) • Filters discharge for all outfalls	• Higher impacts to upland & nearshore (4 offshore pipelines, increased pipeline length) compared to Alt 1
	S/W Consolidation to Forcemain/ Offshore	• Single pump station/site for O&M • Consolidates 6 outfalls (3-8) for discharge offshore (77% of 5-yr & 41% of 25-yr flow)	• Outfall 2 (City) flows conveyed to Moorings Bay • Outfall 2 (Private) flows remain Outfalls 8-9 conveyed to Basin 3	• Consolidates 9 outfalls (2-10) for discharge offshore (100% of 5-yr & 69% of 25-yr flow)	• Two pump stations/sites for O&M • Outfall 2 (Private) flows remain	• Consolidates 9 outfalls (2-10) for discharge offshore (100% of 5-yr & 71% of 25-yr flow) • One of the pump station sites is landward of GSB • Reduced size of Outfall 6 overflow pipes compared to Alts 1 & 2	• Two pump stations/sites for O&M
	Meets/ Exceeds the exiting LOS for (a) 5-yr/1-hr (130.5 cfs) & (b) 25-yr/3-day (244.7 cfs) rain events	• 77% / 41% of total flow consolidated to pump station for 5-yr / 25-yr events	• Outfall 2 (City) flows conveyed to Moorings Bay (7% 5-yr) • Outfall 2 (Private) flows remain (4% 5-yr) • Outfalls 8-9 conveyed to Basin 3 (12% 5-yr)	• 96% / 69% of total flow consolidated to pump station for 5-yr / 25-yr events	• Outfall 2 (Private) flows remain (4% 5-yr)	100% / 77% of total flow consolidated to pump station for 5-yr / 25-yr events	

Description		Alterative 1		Alterative 2		Alternative 3	
		Benefits	Challenges	Benefits	Challenges	Benefits	Challenges
Technical							
Tech Complexity (5%)	**Technical Complexity of System (Pipeline Consolidation)**	• Proven technologies (pump station, treatment, etc) • Ancillary treatment (backup generator, sediment removal, etc) offsite at Alligator Lake • Single pump station	• Existing utility infrastructure/conflicts • Limiting elevations of road for pipe consolidation and design • Large pipeline sizes required along GSB • All consolidation/routing along GSB • Overflow system for low-frequency events	• Proven technologies (pump station, treatment, etc) • Ancillary treatment (backup generator, sediment removal, etc) offsite at Alligator Lake • Potential to route 2,000 ft of consolidated pipe along dune • Smaller pipeline sizes along GSB compared to Alt 1	• Existing utility infrastructure/conflicts • Limiting elevations of road for pipe consolidation and design • Overflow system for low-frequency events • 2 pump stations • Overflow system for low-frequency events	• Proven technologies (pump station, treatment, etc) • Ancillary treatment (backup generator, sediment removal, etc) offsite at Alligator Lake • Potential to route 2,000 ft of consolidated pipe along dune • Smaller pipeline sizes along GSB compared to Alt 1 • Reduced size of Outfall 6 overflow pipes compared to Alts 1 & 2	• Existing utility infrastructure/conflicts • Limiting elevations of road for pipe consolidation and design • Overflow system for low-frequency events
O&M (7.5%)	**Operational Integrity & Reliability**	• One pump to maintain compared to 2 pumps for Alts 2 & 3 • Backup generator	• Pump station underground	• Greater resiliency and redundancy • Backup generator	• Two pump stations to maintain as compared to Alt 1 • Pump stations underground	• Greater resiliency and redundancy • Backup generator	• Two pump stations to maintain as compared to Alt 1 • Backup generator • Pump stations underground
Construction (7.5%)	**Constructability**	• All technologies are proven and local prime contractors are experienced • Beach accesses established truck access • Single pump station	• All pipeline consolidation along GSB • Existing utility infrastructure • Pump station within beach access ROW (confined space)	• All technologies are proven and local prime contractors are experienced • Potential to route 2,000 ft of consolidated pipe along dune • Beach accesses established truck access	• Pipeline consolidation along GSB • Existing utility infrastructure • 2 pump stations within beach access ROW	• All technologies are proven and local prime contractors are experienced • Potential to route 2,000 ft of consolidated pipe along dune • Beach accesses established truck access • 1 pump station landward of GSB (open space)	• Pipeline consolidation along GSB • Existing utility infrastructure • 1 pump station within beach access ROW (confined space)
Scalability (5%)	**Scalability/ Expandability for Increased LOS**	• Additional WQ treatment (e.g. UV) can be added in-line if needed	• Not scalable – pipeline sizes and pump station are maxed out at time of initial construction	• Can be built in phases (North and South Systems) • Pump stations are not at max capacity • Additional WQ treatment (e.g. UV) can be added in-line if needed		• May be built in phases (North and South Systems) • Pump stations are not at max capacity • Additional WQ treatment (e.g. UV) can be added in-line if needed • Golf course improvements result in reduced demands on system	
Financial							
Capital Expenditure	**Overall Cost to Construct**	• \$14.99M initial construction cost • Single pump system minimizes cost • City-Owned beachfront access available for pump station	• All pipeline consolidation along GSB	• \$23.57M initial construction cost • Potential reduction in cost for outfall consolidation along dune between 2nd Ave S and 3rd Ave N (2,000 ft) • City-Owned beachfront access available for pump station	• Two pump stations results in higher initial costs than single system	• \$22.79M initial construction cost • Potential reduction in cost for outfall consolidation along dune between 2nd Ave S and 3rd Ave N (2,000 ft) • City-Owned beachfront access available for pump station	• Two pump stations results in higher initial costs than single system • Procurement of land (purchase or lease agreement) for north pump station required
Effectiveness (5%)	**Effective Dollar Spent**	• 5-yr flow: \$13.2M/77%= \$17.1M • 25-yr flow: \$13.2M/41%= \$32.1M	• City contribution at Outfall 2 re-routed out of Basin 2 (Moorings Bay) • Outfalls 9-10 re-routed to Basin 3 (Naples Bay)	• 5-yr flow multiplier: \$21.0M/96% \$21.9M • 25-yr flow multiplier: \$21.0M/69% = \$30.5M		• 5-yr flow multiplier: \$20.2M/100% \$20.2M • 25-yr flow multiplier: \$20.2M/77% = \$26.2M	

Description		Alterative 1		Alterative 2		Alternative 3	
		Benefits	Challenges	Benefits	Challenges	Benefits	Challenges
Non-Technical							
Social Impact (10%)	**Addresses Concerns of the Community**	• Aesthetics - all outfalls (except Outfall 2) removed from visible beach • Positive impact on tourism • Water quality improvements (swimming beach) • Minimizes impacts to parking w/ pump station underground • Treatment (filtration, UV, etc) prior to offshore discharge with sufficient mixing zone to hardbottom • Single pump station as compared to Alts 2 & 3	• City contribution at Outfall 2 re-routed out of Basin 2 (Moorings Bay) • Outfalls 9-10 re-routed to Basin 3 (Naples Bay)	• Aesthetics - all outfalls (except Outfall 2) removed from visible beach • Minimizes impacts to parking w/ pump stations underground • Treatment (filtration, UV, etc) prior to offshore discharge with sufficient mixing zone to hardbottom	• Two pump stations as compared to Alt 1 • Pump stations adjacent to high value estate homes & residential land	• Aesthetics - all outfalls (removed from visible beach • Reduced size of Outfall 6 overflow pipes compared to Alts 1 and 2 • Minimizes impacts to parking w/ pump stations underground • Treatment (filtration, UV, etc) prior to offshore discharge with sufficient mixing zone to hardbottom • One pump station landward of GSB and in open space as compared to Alt 2.	• Pipeline drill is narrow easement • Pump station located near private commercial lands (Golf Club)
Environmental Impact (15%)	**Enhances Shoreline Preservation**	• 7 of 9 outfalls (3-5;7-10) removed • City contribution at outfall 2 re-routed to reduce discharge (eliminate 1 pipe) • Outfall 6 overflow for low-frequency events only • Remove Outfall 6 from visible beach	• Outfall 2 pipe remain to convey Gulf Club Discharge (1 pipe remains) • Outfall 6 remains for low-frequency events	• 7 of 9 outfalls (3-5;7-10) removed • City contribution at outfall 2 re-routed to reduce discharge (eliminate 1 pipe) • Outfall 6 overflow for low-frequency events only • Remove Outfall 6 from visible beach	• Outfall 2 pipe remain to convey Gulf Club Discharge (1 pipe remains) • Outfall 6 overflow for low-frequency events only	• 8 of 9 outfalls removed (2-5;7-10) • Outfall 6 overflow for low-frequency events only • Outfall 6 removed from visible beach • Reduced size of Outfall 6 overflow pipes compared to Alts 1 & 2	• Overflow from Outfall 6 during low-frequency events
	Nearshore & Hardbottom Resources	• Outfalls (except Outfall 2) removed from visible beach increasing/enhancing habitat for sea turtles & shorebirds • Reduced impacts to upland & nearshore (2 offshore pipelines, reduced pipeline length) compared to Alts 2 & 3 • Filters discharge for 6 outfalls (3-8)	• Private Golf Club discharge at Outfall 2 remains	• Outfalls (except Outfall 2) removed from visible beach increasing/enhancing habitat for sea turtles& shorebirds • Filters discharge for all outfalls	• Higher impacts to upland & nearshore (4 offshore pipelines, increased pipeline length) compared to Alt 1 • Private Golf Club discharge at Outfall 2 remains • Offshore discharge pipes are closer together than Alt 3 affecting the mixing zone • Pipeline length is greatest	• All outfalls removed from visible beach increasing/enhancing habitat for sea turtles& shorebirds • Lower impacts to upland & nearshore compared to Alt 2 as offshore discharge pipes are separated by considerable distance; and one of the pump stations is landward of GSB • Filters discharge for all outfalls	• Higher impacts to upland & nearshore (number of pipelines) compared to Alt 1
Non-Technical							
Regulatory Process (10%)	**Expected Success to Receive Permits (Federal & State)**	• Similar Permits issued by State and Federal Agencies • Single pump station		• Similar Permits issued by State and Federal agencies		• Similar Permits issued by State and Federal agencies • North pump station is landward of CCCL	
Health and Safety (5%)	**Potential to improve the health, safety and welfare of the community**	• Enhances swimmable waters • Improves water quality • Removes obstacles & potential injuries to public • Reduces flooding for safety of public	• Outfall 2 remains	• Enhances swimmable waters • Improves water quality • Removes obstacles & potential injuries to public • Reduces flooding for safety of public	• Outfall 2 remains	• Enhances swimmable waters • Improves water quality • Removes obstacles & potential injuries to public • Reduces flooding for safety of public	

APPENDIX G

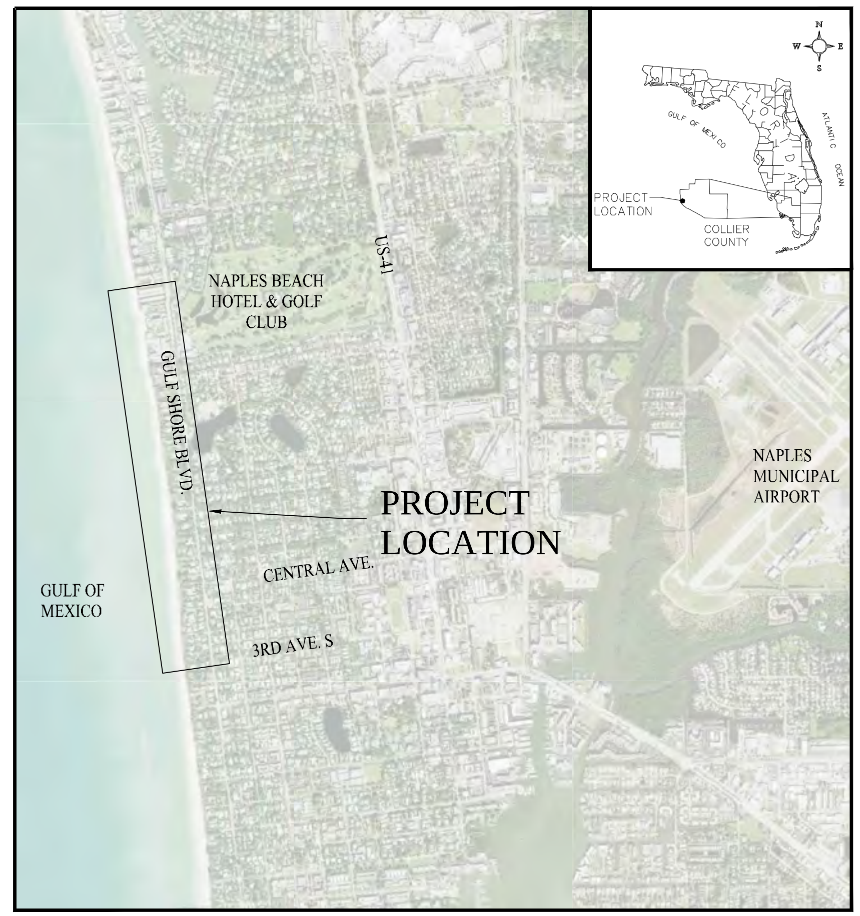
30% DESIGN DRAWINGS

(ALTERNATIVE 3: PREFERRED ALTERNATIVE)

NAPLES BEACH RESTORATION & WATER QUALITY IMPROVEMENT PROJECT
30% DESIGN DRAWINGS

Prepared For:

CITY OF NAPLES
735 8th St S,
Naples, FL 34102



VICINITY MAP

DRAWING INDEX

1	COVER SHEET
2-6	NORTH SYSTEM PIPELINE CONSOLIDATION SITE PLAN
7-11	SOUTH SYSTEM PIPELINE CONSOLIDATION SITE PLAN
12	NORTH SYSTEM PUMP STATION SITE PLAN
13-14	SOUTH SYSTEM PUMP STATION SITE PLAN
15	NORTH SYSTEM OFFSHORE DISCHARGE SITE PLAN
16	SOUTH SYSTEM OFFSHORE DISCHARGE SITE PLAN
17	OVERFLOW SITE PLAN
18-20	OVERFLOW AND OFFSHORE DISCHARGE PROFILES

