THE NEW ST. PETERSBURG PIER

SCHEMATIC DESIGN
BOOK 3
May 02, 2013

MICHAEL MALTZAN ARCHITECTURE, INC.

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SCHEMATIC DESIGN

THE NEW ST. PETERSBURG PIER
ST. PETERSBURG, FLORIDA

BOOK 3
MAY 02, 2013

Prepared for
The City of St. Petersburg

A/E Team
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Buro Happold
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CONTENT:
SCHEMATIC DESIGN
BOOK 3

1

INTRODUCTION

EXECUTIVE STATEMENT

As stated in the Basis of Design, The New St Petersburg Pier is an extraordinary opportunity to create a new landmark that is representative of both the people and the City of St Petersburg. It is this process, set forth by the City over six years ago, that has given our team a chance to be a part of this opportunity, and has provided us the framework, direction, and guidance that allows us to be able to present to you on May 2, 100% Schematic Design.

In the Basis of Design we communicated that the document is a living one: the Schematic Design Book 3 report is the next chapter in this process, and has been prepared by Michael Maltzan Architecture, Inc. along with the A/E team for the City of St Petersburg. The reports, plans and analysis are in accordance with the requirements communicated to us by the City of St Petersburg and continue to set the technical and design approach for the project going forward.

Once again, at the conclusion of Schematic Design, with the continuing committed assistance of Skanska, the A/E team, and the dedicated representatives of the City of St Petersburg, we are able to provide a project that remains representative of the original competition entry while meeting the stipulated budget assigned to the cost of work. Additionally, the ongoing dialog and feedback from the citizens of St Petersburg have helped to ensure a thorough process as the team develops and moves the original concept and basis of design into a more developed project. We deeply appreciate this attention and focus on this process and look forward to continued collaboration with the citizens of the City of St. Petersburg.

While this recent process has been challenging and many details already painstakingly designed and engineered, there continues to be hard work and tough decisions ahead in the following phases. The collaborative and cooperative spirit of the team remains strong and will continue to deliver a world class effort for this world class project, The New St Petersburg Pier.

The achievement of completing Schematic Design on schedule and on budget, with the design intent intact, and with the Project Team and Construction Manager more unified than when they started remains no small feat and serves as a testament to the Team's commitment to the City of St Petersburg, the process and the Project.

BACKGROUND

The purpose of this report is to provide the City of St Petersburg Florida with a summary update to the progress made during the Schematic Design (SD) phase. Like the Basis of Design (BOD) phase the Schematic Design (SD) began with a full key team member coordination meeting to review status of the work and to ask and respond to critical technical questions. Finally, as part of the deliverables for 100% Schematic Design and consistent with a typical process, a complete set of Schematic Design drawings will be submitted to the City for review and comment.

Once the design team is approved to proceed into Design Development, our 3rd full day Client/Project Team/ Construction Manager Coordination meeting will take place in early May.

DESCRIPTION OF WORK PERFORMED

The goal of Phase II, Schematic Design (SD), is to refine and develop the design presented in the Basis of Design (BOD). Michael Maltzan Architecture, Inc. and the members of the A/E team began Schematic Design work in December 2012. In these past few months the team has achieved a number of milestones, among them, the execution of an extensive geotechnical investigation of the area of the proposed pier, the completion of both land and underwater sonar surveys, wind and wave studies, inspection of the existing caissons below the inverted pyramid building, a detailed evaluation of relevant building codes, the construction and evaluation of an exhaustive egress model, and the commissioning of a wind-load study on the canopy. In addition to these reports and surveys, the A/E team has engaged experts in the field of metallurgy and material science to evaluate the canopy and its assembly to ensure the project's 75-year service life. These reports are made available in Sections 2 and 4 of this document.

The A/E team has worked closely with the City of St. Petersburg in refining the design of the new Pier. Feedback from the Basis of Design process has contributed to number of significant improvements to the project which are outlined in Section 2 and shown graphically in Section 4.

Finally, as in the Basis of Design phase, the A/E team worked collaboratively with the Construction Manager to ensure that the project as designed can meet the budget goal set forth by the City. The details of this process can be found in Section 5.

ORGANIZATION OF REPORT

The SD Report is organized into five (5) major sections.

1 Introduction

Includes the background of the project, a description of the work performed during Schematic Design, and the organization of the report.

2 Executive Summary

Includes a comprehensive list of key word definitions pertaining to the project and the SD Report; a summary of the development of project components; amendments to the BOD Document issued in November 2012; photographs of models used to develop the design of the Pier; memos pertaining to the canopy metal and code; a summary of project costing; the A/E team's organizational chart; and the project schedule.

3 Report

Includes surveys pertaining to land and water at the site of the Pier; a geotechnical report; a report on wind and wave loads; wind assessment studies for structure and cladding; a caisson inspection report; a life safety report; structural updates of the Lens Canopy, Bridge, Drive, and Marina; a description of precast beam options; and three-dimensional analytical images of the canopy and balconies.

4 Schematic Design Analysis

Includes a graphic description of the project in the form of architectural drawings, three-dimensional views, structural drawings, Marina drawings, drawings of the Hub and restaurant, and lighting descriptions.

5 Construction Manager at Risk

Includes a more detailed and updated schedule as well as a document detailing the early involvement of key subcontractors.

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EXECUTIVE SUMMARY

INTRODUCTION

This section includes a summary of key general information pertaining to the new Pier, as follows:

- **Definitions**
  Lexicon of key words used within the Schematic Design Report.
- **Component Development Summary**
  Narrative description of the evolution of the design since the Basis of Design phase.
- **Amendments to the Basis of Design Document**
  Corrections and updated figures to the original Basis of Design document.
- **Model Photographs**
  Photographs of the physical design models used in the Schematic Design process.
- **Canopy Metals Memo**
  Memorandum from Det Norske Veritas describing the use and assembly of metals in the Canopy.
- **Canopy Performance Memo**
  Memorandum from Wiss, Janney, Elstner Associates describing the anticipated performance of the Canopy and supporting structure.
- **Code Memo**
  Memorandum from Buro Happold describing the codes applicable to the Project.
- **Sea Level Rise Memo**
  Memorandum from Buro Happold describing the Project's strategy with respect to anticipated sea level rise.
- **A/E Organizational Chart**
  Organization of architecture and engineering teams for the project.
- **Cost Summary**
  Summary of the project budget broken down by CSI format.
- **Project Schedule**
  Schedule and description of all phases and tasks of the project.