LEGEND

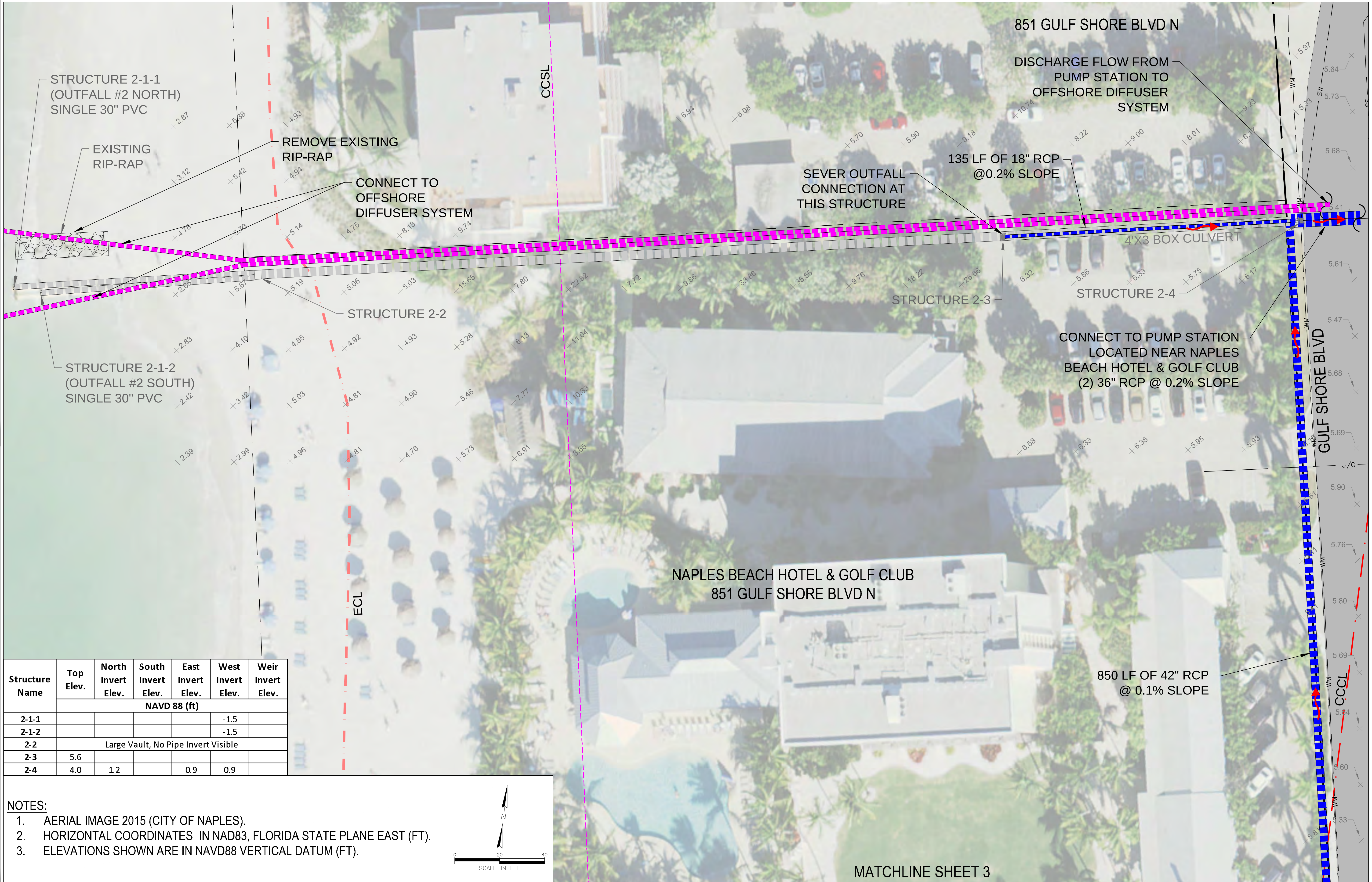
- EXISTING RIP-RAP
- ROW LINE
- PROPERTY LINE
- EASEMENT
- CCCL (COASTAL CONSTRUCTION LINE)
- CCSL (COLLIER COUNTY SETBACK LINE)
- ECL (EROSION CONTROL LINE)
- HARD BOTTOM (2013)
- EXISTING DISCHARGE PIPELINE
- O/H — OVERHEAD POWER CABLE
- U/G — UNDERGROUND POWER CABLE
- SW — STORMWATER NETWORK
- WM — POTABLE WATER MAIN NETWORK
- SS — SANITARY SEWER NETWORK
- CATV — COMMUNICATIONS (CENTURY LINK) NETWORK
- GAS — UNDERGROUND GAS LINE (TECO)
- BP — PROPOSED BURIED POWER CABLE
- +5.05 EXISTING GRADE
- EXISTING DRAINAGE STRUCTURE
- EXISTING MANHOLES
- PROPOSED PIPELINE (GULF SHORE BLVD. CONSOLIDATION)
- PROPOSED PIPELINE (BEACH DUNE CONSOLIDATION)
- PROPOSED PIPELINE (TO OFFSHORE DIFFUSER SYSTEM)
- PROPOSED STRUCTURE
- FLOW DIRECTION
- PUMP STATION ELECTRICAL EQUIPMENT
- BELOW GRADE STORMWATER PUMP STATION

Prepared By:

Erickson Consulting Engineers
7201 Delainey Court
Sarasota FL, 34240
941-373-6460

ECE Project No.: 15-304

Date: May, 2016



Structure Name	Top Elev.	North Invert Elev.	South Invert Elev.	East Invert Elev.	West Invert Elev.	Weir Invert Elev.
	NAVD 88 (ft)					
2-1-1					-1.5	
2-1-2					-1.5	
2-2	Large Vault, No Pipe Invert Visible					
2-3	5.6					
2-4	4.0	1.2		0.9	0.9	

NOTES:

1. AERIAL IMAGE 2015 (CITY OF NAPLES).
2. HORIZONTAL COORDINATES IN NAD83, FLORIDA STATE PLANE EAST (FT).
3. ELEVATIONS SHOWN ARE IN NAVD88 VERTICAL DATUM (FT).

Naples Beach Restoration & Water Quality Improvement Project

NORTH SYSTEM PIPELINE CONSOLIDATION SITE PLAN (NEAR NAPLES BEACH HOTEL & GOLF CLUB)

Erickson Consulting Engineers, Inc.
7201 Delainey Court
Sarasota, FL 32420
(941) 373-6460

Z:\CADD_Graphics\US Projects\15-304_Naples Outfalls\Design\30% Design\15-304_Naples Outfalls-30% Design_02-06_Pipeline Consolidation Plan_North.dwg Sep 29, 2016-5:30pm

NOTES:
1. AERIAL IMAGE 2015 (CITY OF NAPLES).
2. HORIZONTAL COORDINATES IN NAD83, FLORIDA STATE PLANE EAST (FT).
3. ELEVATIONS SHOWN ARE IN NAVD88 VERTICAL DATUM (FT).

Naples Beach Restoration &
Water Quality Improvement Project

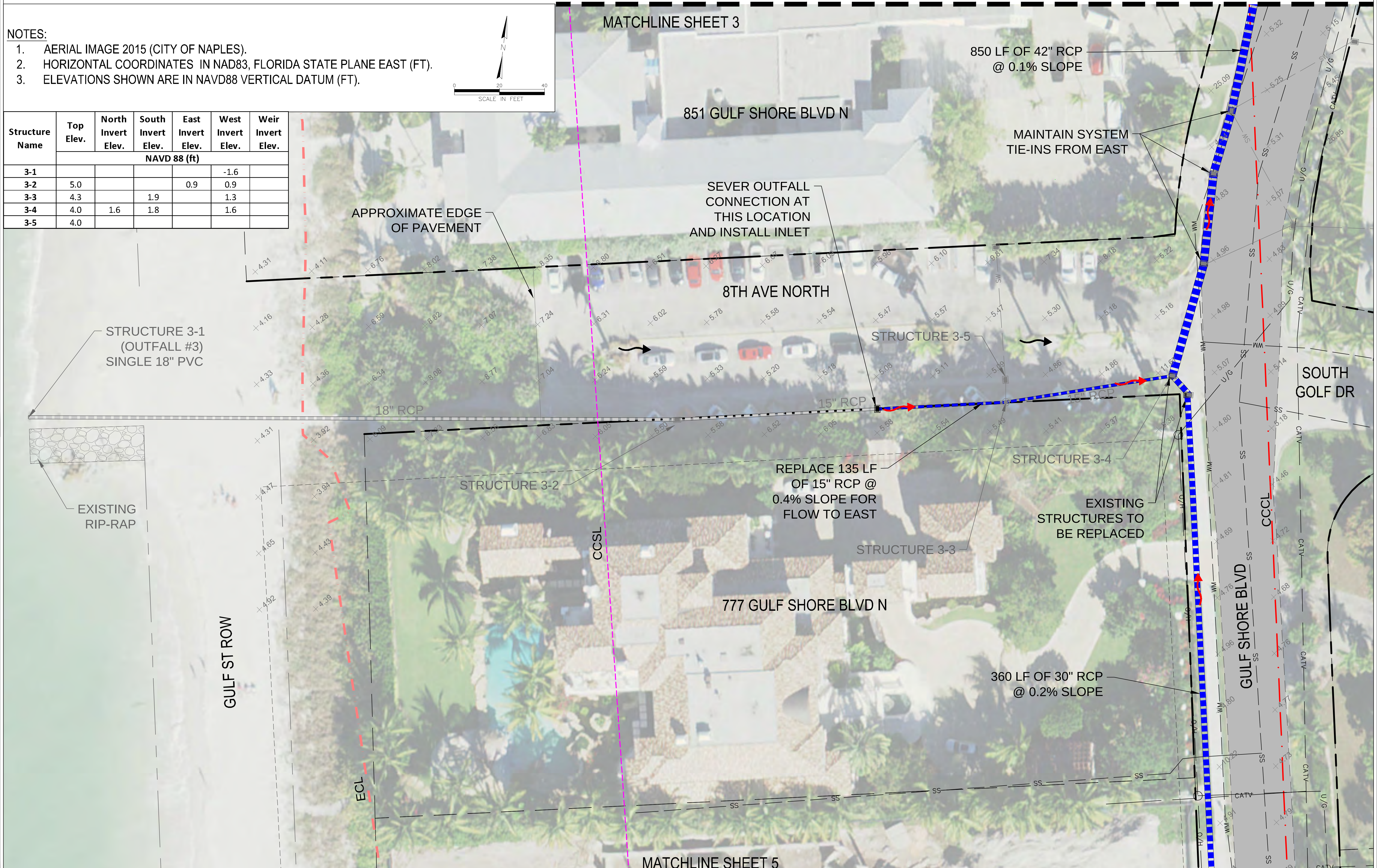
NORTH SYSTEM PIPELINE CONSOLIDATION SITE PLAN
(NEAR NAPLES BEACH HOTEL & GOLF CLUB)

Erickson Consulting Engineers, Inc.
7201 Delainey Court
Sarasota, FL 32420
(941) 373-6460
ECE Erickson Consulting Engineers

Z:\CADD_Graphics\US Projects\15-304_Naples Outfalls\Design\30% Design\15-304_Naples Outfalls-30% Design_02-06_Pipeline Consolidation Plan_North.dwg Sep 29, 2016-5:30pm

NOTES:
1. AERIAL IMAGE 2015 (CITY OF NAPLES).
2. HORIZONTAL COORDINATES IN NAD83, FLORIDA STATE PLANE EAST (FT).
3. ELEVATIONS SHOWN ARE IN NAVD88 VERTICAL DATUM (FT).

Structure Name	Top Elev.	North Invert Elev.	South Invert Elev.	East Invert Elev.	West Invert Elev.	Weir Invert Elev.
	NAVD 88 (ft)					
3-1					-1.6	
3-2	5.0			0.9	0.9	
3-3	4.3		1.9		1.3	
3-4	4.0	1.6	1.8		1.6	
3-5	4.0					



Naples Beach Restoration & Water Quality Improvement Project

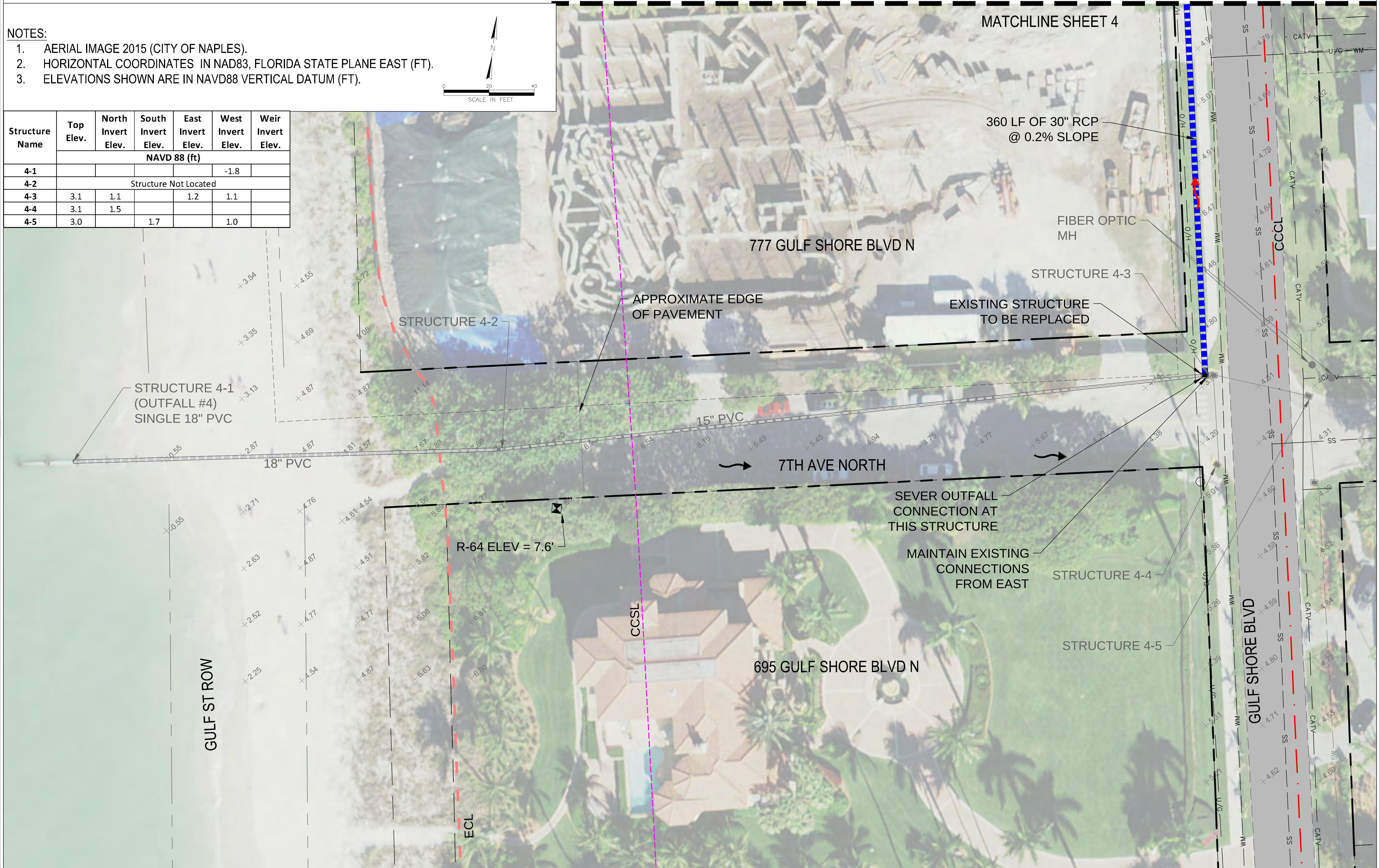
NORTH SYSTEM PIPELINE CONSOLIDATION SITE PLAN (NEAR NAPLES BEACH HOTEL & GOLF CLUB)

Erickson Consulting Engineers, Inc.
7201 Delainey Court
Sarasota, FL 32420
(941) 373-6460

Z:\CADD_Graphics\US Projects\15-304_Naples Outfalls\Design\30% Design\15-304_Naples Outfalls-30% Design_02-06_Pipeline Consolidation Plan_North.dwg Sep 29, 2016-5:30pm

NOTES:
1. AERIAL IMAGE 2015 (CITY OF NAPLES).
2. HORIZONTAL COORDINATES IN NAD83, FLORIDA STATE PLANE EAST (FT).
3. ELEVATIONS SHOWN ARE IN NAVD88 VERTICAL DATUM (FT).

Structure Name	Top Elev.	North Invert Elev.	South Invert Elev.	East Invert Elev.	West Invert Elev.	Weir Invert Elev.
	NAVD 88 (ft)					
4-1					-1.8	
4-2	Structure Not Located					
4-3	3.1	1.1		1.2	1.1	
4-4	3.1	1.5				
4-5	3.0		1.7		1.0	



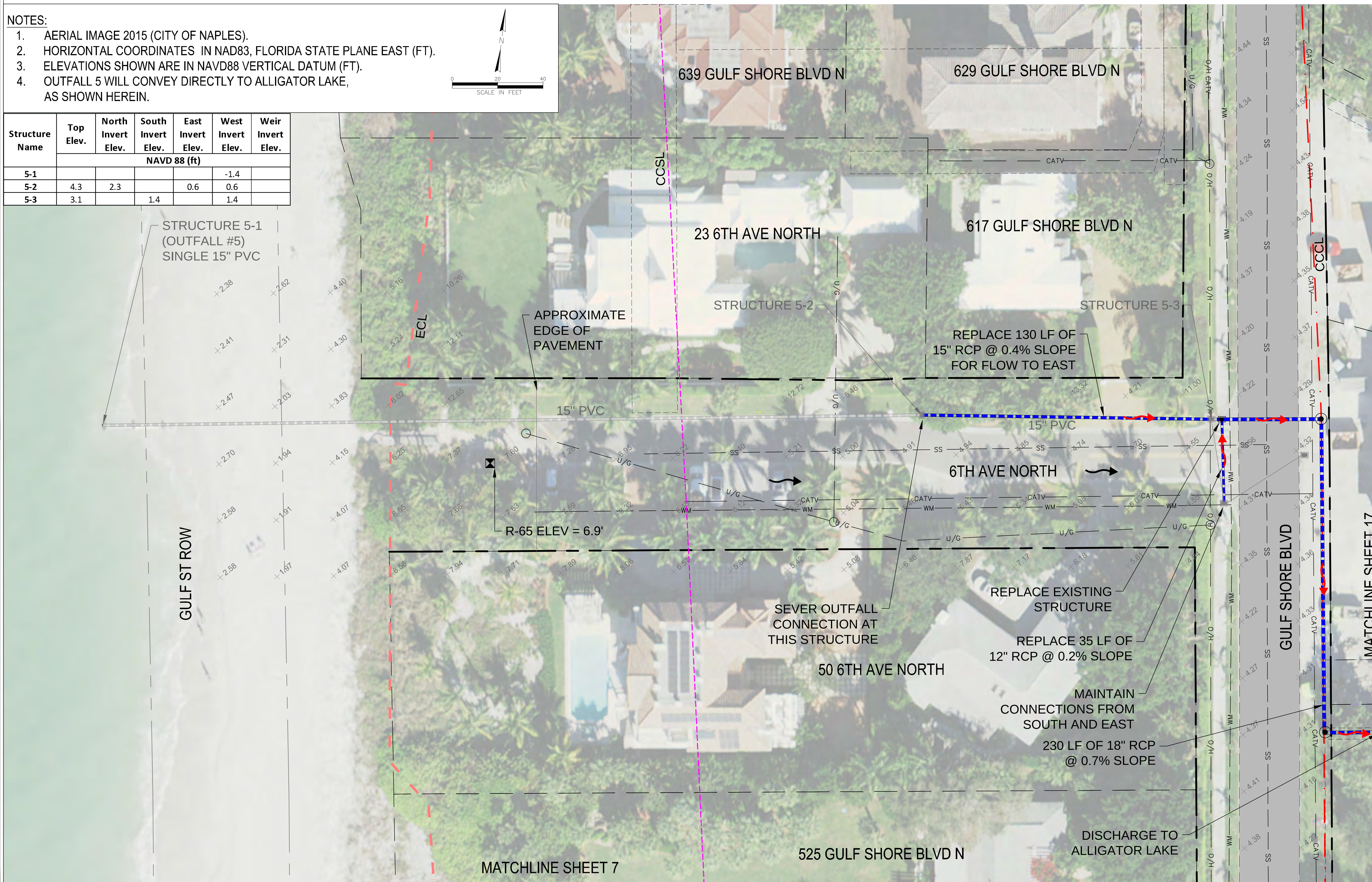
Naples Beach Restoration & Water Quality Improvement Project

NORTH SYSTEM PIPELINE CONSOLIDATION SITE PLAN (NEAR NAPLES BEACH HOTEL & GOLF CLUB)

Erickson Consulting Engineers, Inc.
7201 Delainey Court
Sarasota, FL 32420
(941) 373-6460

NOTES:
1. AERIAL IMAGE 2015 (CITY OF NAPLES).
2. HORIZONTAL COORDINATES IN NAD83, FLORIDA STATE PLANE EAST (FT).
3. ELEVATIONS SHOWN ARE IN NAVD88 VERTICAL DATUM (FT).
4. OUTFALL 5 WILL CONVEY DIRECTLY TO ALLIGATOR LAKE, AS SHOWN HEREIN.

Structure Name	Top Elev.	North Invert Elev.	South Invert Elev.	East Invert Elev.	West Invert Elev.	Weir Invert Elev.
	NAVD 88 (ft)					
5-1					-1.4	
5-2	4.3	2.3		0.6	0.6	
5-3	3.1		1.4		1.4	



Z:\CADD_Graphics\US Projects\15-304_Naples Outfalls\Design\30% Design\15-304_Naples Outfalls-30% Design_02-06_Pipeline Consolidation Plan_North.dwg Sep 29, 2016-5:31pm

Naples Beach Restoration & Water Quality Improvement Project

SOUTH SYSTEM PIPELINE CONSOLIDATION SITE PLAN (AT 3RD AVE NORTH)

Erickson Consulting Engineers, Inc.
ECE Erickson Consulting Engineers
7201 Delainey Court
Sarasota, FL 32420
(941) 373-6460

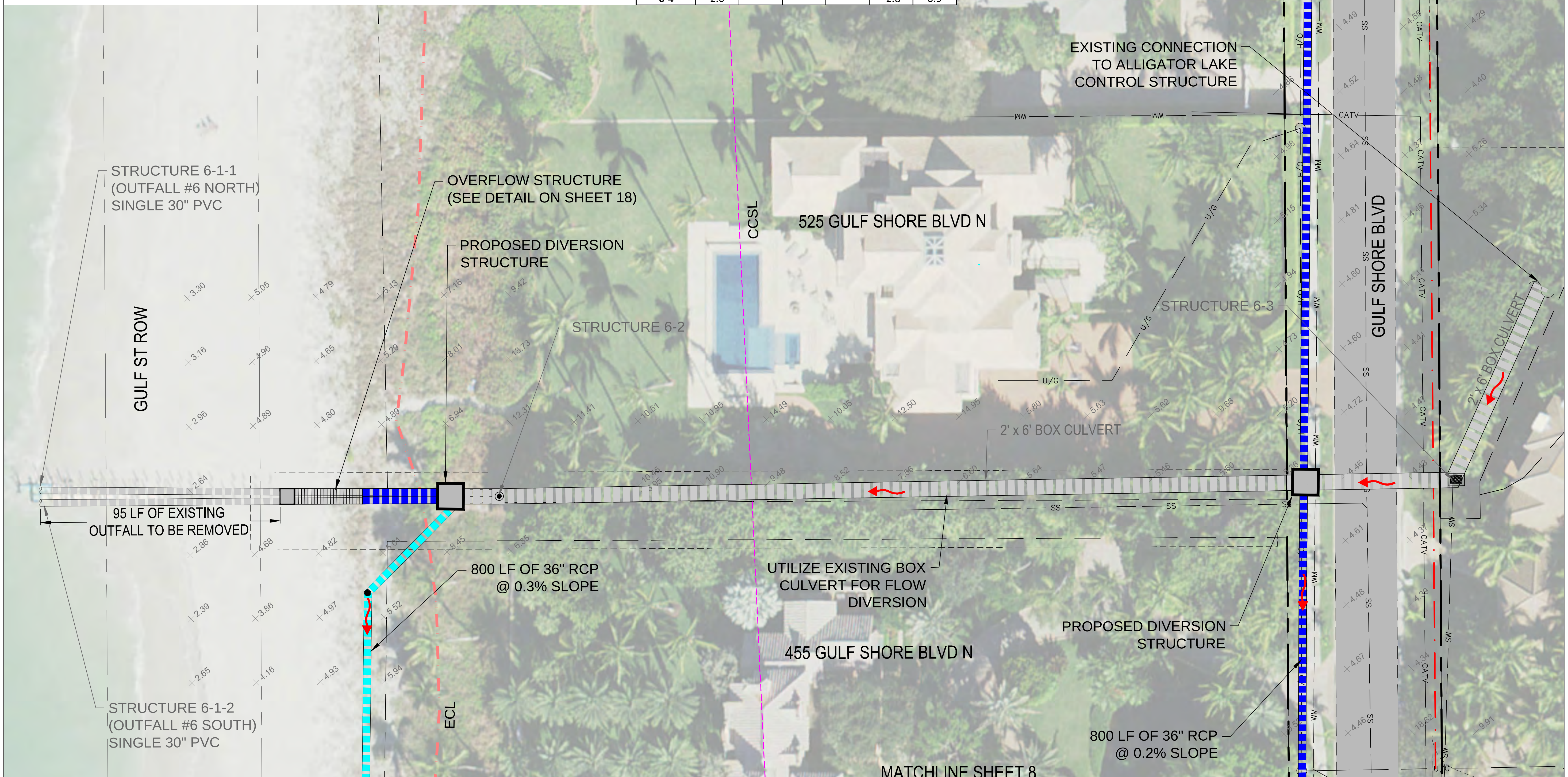
NOTES:

1. AERIAL IMAGE 2015 (CITY OF NAPLES).
2. HORIZONTAL COORDINATES IN NAD83, FLORIDA STATE PLANE EAST (FT).
3. ELEVATIONS SHOWN ARE IN NAVD88 VERTICAL DATUM (FT).
4. FOR BEACH DUNE PIPELINE CONSOLIDATION, EXISTING CONVEYANCE LINES FROM GULF SHORE BLVD TO THE BEACH DUNE WILL REMAIN. PROPOSED BEACH DUNE CONSOLIDATION TRUNK LINE WILL INTERSECT EXISTING SYSTEM AT THE DUNE AND CONVEY FLOWS TO PUMP STATION AND OVERFLOW.