DEFINITIONS

Architectural Phases

Basis of Design (BOD): First phase of the design project. Document developed by the architecture and engineering teams that translates the City of St. Petersburg's requirements into building components and describes the technical approach and design parameters used for the project.

Schematic Design (SD): Preparation of drawings and other documents illustrating the scale and relationship of project components.

Design Development (DD): Development of plans and elevations for the project. Drawings establishing all major elements and outline specifications and a revised statement of construction cost.

Construction Documents (CD): Preparation of working drawings, specifications and bidding information.

Construction Administration (CA): Construction of project as specified in the CD phase by the Construction Manager with assistance from the Architect. Additional clarifications to the drawings issued in the CD phase are made through the issuance of additional architectural drawings.

A/E Team

Architecture and engineering team designing the new Pier.

American Association of State Highway and Transportation Officials (AASHTO)

A standards setting entity which publishes specifications, test protocols, and guidelines which are used in highway design and construction throughout the United States. The association represents not only highways but air, rail, water, and public transportation as well.

American Society for Testing and Materials (ASTM)

International standards organization that develops and publishes voluntary consensus technical standards for a wide range of materials, products, systems, and services.

Americans with Disabilities Act (ADA)

Legislation enacted by the U.S. Federal Government in 1991 with the goal of removing barriers that limit the engagement of an individual with a disability in normal daily activity in the physical public environment.

Base Flood Elevation (BFE)

Water surface elevation corresponding to a flood having a 1% probability of being equaled or exceeded in a given year as defined in the FEMA Flood Map. The base flood elevation for the site of the new Pier is +8 feet NAVD88.

Bent

Part of a bridge substructure. A rigid frame commonly made of reinforced concrete or steel that supports a vertical load and is placed transverse to the length of a structure.

Bond Breaker

A seal, gasket, or bushing that prevents dissimilar metals from coming into electrical contact with each other. See Galvanic Corrosion.

Bulkhead

Retaining wall along a waterfront. Synonymous with 'seawall'.

Canopy

The large, aluminum-clad structure that forms the iconic focal point of the project. One of eight central Components of the Project.

Capital Improvement Plan (CIP)

Short range plan which identifies capital projects and equipment purchases, provides a planning schedule, and identifies options for financing the plan.

Coastal High Hazard Zone

Area particularly vulnerable to the effects of coastal flooding.

Community Redevelopment Area (CRA)

Area designated for redevelopment by a municipality or county after a determination that "slum and blight" criteria have been met, as established in Chapter 163 Part III of the Florida Statutes, traditionally funded by Tax Increment Financing (TIF).

Component

Discrete grouping of spaces and activities that are physically related, composing an area of the new Pier designed by Michael Maltzan Architecture, Inc. The project has eight central Components; the Welcome Mat, the Hub, the Overwater Drive, The Promontory, the Overwater Bridge, the Marina, the Canopy, and the Underwater Feature.

Construction Manager (CM)

The construction team that will lead the construction efforts of the various subcontractors and hold the contract with the City of St. Petersburg to build the new Pier. The Construction Manager for the Pier is Skanska USA, Inc.

Construction Manager at Risk (CMR)

Delivery method that entails a commitment by the construction manager to deliver the project within a Guaranteed Maximum Price (GMP).

DEFINITIONS (continued)

Construction Specifications Institute (CSI)

An organization that maintains and advances the standardization of construction language as it pertains to building specifications. CSI authored MasterFormat, which is an indexing system for organizing construction data, particularly construction specifications.

Design-Assist

A project delivery method in which the construction team is engaged by the Owner to collaborate with the architect or engineer during the design phase. It is intended to reduce the cost and time for construction, improve constructability, and add value.

Design Flood Elevation (DFE)

Elevation of the 100-year storm as defined in FEMA Flood Insurance Studies or, in areas without FEMA flood plains, the elevation of the 25-year storm.

Dissimilar Metals

Two or more different metals or alloys in electrical contact with each other. See Galvanic Corrosion.

Federal Emergency Management Agency (FEMA)

Agency that coordinates the Federal Government's role in preparing for, preventing, mitigating the effects of, and recovering from all domestic disasters, whether natural or man-made.

Flood Hazard Area

Areas that are subject to flooding.

Florida Accessibility Code for Building Construction (FACBC)

State of Florida Legislation, adopted in 2012, that contains guidelines and provisions more stringent than the Federal Americans with Disabilities Act (ADA).

Florida I-Beam

A highly-efficient precast, prestressed concrete beam used for the construction of bridges.

Galvanic Corrosion

An electrochemical process that occurs between dissimilar metals in which one metal corrodes preferentially to another when both metals are in electrical contact and immersed in an electrolyte.

Galvanization

The process by which steel is coated with zinc to provide a barrier against corrosion.

Geotechnical Investigation

Used to obtain information on the physical properties of soil and rock around a site to design earthworks and foundations for proposed structures and for repair of distress to earthworks and structures caused by subsurface conditions.

Hub

Program component of the new Pier located on the Uplands serving as the main retail and dining attraction for the project. Serves as the terminus for the Overwater Bridge. One of eight central Components of the Project.

HVAC

Term used to refer to the mechanical systems which heat, cool, filter, or dehumidify air in a room or building. Acronym for 'heating, ventilation and air conditioning'.

Iconic Architecture

Architecture that is beautiful in form, serves a useful purpose and creates a sense of place by contributing to the public realm while being unique and unprecedented.