N

0 20 40
SCALE IN FEET

Structure Name	Top Elev.	North Invert Elev.	South Invert Elev.	East Invert Elev.	West Invert Elev.	Weir Invert Elev.
	NAVD 88 (ft)					
6-1-1a		-0.6				
6-1-1b					-1.8	
6-1-1c			-2.3			
6-1-2a		-2.1				
6-1-2b			-1.0			
6-2	5.3					
6-3	4.0	-3.4			-3.4	
6-4	2.6				-2.8	0.9



Naples Beach Restoration & Water Quality Improvement Project

SOUTH SYSTEM PIPELINE CONSOLIDATION SITE PLAN (AT 3RD AVE NORTH)

Erickson Consulting Engineers, Inc.
7201 Delainey Court
Sarasota, FL 32420
(941) 373-6460

Z:\CADD_Graphics\US Projects\15-304_Naples Outfalls\Design\30% Design\15-304_Naples Outfalls-30% Design_07-11_Pipeline Consolidation Plan_South.dwg Sep 29, 2016-5:32pm

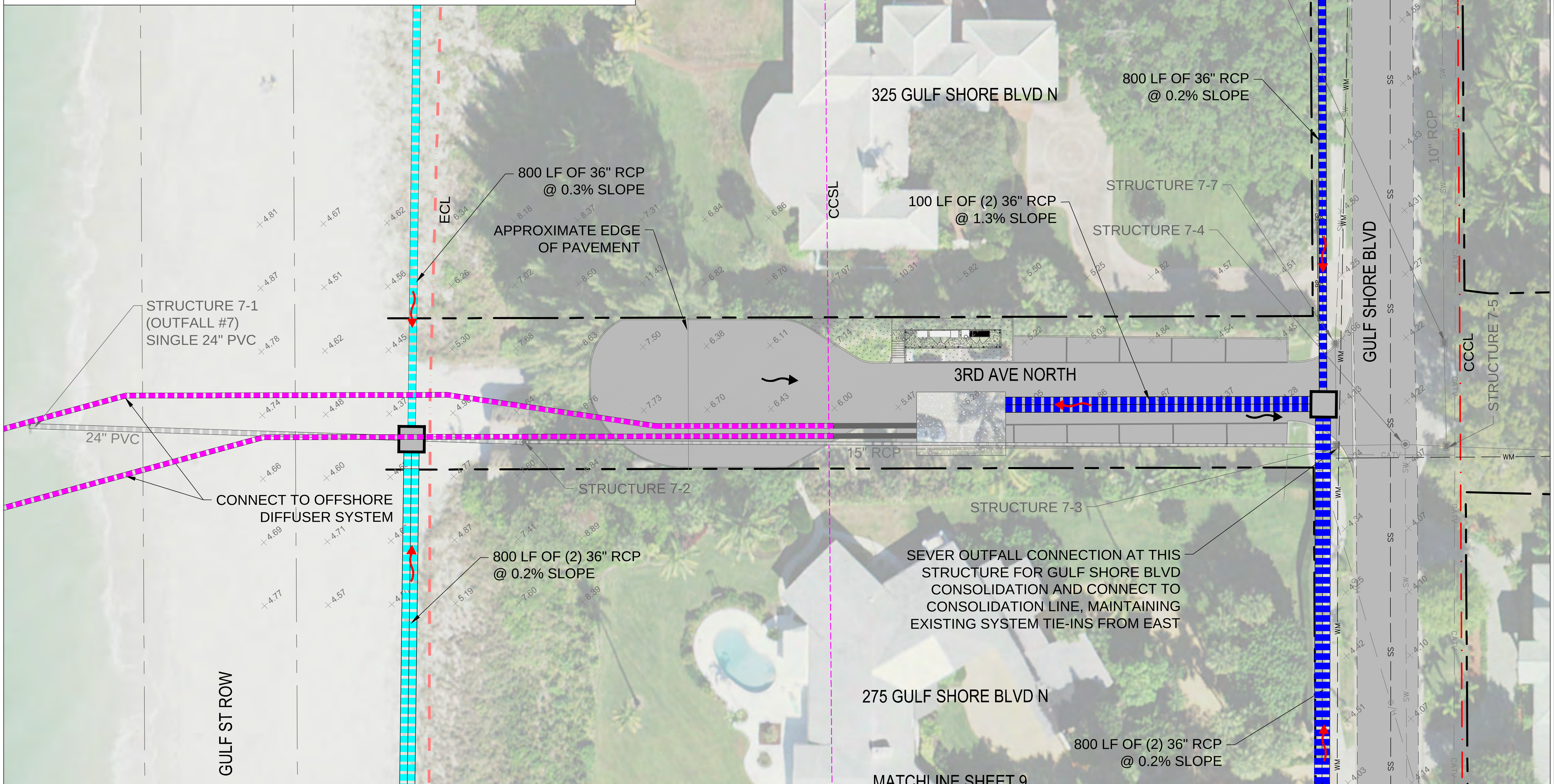
NOTES:

1. AERIAL IMAGE 2015 (CITY OF NAPLES).
2. HORIZONTAL COORDINATES IN NAD83, FLORIDA STATE PLANE EAST (FT).
3. ELEVATIONS SHOWN ARE IN NAVD88 VERTICAL DATUM (FT).
4. FOR BEACH DUNE PIPELINE CONSOLIDATION, EXISTING CONVEYANCE LINES FROM GULF SHORE BLVD TO THE BEACH DUNE WILL REMAIN. PROPOSED BEACH DUNE CONSOLIDATION TRUNK LINE WILL INTERSECT EXISTING SYSTEM AT THE DUNE AND CONVEY FLOWS TO PUMP STATION AND OVERFLOW.

N

SCALE IN FEET 0 20 40

Structure Name	Top Elev.	North Invert Elev.	South Invert Elev.	East Invert Elev.	West Invert Elev.	Weir Invert Elev.
	NAVD 88 (ft)					
7-1					-1.9	
7-2	5.6					
7-3	3.4	0.6		0.3	0.3	
7-4	3.4					
7-5	3.2	0.6		0.9	0.6	
7-6	3.3	1.4	1.1			
7-7	3.4					



Naples Beach Restoration & Water Quality Improvement Project

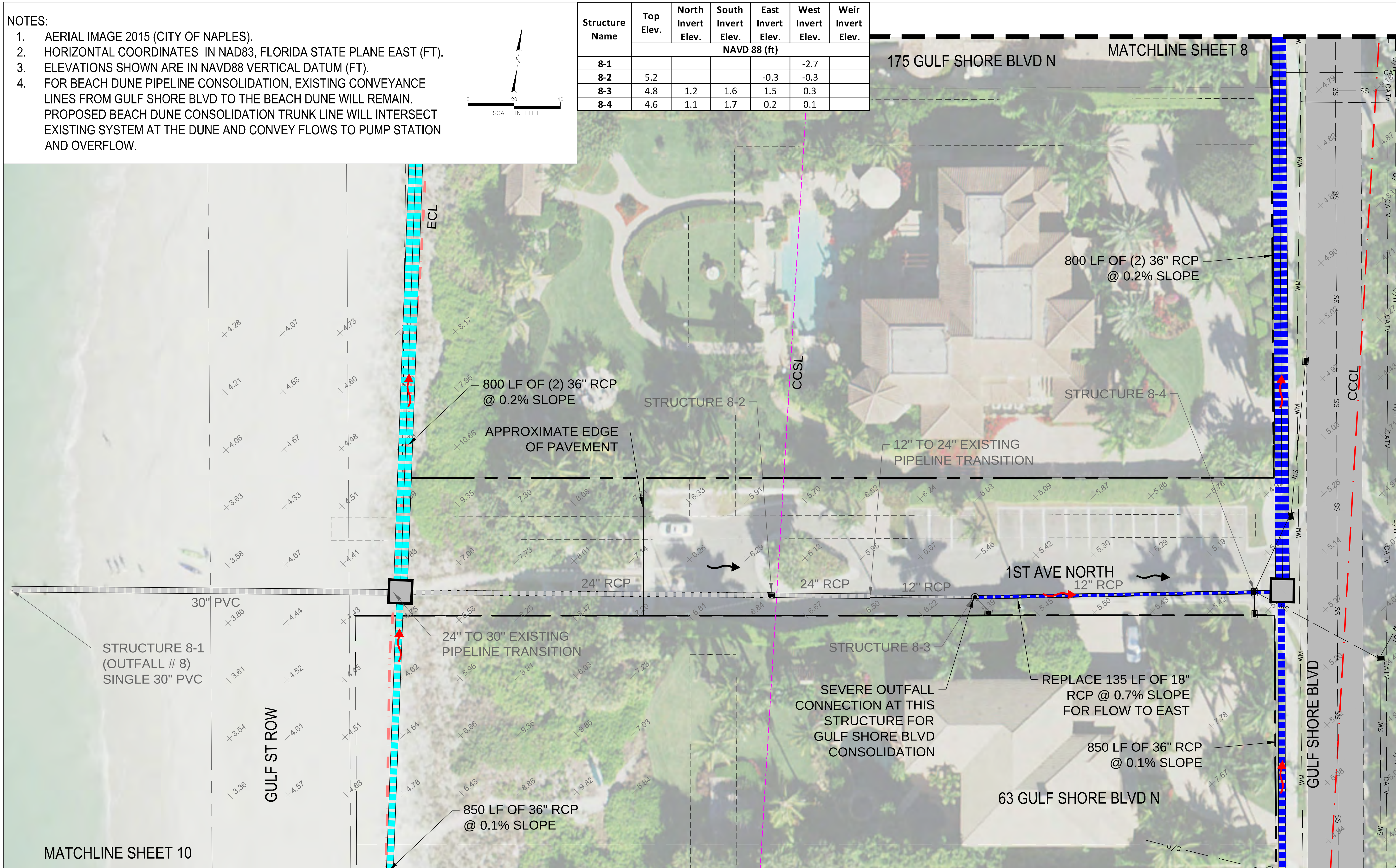
SOUTH SYSTEM PIPELINE CONSOLIDATION SITE PLAN (AT 3RD AVE NORTH)

Erickson Consulting Engineers, Inc.
7201 Delainey Court
Sarasota, FL 32420
(941) 373-6460

NOTES:

1. AERIAL IMAGE 2015 (CITY OF NAPLES).
2. HORIZONTAL COORDINATES IN NAD83, FLORIDA STATE PLANE EAST (FT).
3. ELEVATIONS SHOWN ARE IN NAVD88 VERTICAL DATUM (FT).
4. FOR BEACH DUNE PIPELINE CONSOLIDATION, EXISTING CONVEYANCE LINES FROM GULF SHORE BLVD TO THE BEACH DUNE WILL REMAIN. PROPOSED BEACH DUNE CONSOLIDATION TRUNK LINE WILL INTERSECT EXISTING SYSTEM AT THE DUNE AND CONVEY FLOWS TO PUMP STATION AND OVERFLOW.

Structure Name	Top Elev.	North Invert Elev.	South Invert Elev.	East Invert Elev.	West Invert Elev.	Weir Invert Elev.
	NAVD 88 (ft)					
8-1					-2.7	
8-2	5.2			-0.3	-0.3	
8-3	4.8	1.2	1.6	1.5	0.3	
8-4	4.6	1.1	1.7	0.2	0.1	



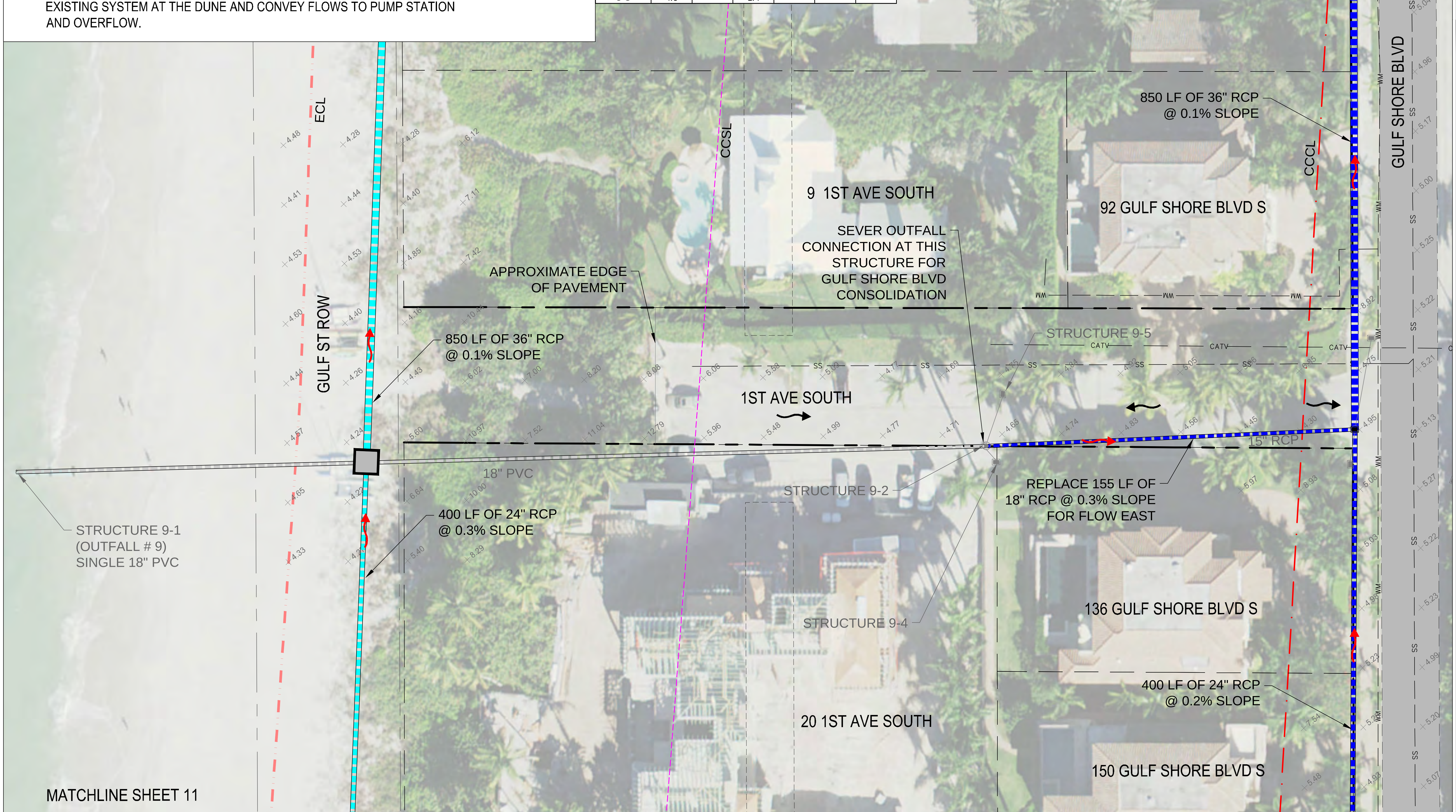
Naples Beach Restoration & Water Quality Improvement Project

SOUTH SYSTEM PIPELINE CONSOLIDATION SITE PLAN (AT 3RD AVE NORTH)

Erickson Consulting Engineers, Inc.
7201 Delainey Court
Sarasota, FL 32420
(941) 373-6460

NOTES:
1. AERIAL IMAGE 2015 (CITY OF NAPLES).
2. HORIZONTAL COORDINATES IN NAD83, FLORIDA STATE PLANE EAST (FT).
3. ELEVATIONS SHOWN ARE IN NAVD88 VERTICAL DATUM (FT).
4. FOR BEACH DUNE PIPELINE CONSOLIDATION, EXISTING CONVEYANCE LINES FROM GULF SHORE BLVD TO THE BEACH DUNE WILL REMAIN. PROPOSED BEACH DUNE CONSOLIDATION TRUNK LINE WILL INTERSECT EXISTING SYSTEM AT THE DUNE AND CONVEY FLOWS TO PUMP STATION AND OVERFLOW.

Structure Name	Top Elev.	North Invert Elev.	South Invert Elev.	East Invert Elev.	West Invert Elev.	Weir Invert Elev.
	NAVD 88 (ft)					
9-1					-1.4	
9-2	3.9	1.2	1.2	1.2	1.1	
9-3	4.2	1.5	1.5		1.5	
9-4	3.9	0.3				
9-5	4.0		1.4			

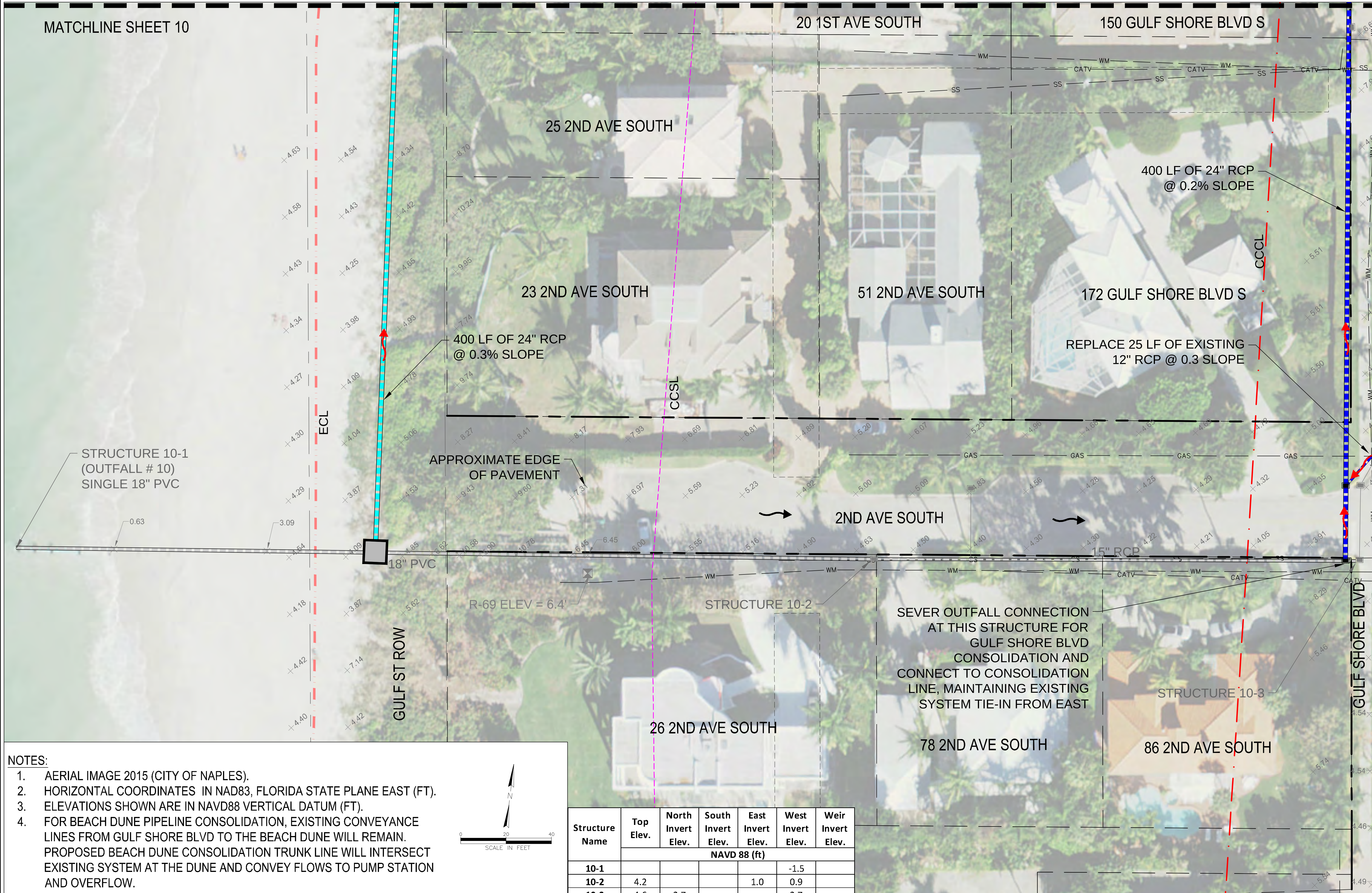


Z:\CADD_Graphics\US Projects\15-304_Naples Outfalls\Design\30% Design\15-304_Naples Outfalls-30% Design_07-11_Pipeline Consolidation Plan_South.dwg Sep 29, 2016-5:32pm

Naples Beach Restoration & Water Quality Improvement Project

SOUTH SYSTEM PIPELINE CONSOLIDATION SITE PLAN (AT 3RD AVE NORTH)

ECE Erickson Consulting Engineers
Erickson Consulting Engineers, Inc.
7201 Delainey Court
Sarasota, FL 32420
(941) 373-6460



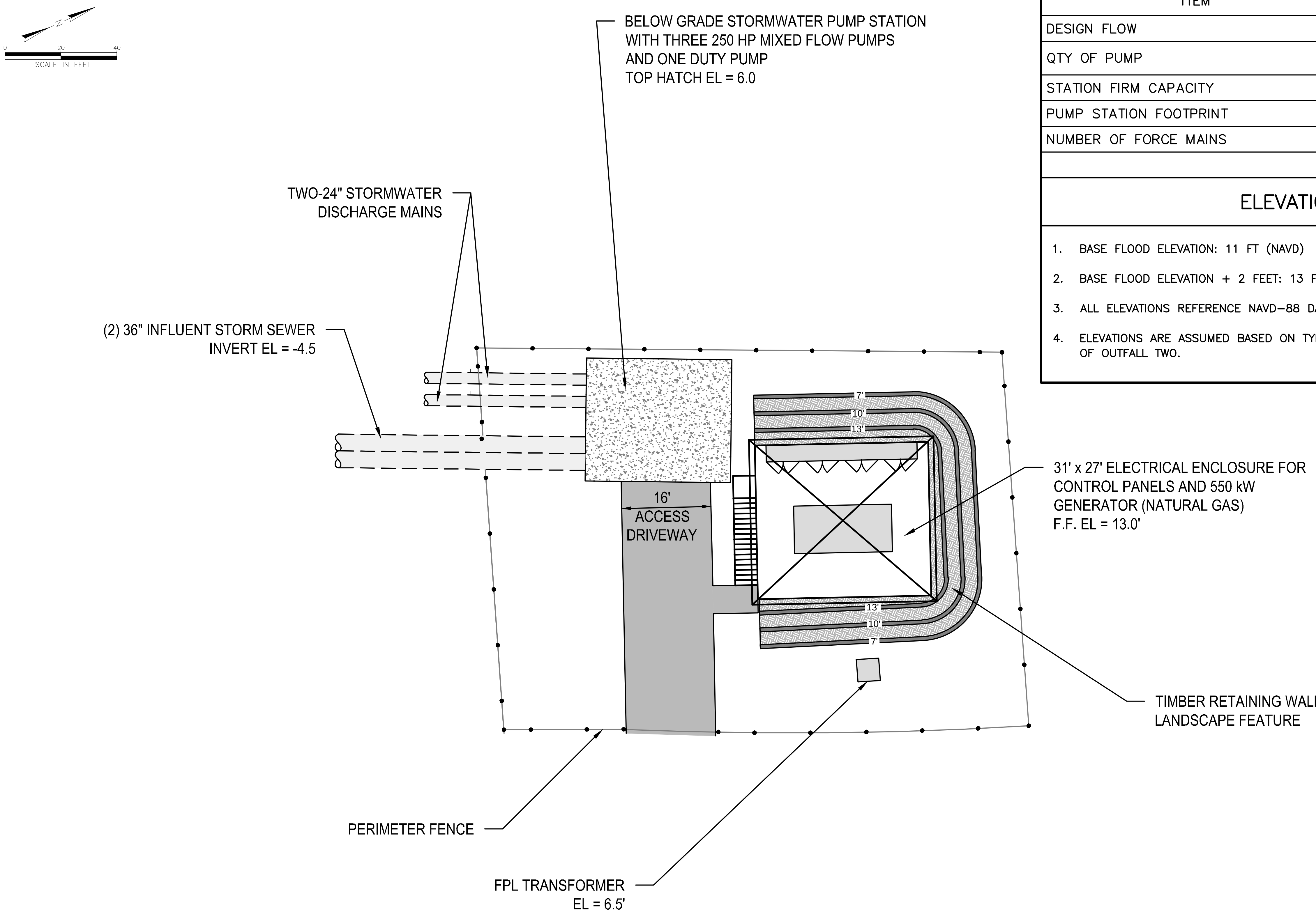
NOTES:
1. AERIAL IMAGE 2015 (CITY OF NAPLES).
2. HORIZONTAL COORDINATES IN NAD83, FLORIDA STATE PLANE EAST (FT).
3. ELEVATIONS SHOWN ARE IN NAVD88 VERTICAL DATUM (FT).
4. FOR BEACH DUNE PIPELINE CONSOLIDATION, EXISTING CONVEYANCE LINES FROM GULF SHORE BLVD TO THE BEACH DUNE WILL REMAIN. PROPOSED BEACH DUNE CONSOLIDATION TRUNK LINE WILL INTERSECT EXISTING SYSTEM AT THE DUNE AND CONVEY FLOWS TO PUMP STATION AND OVERFLOW.

Structure Name	Top Elev.	North Invert Elev.	South Invert Elev.	East Invert Elev.	West Invert Elev.	Weir Invert Elev.
	NAVD 88 (ft)					
10-1					-1.5	
10-2	4.2			1.0	0.9	
10-3	4.6	2.7			2.7	

Naples Beach Restoration & Water Quality Improvement Project

SOUTH SYSTEM PIPELINE CONSOLIDATION SITE PLAN (AT 3RD AVE NORTH)

Erickson Consulting Engineers, Inc.
7201 Delainey Court
Sarasota, FL 32420
(941) 373-6460



PUMP INFORMATION SUMMARY

ITEM	SPECIFICATION
DESIGN FLOW	ALTERNATIVE 3 = 79 CFS
QTY OF PUMP	THREE 250 HP 24-INCH DIAMETER MIXED FLOW PUMPS AND A DUTY PUMP
STATION FIRM CAPACITY	35,413 GPM @ 38 FT TDH
PUMP STATION FOOTPRINT	22' X 23'
NUMBER OF FORCE MAINS	2 – 24"

ELEVATION NOTES

1. BASE FLOOD ELEVATION: 11 FT (NAVD)
2. BASE FLOOD ELEVATION + 2 FEET: 13 FT (NAVD)
3. ALL ELEVATIONS REFERENCE NAVD-88 DATUM
4. ELEVATIONS ARE ASSUMED BASED ON TYPICAL ELVATIONS IN THE VACINITY OF OUTFALL TWO.