Intertidal Zone

Area that is exposed to the air at low tide and underwater at high tide.

Intermodal

Accommodation of multiple means of transportation, including pedestrian, bicycle, and vehicular.

Leadership in Energy and Environmental Design (LEED)

Suite of rating systems for the design, construction, and operation of high performance green buildings, homes, and neighborhoods. Developed by the U.S. Green Building Council, LEED is intended to provide building owners and operators a concise framework for identifying and implementing practical and measurable green building design, construction, operations, and maintenance solutions.

Learning Steps

A sub-component to the Promontory consisting of a tiered seating area that can accommodate gatherings and special events.

Lens

Term referring to the iconic design of The New St. Petersburg Pier by Michael Maltzan Architecture, Inc.

Marina

One of the eight central Components of the Project. Consists of a circular Floating Dock, gangways, and the arched Rialto Stair. Intended for use by small motorized boats, kayaks, and fishermen.

DEFINITIONS (continued)

Marina Overlook

A sub-component of the Overwater Bridge that incorporates terraced seating with a meandering ADA ramp. Provides a connection from the Overwater Drive to the Overwater Bridge.

Mean Sea Level (MSL)

A tidal datum. The arithmetic mean of hourly heights observed over the National Tidal Datum Epoch. Shorter series are specified in the name; e.g., monthly mean sea level and yearly mean sea level. The Mean Sea Level for Tampa bay is -0.26 feet NAVD88.

Millage Rate

Amount per $1,000 that is used to calculate taxes on property.

National Electrical Manufacturers Association (NEMA)

Association of electrical equipment manufacturers for the development of technical standards that are in the best interests of the industry and users.

National Geodetic Vertical Datum of 1929 (NGVD 29)

A fixed reference adopted as a standard geodetic datum for elevations determined by leveling. The geodetic datum is fixed and does not take into account the changing stands of sea level. Because many variables affect sea level and because the geodetic datum represents a best fit over a broad area, the relationship between the geodetic datum and local mean sea level (MSL) is not consistent from one location in either time or space. NGVD (1929) has been superseded for use by the North American Vertical Datum of 1988.

North American Vertical Datum (NAVD88)

A fixed reference for elevations determined by geodetic leveling. Established in 1991 by the minimum-constraint adjustment of the Canadian-Mexican-U.S. leveling observations, which held the fixed height of the primary tidal bench mark, referenced to the new International Great Lakes Datum of 1985 local mean sea level height value, at Father Point/Rimouski, Quebec, Canada.

Overwater Bridge

One of the eight central Components of the Project consisting of a pedestrian walkway elevated on caissons that connects the Promontory to the Hub.

Overwater Drive

One of the eight central Components of the Project. The mixed-use pedestrian and vehicular pathway supported on piles that connects the Welcome Mat with the Promontory.

Piazza

Public square or gathering place.

Pier Approach

Area of the existing Pier that describes the approximately 1/4-mile long bridge portion of the Pier between the Uplands seawall and the Pier head.

Pier Head

Portion of the existing Pier that describes the large rectangular area at the eastern end of the 1926 Pier approach.

Pile Cap

A reinforced concrete slab constructed on top of a group of piles to distribute the load evenly to the individual piles.

Project

Term used in the Schematic Design document to describe the new Pier designed by Michael Maltzan Architecture, Inc. in all of its scope, inclusive of all design components and site improvements.

Promontory

The rock-like platform at the terminus of the Overwater Drive providing a foundation for the proposed Promontory Grill, Concessions Space, and Restrooms.

Return Period

Estimate of the interval of time between a flood of a certain intensity or size.

Risk Category

Categorization of buildings and other structures for the determination of flood, wind, snow, ice, and earthquake loads based on the risk associated with unacceptable performance.

Scour

The removal by hydrodynamic forces of bed material in the vicinity of coastal structures.

Seagrass

Underwater flowering plants that live in protected bays, lagoons, and other shallow coastal waters. This grass-like vegetation forms small patchy beds that can develop into expansive meadows. Seagrasses perform a number of ecological functions such as improving water quality, contributing to the marine food web and stabilizing loose sediment.

Seawall

See Bulkhead.

DEFINITIONS (continued)

Tax Increment Financing (TIF)

Mechanism that allows local governments to use future projected taxes generated within an approved Community Redevelopment Area to finance public improvement projects.

Upland

Landmass connecting the existing pier approach to the City and Bay Shore Drive NE. Extending 2nd Avenue NE into Tampa Bay, it is also the site of Spa Beach, the Pelican Parking Lot, the Dolphin Parking Lot, and the St. Petersburg Museum of History.

Wave Attenuator

Man-made structure used to extract the energy from incoming waves.

Welcome Mat

The intermodal vehicular turnaround and open plaza located at the eastern terminus of the Uplands. Provides the point of origin for the Overwater Drive. One of eight central Components to the Project.

COMPONENT DEVELOPMENT SUMMARY

Since the completion of the Basis of Design phase, the A/E team has worked to develop each Component of the Project. The following is a summary of the changes made to the design of each Component.

Welcome Mat

- The diameter of the Welcome Mat turnaround has been reduced from 160'-0" to 120'-0" to allow more room for the Hub and Restaurant.

Hub

- The Hub platform has increased in size from 19,100 SF to 21,000 SF to accommodate the added Restaurant.
- The program area allotted on the Hub has been increased from 3,875 SF to 7,500 SF in response to the restaurant interest.

Overwater Drive

- The bottom of all horizontal structural members have been elevated to +11'-0" NAVD88 to raise the project out of the wave zone and accomodate future sea-level rise.
- The Overwater Drive is now 24'-0" out-to-out to allow space for handrails, shade canopies and vertical structure while maintaining a minimum of 22'-0" clear along the entire length of the approach and a minimum of 20'-0" clear beneath the canopy for emergency access.

Overwater Bridge

- The Overwater Bridge is now 12'-0" out-to-out with guardrails redesigned to allow a minimum of 12'-0" clear width at all times.
- The aluminum cladding on the underside of the structure has been removed to reduce wind loads and allow for a smaller bridge profile.

Marina

- The Marina is now circular and has a diameter of 220'-0". This was done to optimize the constructability of the Floating Dock.
- The design of the Marina will accommodate motorboats as well as human-powered craft, allowing the usage to be at the City's discretion.
- The Arched Stair that connects the Overwater Bridge to the Marina is now pile-supported to simplify construction and reduce cost.

COMPONENT DEVELOPMENT SUMMARY (continued)

Promontory

- The Promontory has increased in size from 18,050 SF to 22,900 SF to accommodate a 20'-0" clear path of travel at all times and to allow for an expanded Promontory Grill.
- The location of the proposed Promontory Grill has changed from the south side of the Overwater Drive, along the outer "bay-side" edge of the Promontory, to the north side of the Overwater Drive along the inner, "lens-side" edge of the Promontory. The space can then be more easily enclosed and better sheltered from the elements. Further development of this area as it relates to protection from the elements is pending.
- The area dedicated to the proposed Promontory Grill has been increased from 1,800 SF to 3,200 SF.
- The seating area of the Learning Steps has increased from 1,850 SF to 2,000 SF and will now accommodate up to 285 individuals at 7 SF/Person.
- The Alternate Structural Core described in the BOD report has been eliminated. There are now only two vertical cores on the Promontory, one for an elevator and one for stairs. The program that resided in this element will now be located adjacent to the Promontory restrooms.

Canopy

- The top of the Canopy has been increased from +86'-3" NAVD88 to +104'-0" NAVD88 in order to accomodate the elevated balconies
- The Bike Path has increased in length from 590'-0" to 749'-0" to increase the apex of the path, now at +44'-6" NAVD88, and to provide adequate clearance below the Bike Path for the Overwater Drive and Promontory.
- Both levels of the Balconies are more fully accessible via elevator and stairs and have improved means of egress in emergency situations.
- The Balconies have been widened to maintain a minimum of 7'-0" clearance at all times.
- The height of the highest Balcony has been raised to +67'-0" NAVD88, approximately 7'-0" higher than the current Inverted Pyramid's observation platform.

Underwater Feature

- Grant applications have been submitted to the Army Corps of Engineers and the Restore Act for the development of this this area.

AMENDMENTS TO THE BASIS OF DESIGN DOCUMENT

This addendum is intended to correct any errors or omissions in the original Basis of Design document that was issued on November 26, 2012. Revisions are shown in *italic*.

1 **Page 3-8, Public Outreach Notes**
Revised answer to FAQ #10:
No.

2 **Page 3-9, Public Outreach Notes**
Revised answer to FAQ #16:
No. Program elements that cost more than the current total cost of $50 million are not part of the project and are not required to make the project successful. The replacement of the over water pier and the upland connection to the pier will not require additional public investment beyond the $50 million budget.

3 **Page 3-11, Public Outreach Notes**
Revised answer to FAQ #30:
The community and the City will decide what program elements, if any, shall be included, how they will be paid for, and when they will be implemented. Suggested Uplands enhancements requested by the community are found on pages 3-17 thru 3-19 of this Report.

4 **Page 3-14, Public Outreach Notes**
Revised answer to FAQ #42:
These concerns and others will be reviewed at upcoming public meetings with the City Council and City Staff. Management, operational and design recommendations will be made to ensure the safety of the public. The Marina, as currently designed, will allow courtesy boat dockage for human powered watercraft (kayaks, canoes, stand up paddleboards, pedal boats, etc.), silent electric vessels, small sailboats and motorized vessels.

5 **Page 3-70, Architectural Criteria**
Full 'Canopy Materials' section replaced with:
Over the course of the BOD phase, the design team looked at several options for the material of the Canopy, taking into consideration life cycle and maintenance cost, initial material cost, constructability, and visual impact both upon completion and long term. The material understood by the team to best meet these criteria is 5454 aluminum alloy with a high grade coating. This alloy has very good corrosive resistance in harsh seawater environments and is typically used in boat building and other constructions near or on water. As a precaution, the panel manufacturer will provide a specified 30 year warranty against defects in material and workmanship. Furthermore, the panels will be coated with a Kynar 500 base coating which will be covered by its own 30 year warranty. The following attributes render this material appropriate for the construction of the

AMENDMENTS TO THE BASIS OF DESIGN DOCUMENT (continued)

Canopy:

- *Fits the current budget goals while maximizing the Canopy's iconic look.*
- *Good strength-to-weight ratio, minimizing the impact on foundations.*
- *Panels are easily erected, replaced, or modified.*
- *Self-cleaning and not susceptible to algae, mold, or staining.*
- *Long-term color consistency, regardless of exposure to the sun and elements.*

As the team moves into the next phases of the project, large scale performance mock-ups are being planned in order to continue to explore the constructability, life cycle and maintenance, and aesthetic criteria that must be met. At this juncture, the aluminum panels are anticipated to be approximately 30 sq. ft. in size and attached to a galvanized substructure, which is in turn attached to a galvanized super structure producing a compatible assembly system.