Naples Beach Restoration &
Water Quality Improvement Project

NORTH SYSTEM TYPICAL PUMP STATION

Stantec
Stantec
3200 Bailey Lane
Suite 200
Naples, FL 34105
(239) 263-6403

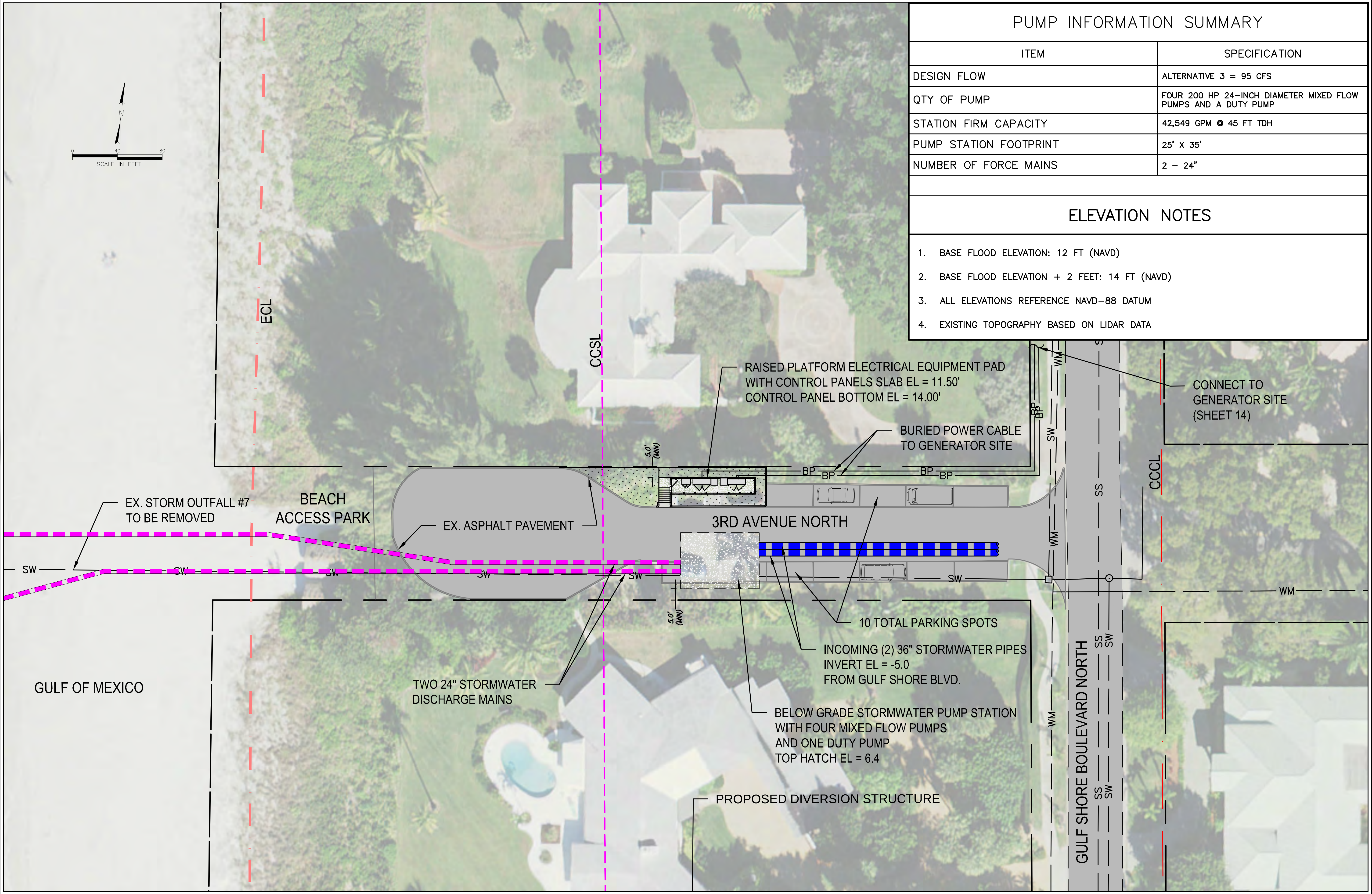
Erickson Consulting Engineers, Inc.
ECE Erickson Consulting Engineers
7201 Delainey Court
Sarasota, FL 32420
(941) 373-6460

PUMP INFORMATION SUMMARY

ITEM	SPECIFICATION
DESIGN FLOW	ALTERNATIVE 3 = 95 CFS
QTY OF PUMP	FOUR 200 HP 24-INCH DIAMETER MIXED FLOW PUMPS AND A DUTY PUMP
STATION FIRM CAPACITY	42,549 GPM @ 45 FT TDH
PUMP STATION FOOTPRINT	25' X 35'
NUMBER OF FORCE MAINS	2 – 24"

ELEVATION NOTES

1. BASE FLOOD ELEVATION: 12 FT (NAVD)
2. BASE FLOOD ELEVATION + 2 FEET: 14 FT (NAVD)
3. ALL ELEVATIONS REFERENCE NAVD-88 DATUM
4. EXISTING TOPOGRAPHY BASED ON LIDAR DATA



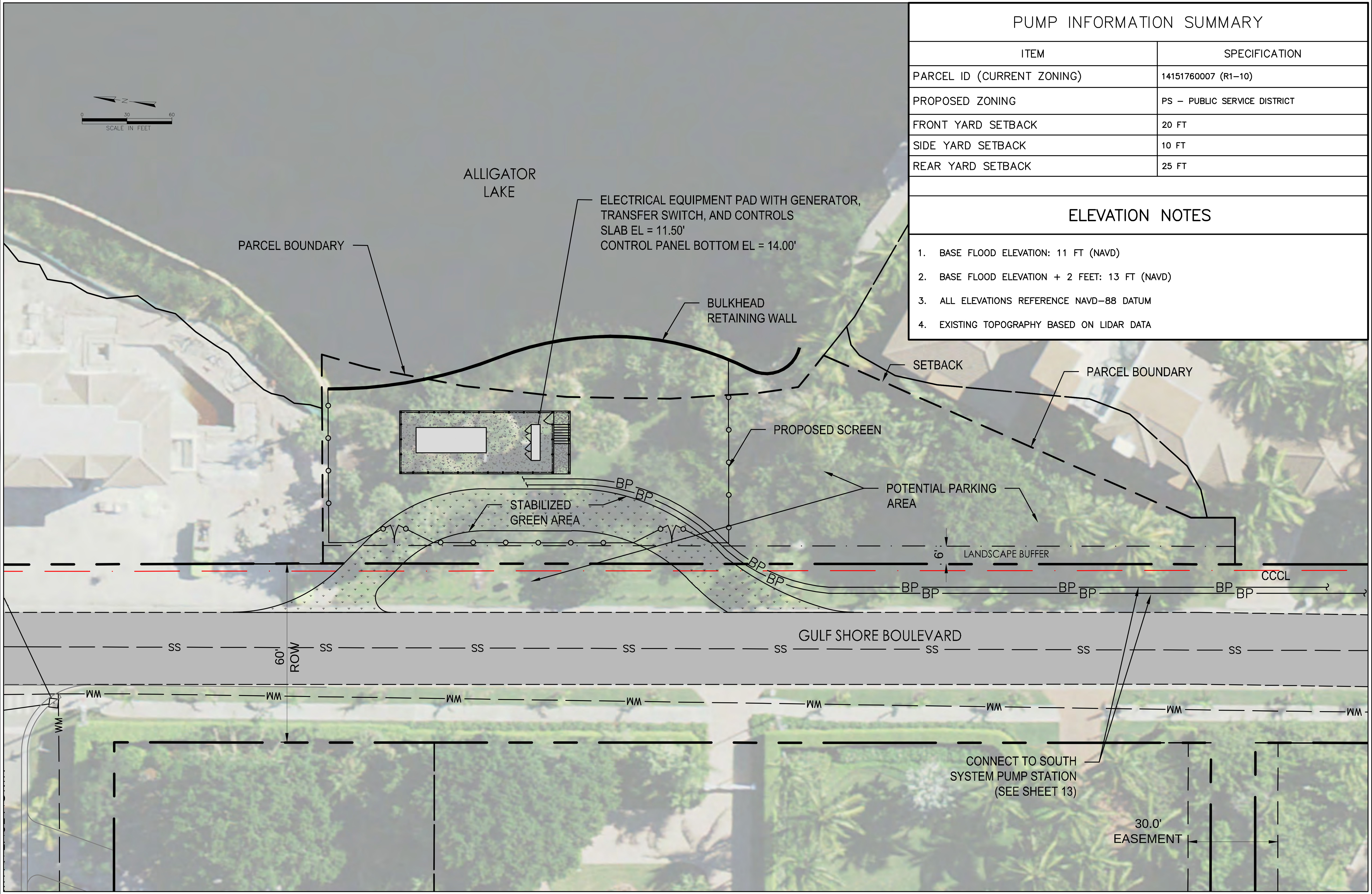
Naples Beach Restoration & Water Quality Improvement Project

3RD AVE NORTH (SOUTH SYSTEM PUMP STATION)

Stantec
3200 Bailey Lane
Suite 200
Naples, FL 34105
(239) 263-6403

Erickson Consulting Engineers, Inc.
7201 Delainey Court
Sarasota, FL 32420
(941) 373-6460

Z:\CADD_Graphics\US Projects\15-304_Naples Outfalls\Design\30% Design\15-304_Naples Outfalls-30% Design_13_PS-Third-Ave-North-SP_Alt3.dwg Sep 29, 2016-5:33pm



PUMP INFORMATION SUMMARY

ITEM	SPECIFICATION
PARCEL ID (CURRENT ZONING)	14151760007 (R1–10)
PROPOSED ZONING	PS – PUBLIC SERVICE DISTRICT
FRONT YARD SETBACK	20 FT
SIDE YARD SETBACK	10 FT
REAR YARD SETBACK	25 FT

ELEVATION NOTES

1. BASE FLOOD ELEVATION: 11 FT (NAVD)
2. BASE FLOOD ELEVATION + 2 FEET: 13 FT (NAVD)
3. ALL ELEVATIONS REFERENCE NAVD–88 DATUM
4. EXISTING TOPOGRAPHY BASED ON LIDAR DATA

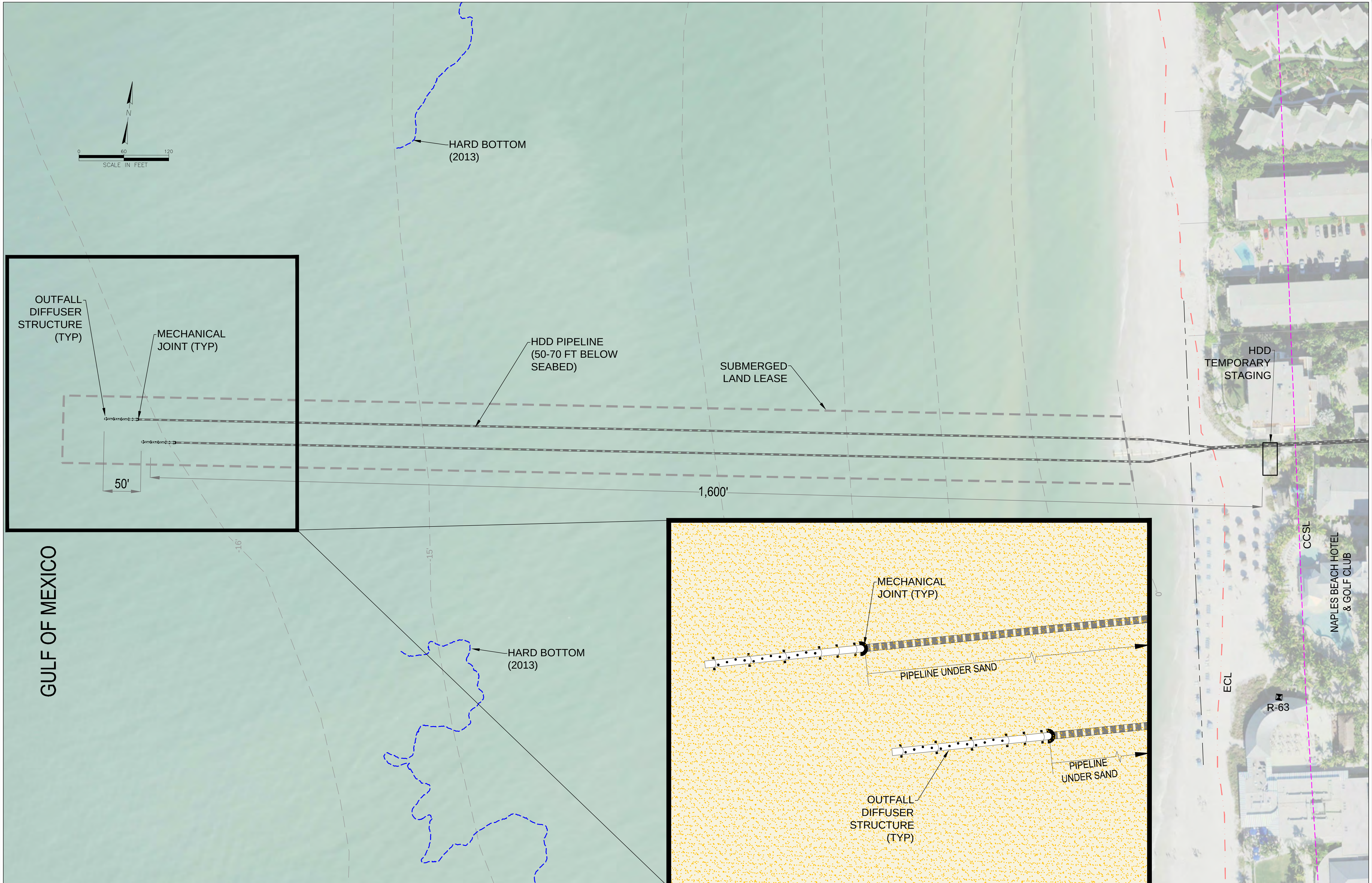
Z:\CADD_Graphics\US Projects\15–304_Naples Outfalls\Design\30% Design\15–304_Naples Outfalls–30% Design_14_Gen–Alligator_Lake.dwg Sep 29, 2016–5:33pm

Naples Beach Restoration & Water Quality Improvement Project

GENERATOR SITE

Stantec
Stantec
3200 Bailey Lane
Suite 200
Naples, FL 34105
(239) 263–6403

Erickson Consulting Engineers, Inc.
ECE Erickson Consulting Engineers
7201 Delainey Court
Sarasota, FL 32420
(941) 373–6460

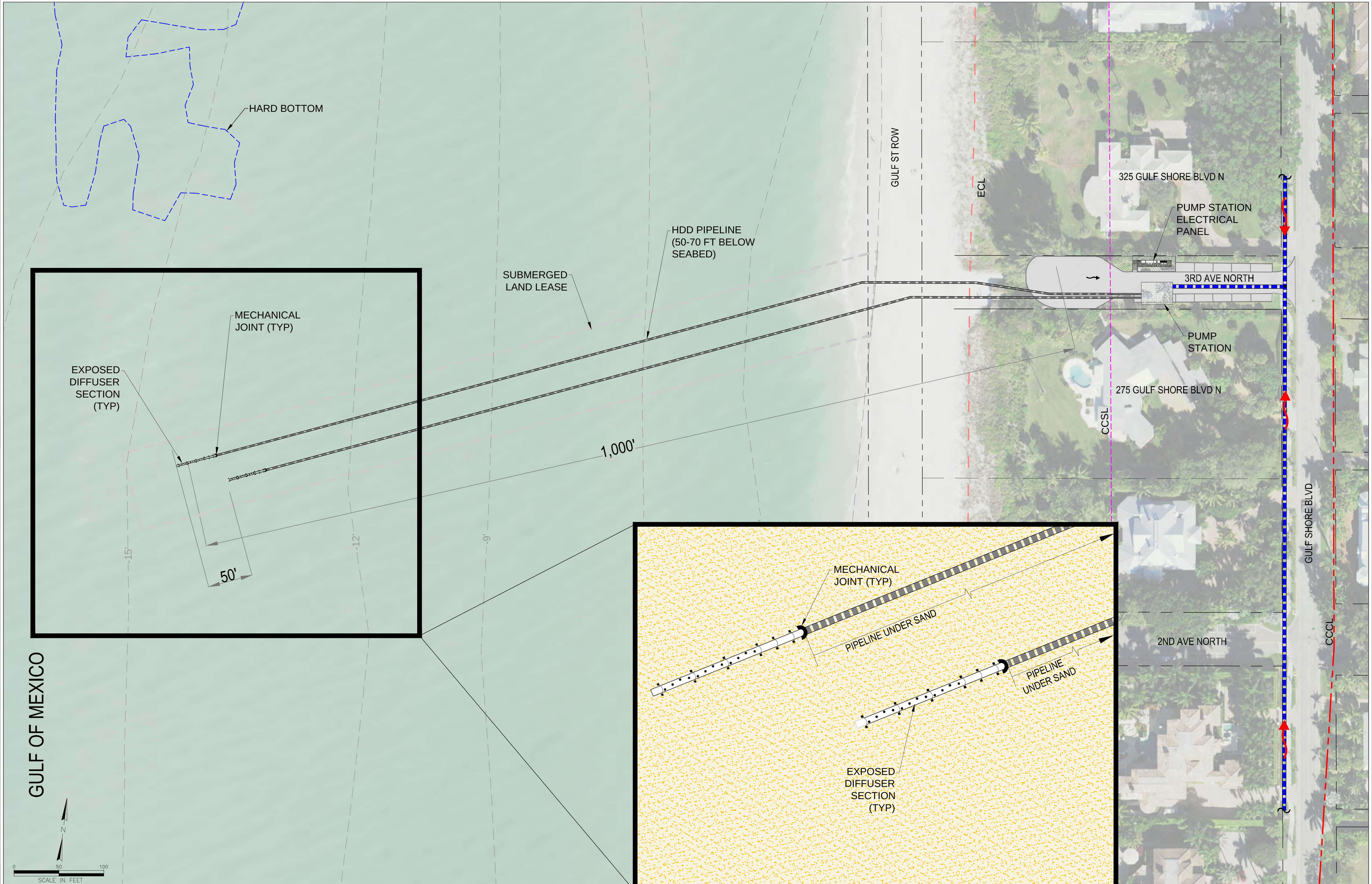


Z:\CADD_Graphics\US Projects\15-304_Naples Outfalls\Design\30% Design\15-304_Naples Outfalls-30% Design_15_Discharge_Beach Hotel.dwg Sep 29, 2016-5:34pm

Naples Beach Restoration & Water Quality Improvement Project

NORTH SYSTEM OFFSHORE DISCHARGE SITE PLAN (NEAR NAPLES BEACH HOTEL & GOLF CLUB)

Erickson Consulting Engineers, Inc.
ECE Erickson Consulting Engineers
7201 Delainey Court
Sarasota, FL 32420
(941) 373-6460



Z:\CADD_Graphics\US Projects\15-304_Naples Outfalls\Design\30% Design\15-304_Naples Outfalls-30% Design_16_Discharge_3rd Ave.dwg Sep 29, 2016-5:35pm

Naples Beach Restoration &
Water Quality Improvement Project

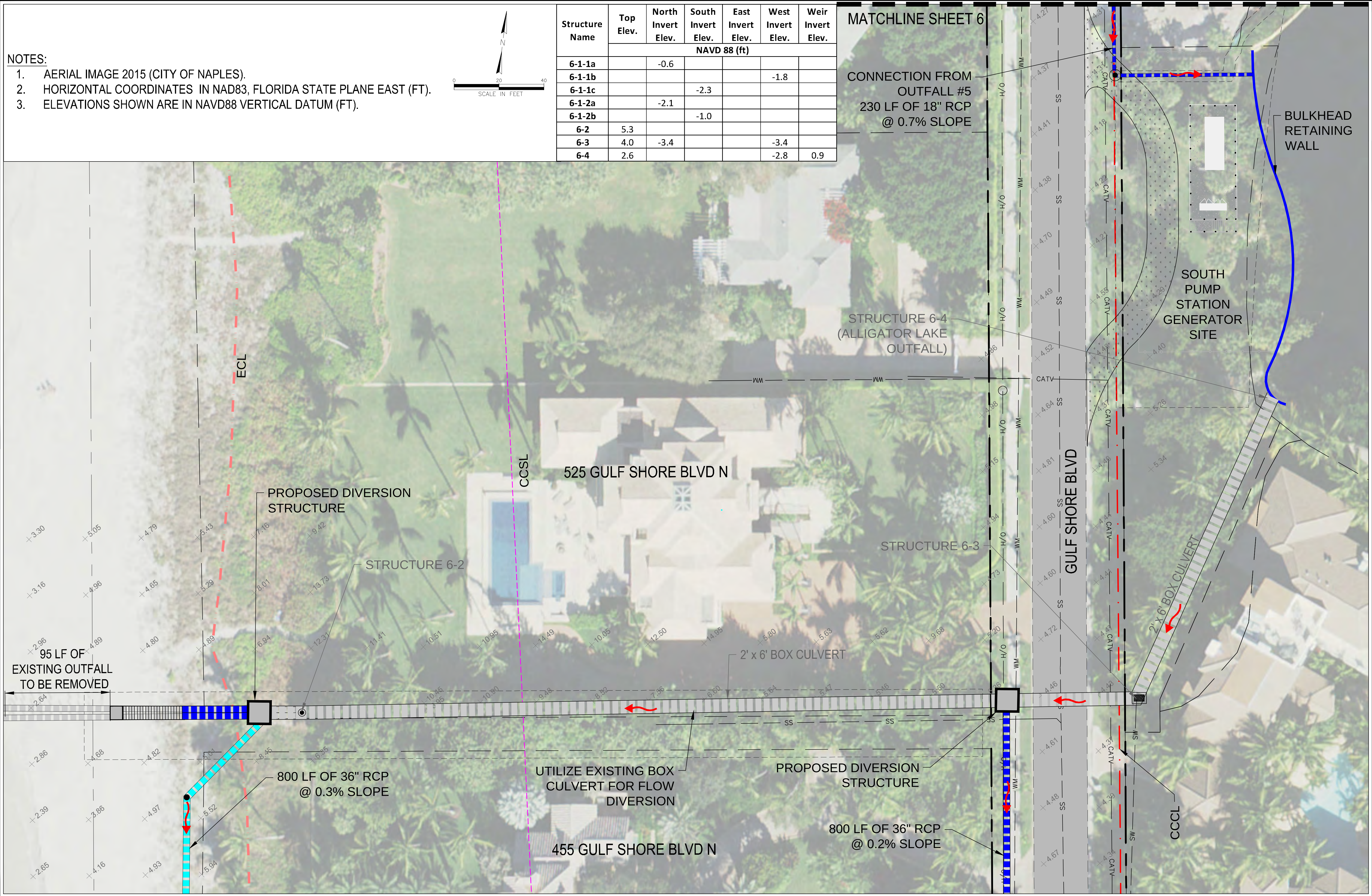
SOUTH SYSTEM OFFSHORE DISCHARGE SITE PLAN

Erickson Consulting Engineers, Inc.
7201 Delainey Court
Sarasota, FL 32420
(941) 373-6460

16

NOTES:
1. AERIAL IMAGE 2015 (CITY OF NAPLES).
2. HORIZONTAL COORDINATES IN NAD83, FLORIDA STATE PLANE EAST (FT).
3. ELEVATIONS SHOWN ARE IN NAVD88 VERTICAL DATUM (FT).

Structure Name	Top Elev.	North Invert Elev.	South Invert Elev.	East Invert Elev.	West Invert Elev.	Weir Invert Elev.
	NAVD 88 (ft)					
6-1-1a		-0.6				
6-1-1b					-1.8	
6-1-1c			-2.3			
6-1-2a		-2.1				
6-1-2b			-1.0			
6-2	5.3					
6-3	4.0	-3.4			-3.4	
6-4	2.6				-2.8	0.9

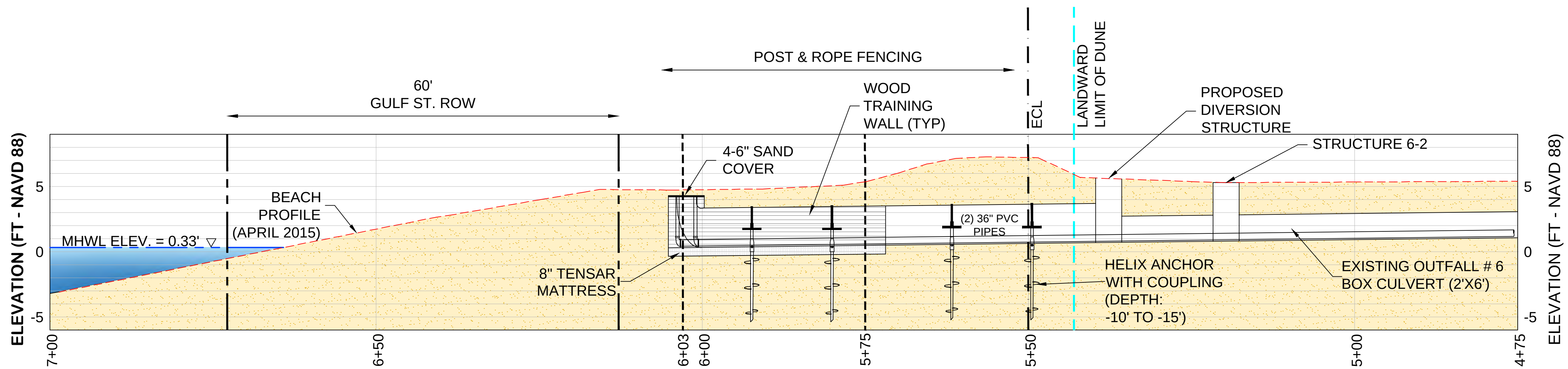


Z:\CADD_Graphics\US Projects\15-304_Naples Outfalls\Design\30% Design\15-304_Naples Outfalls-30% Design_17_Overflow Site Plan.dwg Sep 29, 2016-5:37pm

Naples Beach Restoration & Water Quality Improvement Project

OVERFLOW SITE PLAN

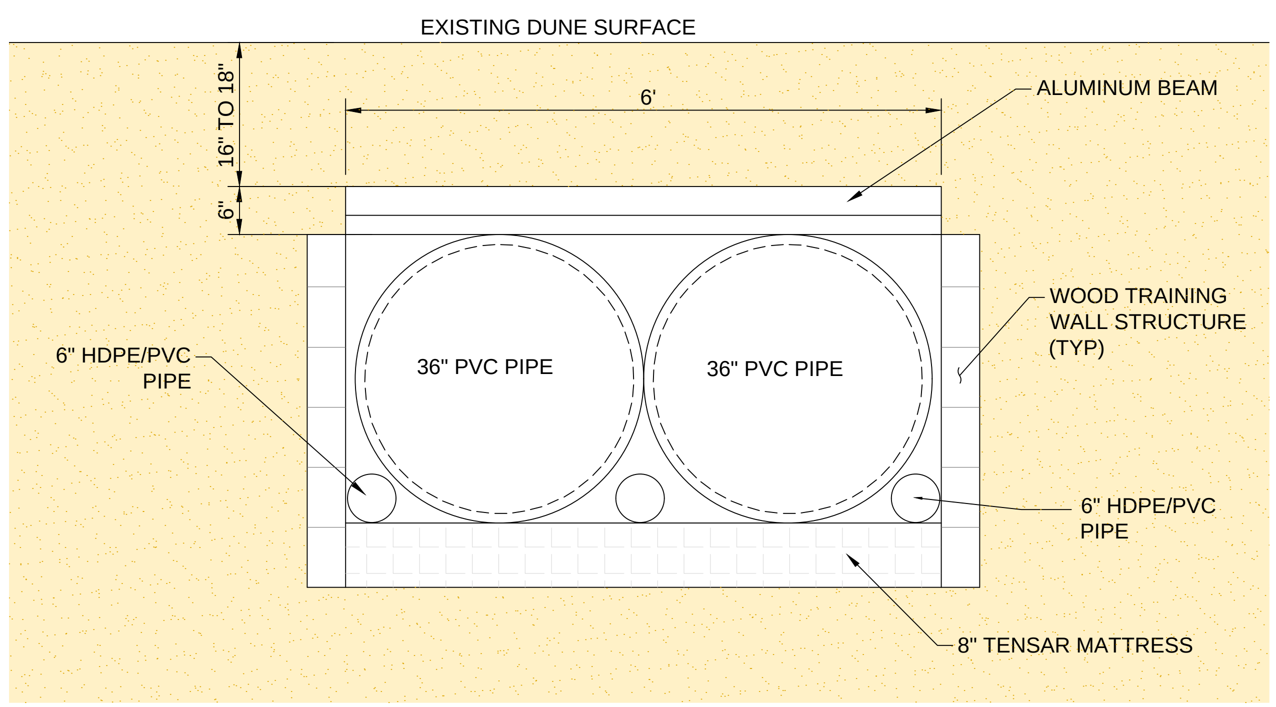
Erickson Consulting Engineers, Inc.
7201 Delainey Court
Sarasota, FL 32420
(941) 373-6460