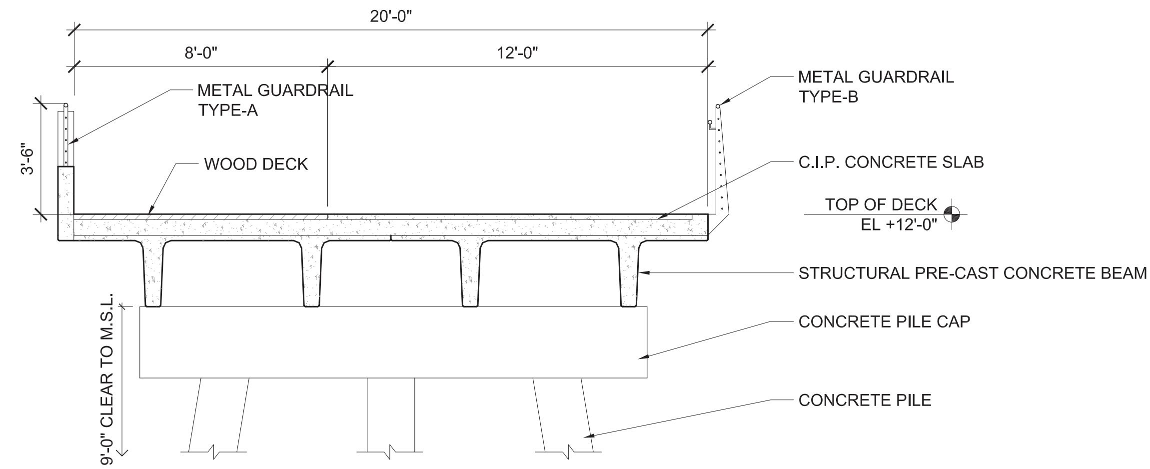
6 **Page 4-32, Component Descriptions**
Second sentence of first paragraph changed to:
The Marina will accommodate a range of watercraft from kayaks, to paddle boats and small motorboats.

7 **Page 4-36, Component Descriptions**
Last sentence of first paragraph changed to:
The Underwater Feature is intended to function as a framework supporting future habitat enhancement by the local scientific community, potentially funded by grants from various sources.

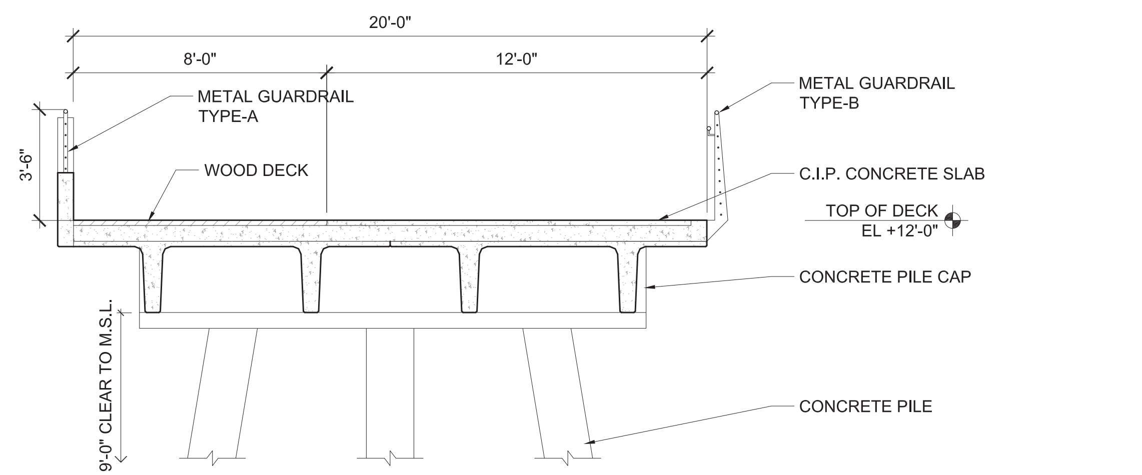
List of Revised Figures

1 **Page 3-6, Public Outreach Notes**
Additions to Figure 3.1 / Public Presentations and Information Sessions:
WOW St. Petersburg "Rock the Lens" event / Dec 3 /1,500+
St. Petersburg Yacht Club Golf Group / Jan 8 / 55

2 Page 5-19, Basis of Design Concept Plans and Diagrams
Figure 3 / Overwater Drive Section:
Figure revised

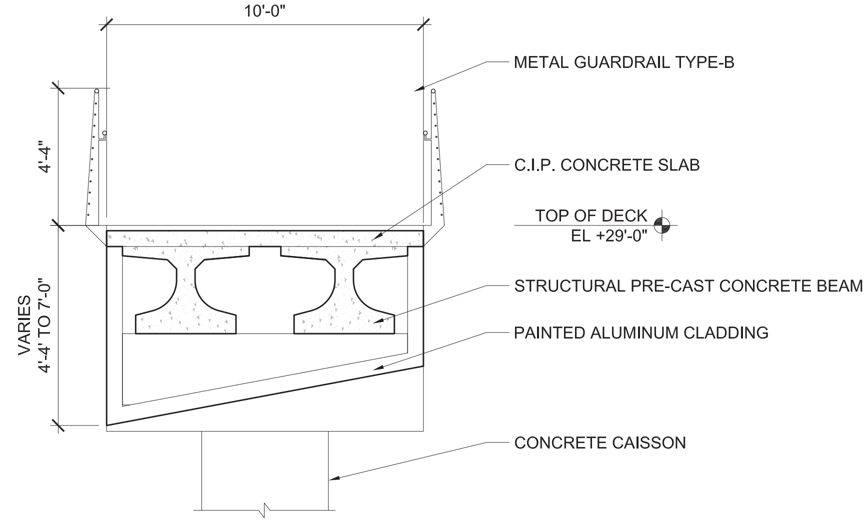


3 Page 5-19, Basis of Design Concept Plans and Diagrams
Figure 5 / Alt. Overwater Drive Section
Figure revised

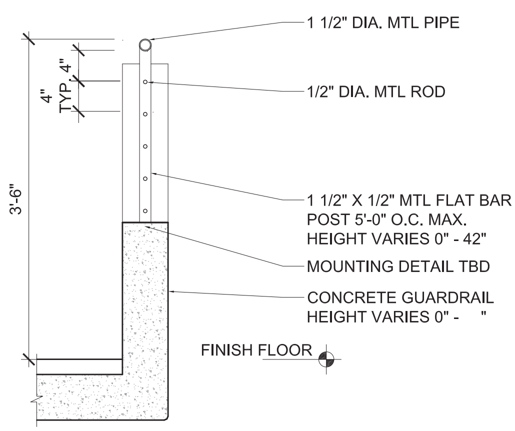


AMENDMENTS TO THE BASIS OF DESIGN DOCUMENT (continued)