DISTANCE (FT)

ALLIGATOR LAKE TO OUTFALL # 6 PROFILE (R-MONUMENT T-65)

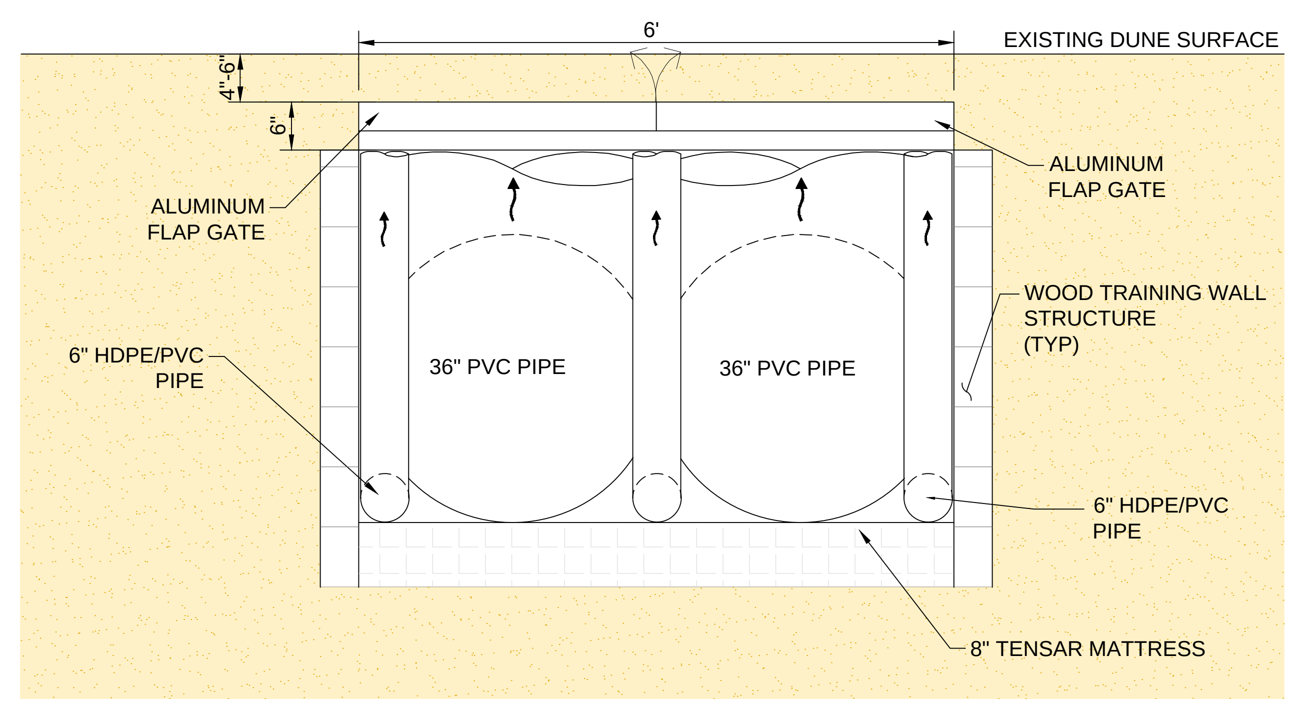
SCALE: 1"=20' (H)
1"=10' (V)



STA 5+75 SEAWARD ELEVATION VIEW

TRAINING WALL STRUCTURE (MODIFIED)

SCALE: 1" = 2'



STA 6+03 SEAWARD ELEVATION VIEW

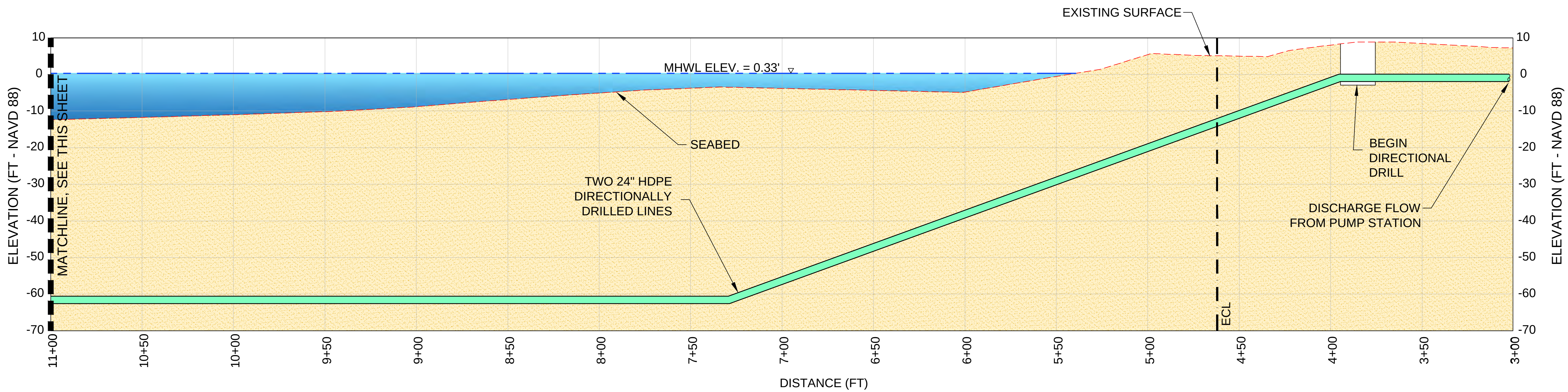
TRAINING WALL STRUCTURE (MODIFIED)

SCALE: 1" = 2'

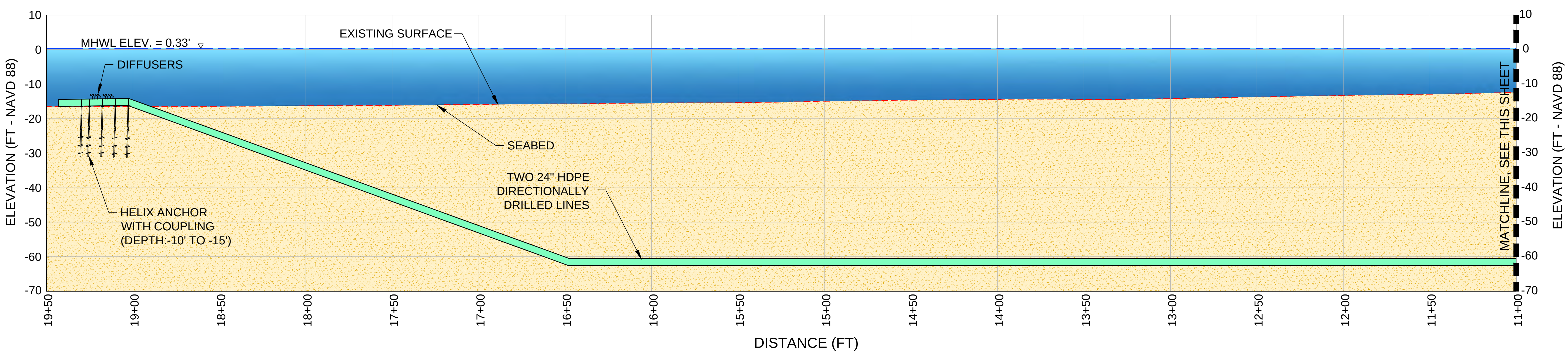
Naples Beach Restoration &
Water Quality Improvement Project

SOUTH SYSTEM OVERFLOW PROFILE
(AT CURRENT OUTFALL # 6 LOCATION)

Erickson Consulting Engineers, Inc.
7201 Delainey Court
Sarasota, FL 32420
(941) 373-6460



NAPLES BEACH HOTEL & GOLF CLUB
OFFSHORE DISCHARGE PROFILE
SCALE: 1"=60' (H)
1"=30' (V)



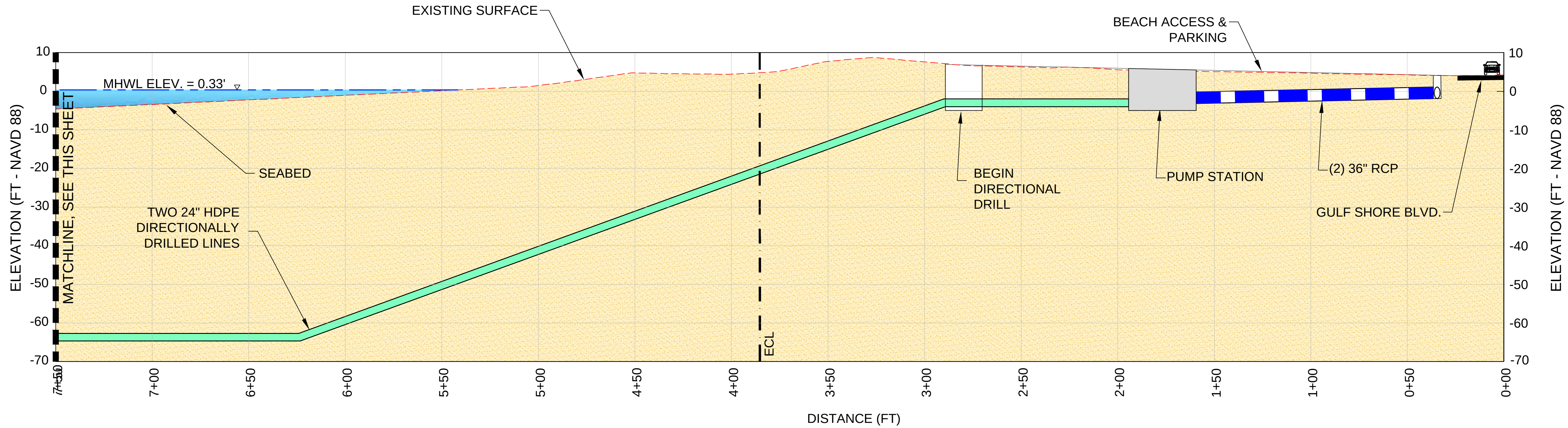
NAPLES BEACH HOTEL & GOLF CLUB
OFFSHORE DISCHARGE PROFILE
SCALE: 1"=60' (H)
1"=30' (V)

Naples Beach Restoration & Water Quality Improvement Project

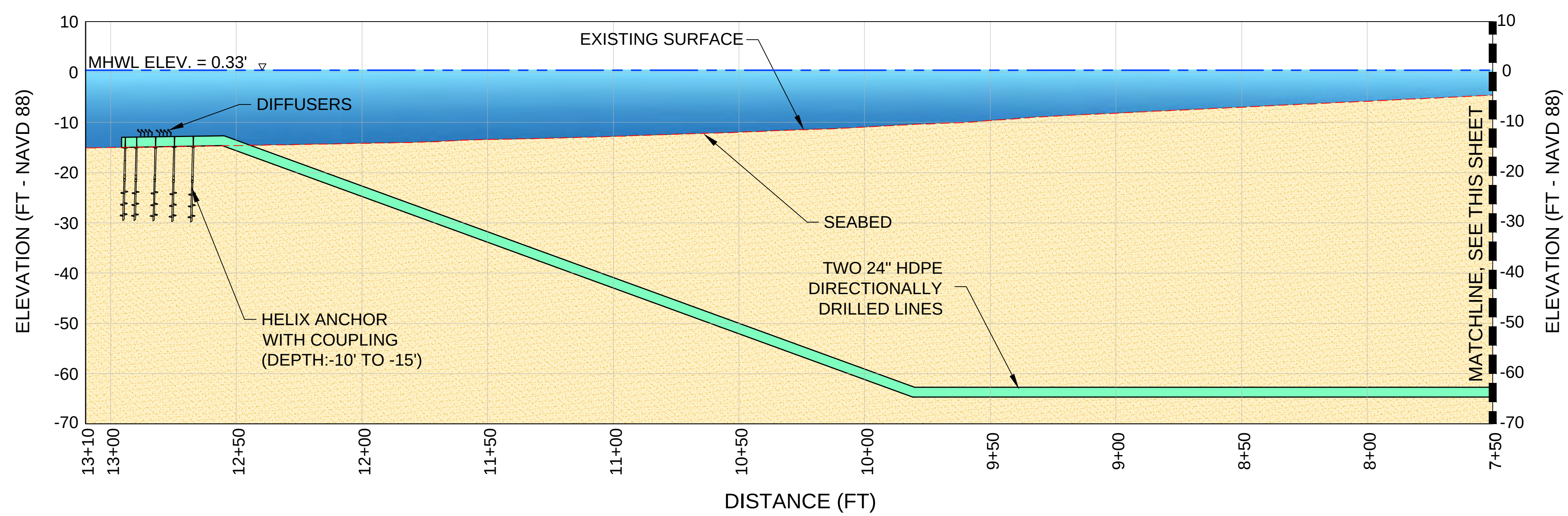
NORTH SYSTEM DISCHARGE PROFILES (AT NAPLES BEACH HOTEL & GOLF CLUB)

Erickson Consulting Engineers, Inc.
7201 Delainey Court
Sarasota, FL 32420
(941) 373-6460

Z:\CADD_Graphics\US Projects\15-304_Naples Outfalls\Design\30% Design\15-304_Naples Outfalls-30% Design_19-20_Discharge Profiles.dwg Sep 29, 2016-5:38pm



3RD AVE N OFFSHORE DISCHARGE PROFILE
SCALE: 1"=60' (H)
1"=30' (V)



3RD AVE N OFFSHORE DISCHARGE PROFILE
SCALE: 1"=60' (H)
1"=30' (V)

Naples Beach Restoration & Water Quality Improvement Project

SOUTH SYSTEM DISCHARGE PROFILES (AT 3RD AVE NORTH)

Erickson Consulting Engineers, Inc.
7201 Delainey Court
Sarasota, FL 32420
(941) 373-6460