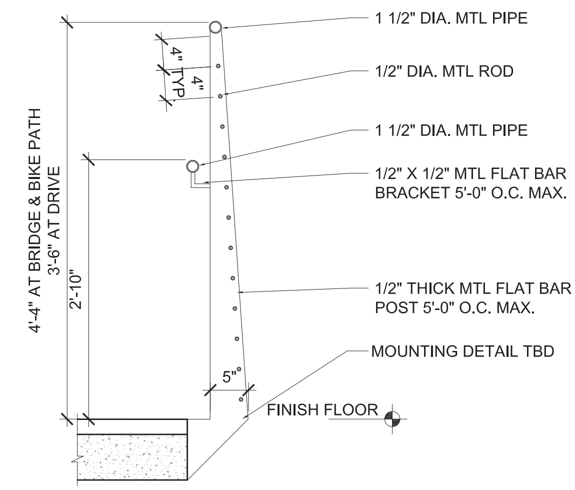
4 Page 5-19, Basis of Design Concept Plans and Diagrams
Figure 7 / Overwater Bridge Section
Figure revised



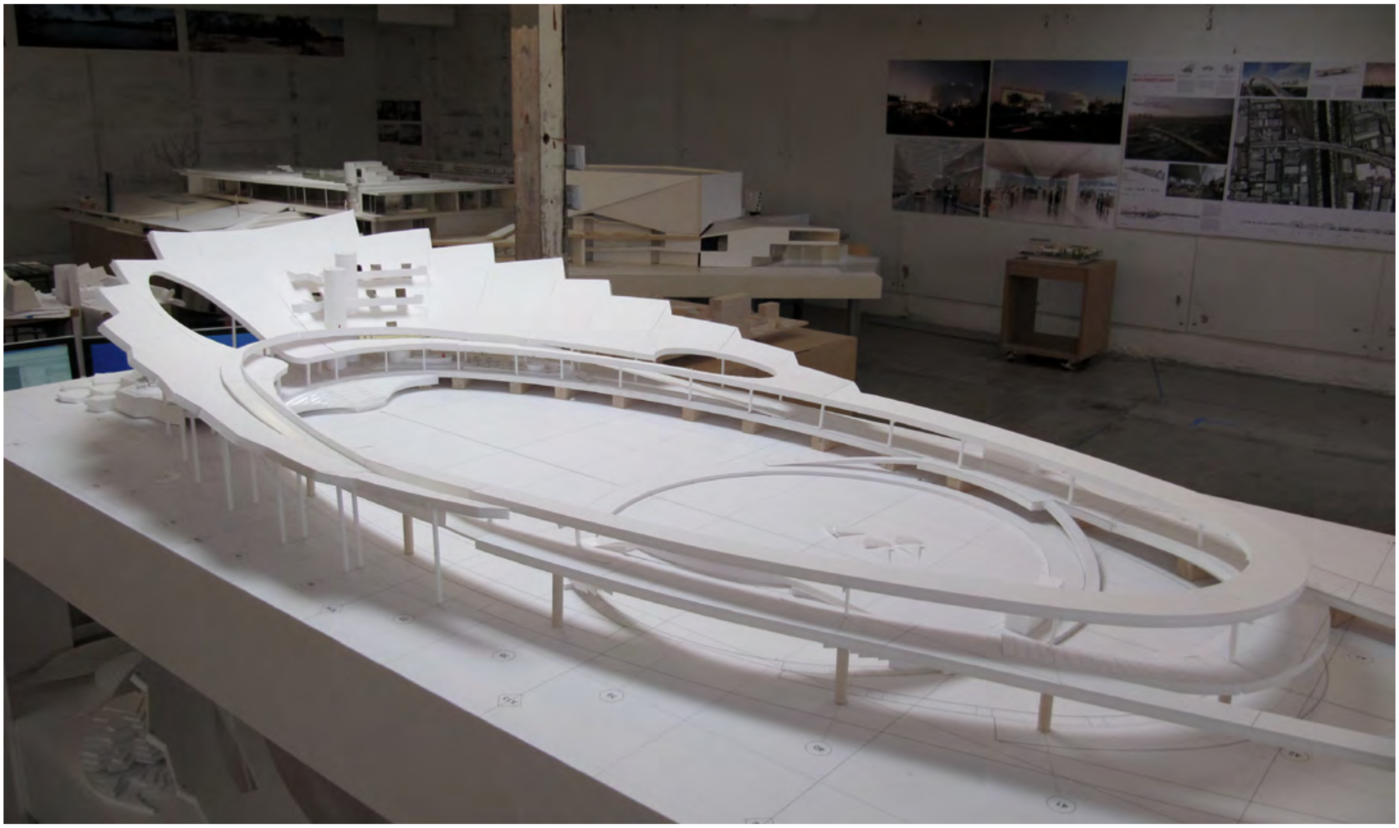
5 Page 5-27, Basis of Design Concept Plans and Diagrams
Figure 1 / Guardrail Type A Section
Figure revised

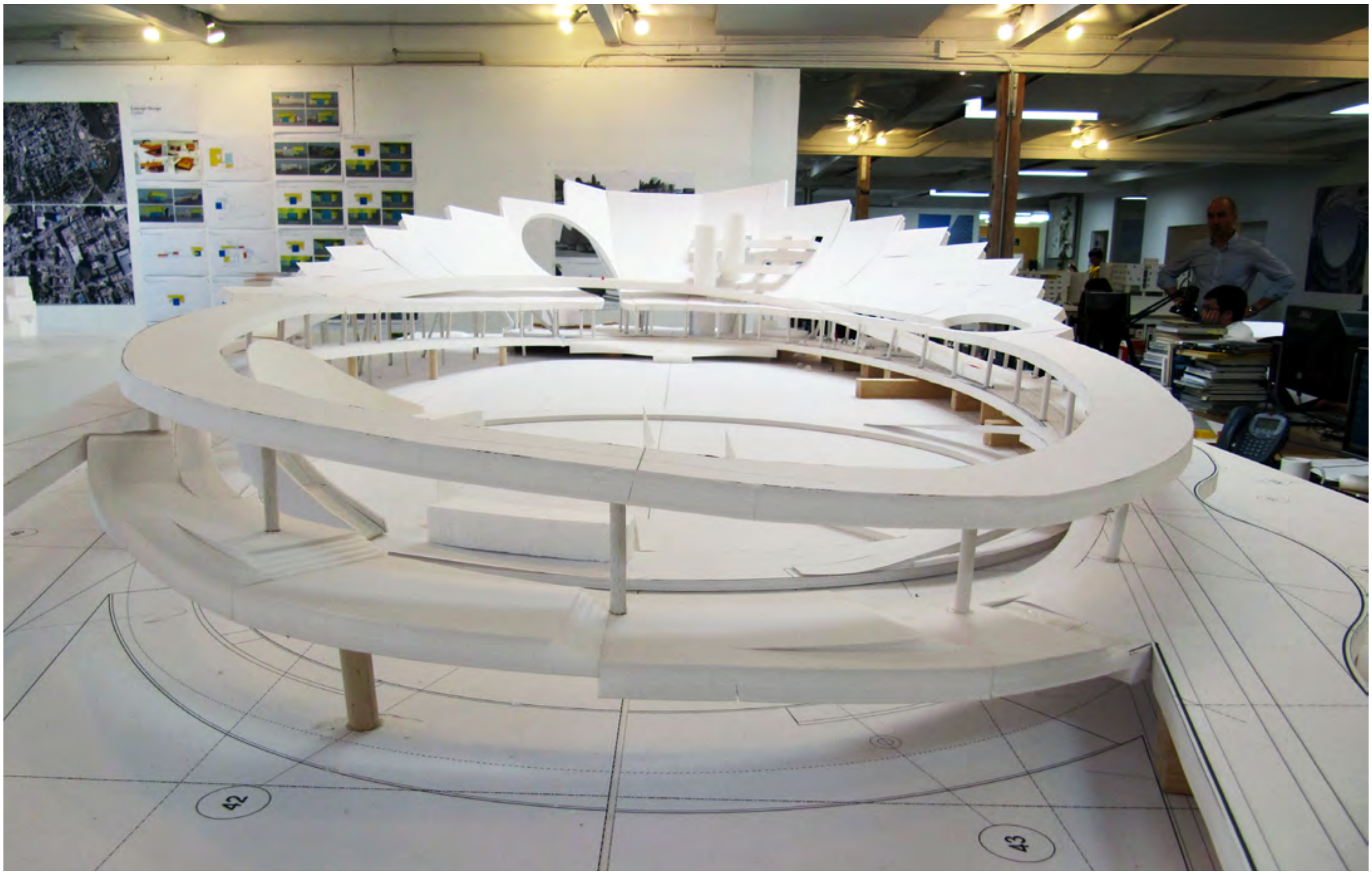


6 Page 5-27, Basis of Design Concept Plans and Diagrams
Figure 2 / Guardrail Type B Section
Figure revised



MODEL PHOTOGRAPHS

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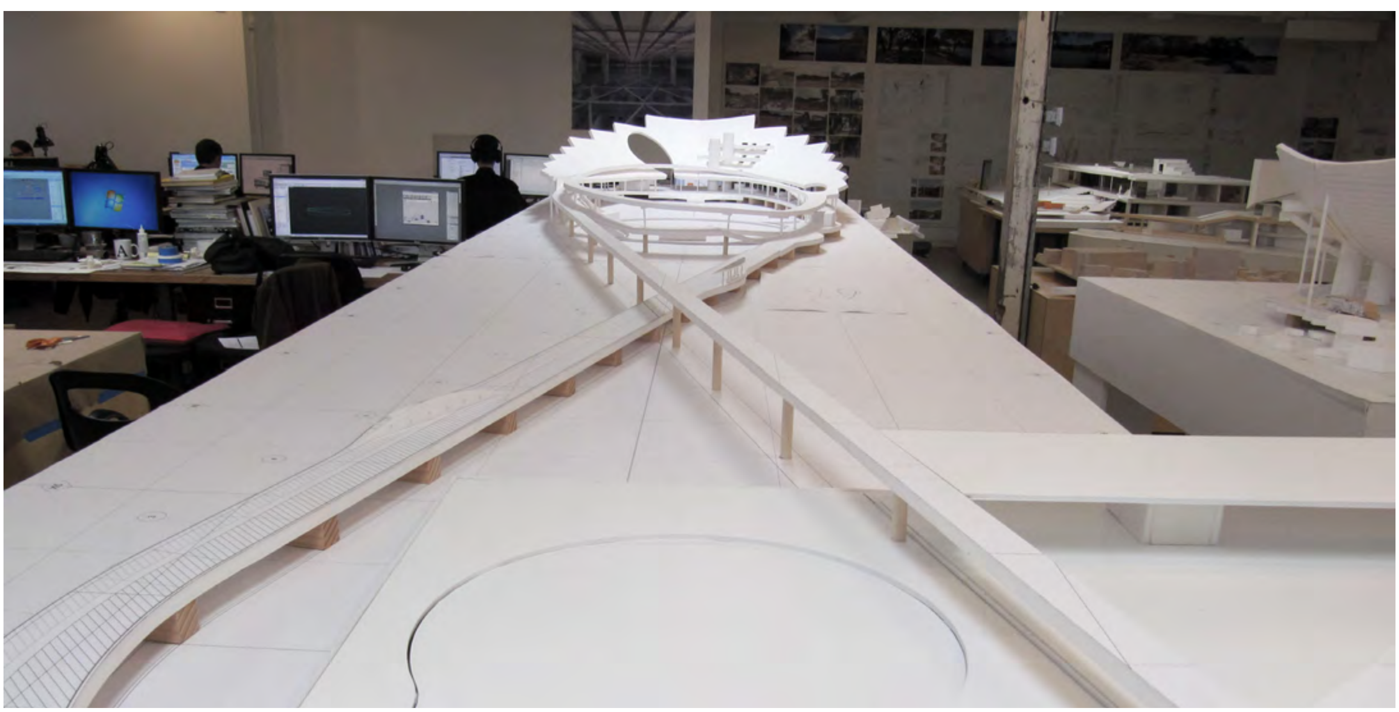
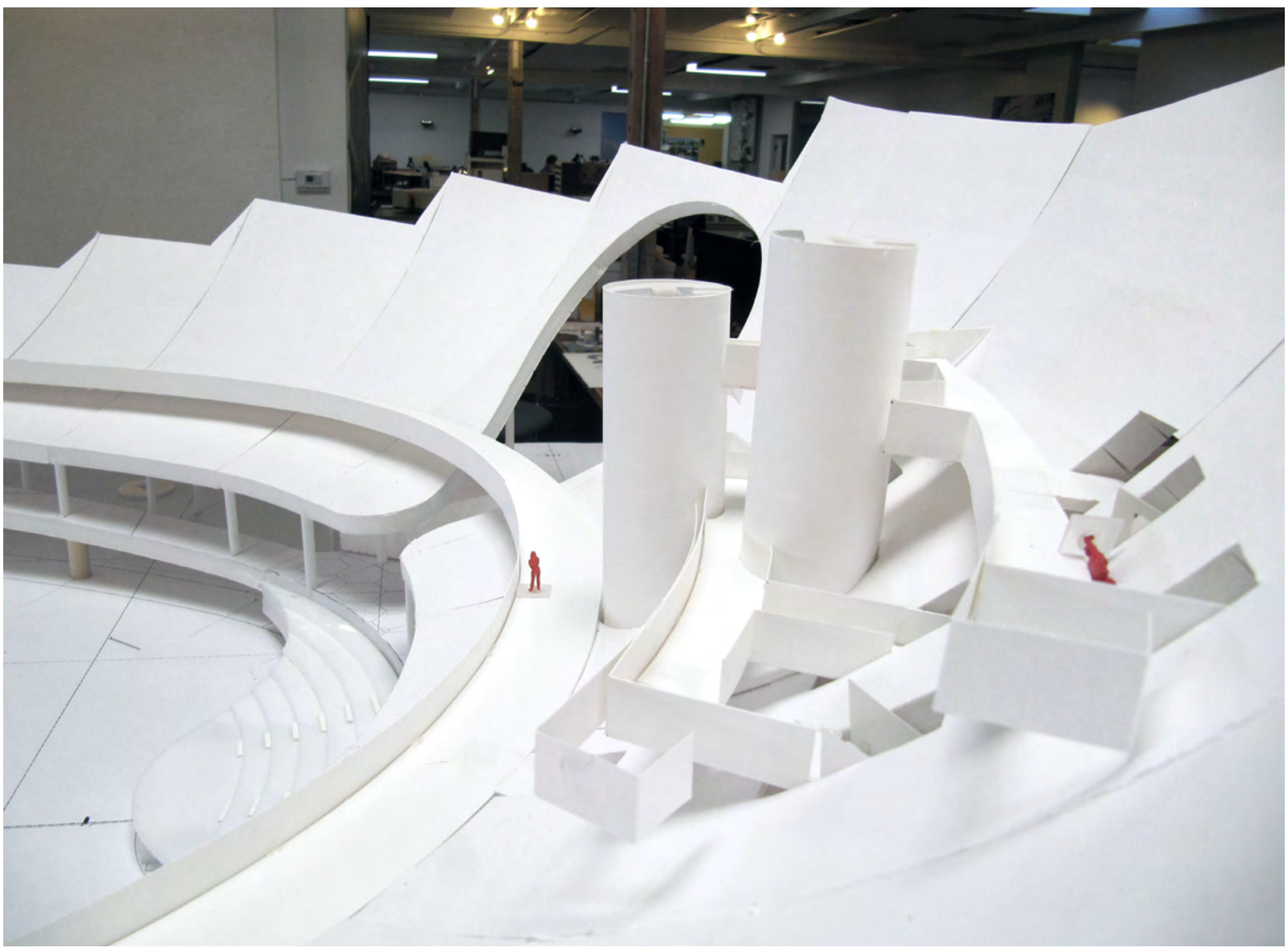


MODEL PHOTOGRAPHS
(continued)



MODEL PHOTOGRAPHS
(continued)

CANOPY METALS MEMO

DET NORSKE VERITAS

March 25, 2013

DET NORSKE VERITAS (U.S.A.), INC.
Materials and Corrosion Technology Center

5777 Frantz Road
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Tim Williams
Michael Maltzan Architecture
2801 Hyperion Avenue, Studio 107
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Re: St. Petersburg Pier

Dear Tim:

Based on review of materials of construction and design details of the St Petersburg Pier Canopy, scientific information, and my professional experience as a corrosion engineer, I recommend a canopy panel system of aluminum alloy 5454 with a good protective coating as a solution that accounts for booth structural and corrosion performance requirements. A more detailed discussion that forms the basis of this recommendation follows:

1. Alloy selection of the canopy panels.
2. Corrosion related structural issues

1. <u>Alloy Selection of the Canopy Panels</u>

Generally, aluminum alloys are used because of their high strength-to-weight-ratio (i.e. aircraft fuselage), but they are not necessarily selected because of their corrosion performance. In fact the typical aircraft materials, which have the highest strength-to-weight ratio, such as the 2000- and 7000 - series alloys have relatively poor corrosion resistance, particularly in marine environments. Of the commercially available aluminum alloys, aluminum-magnesium (5000-series) alloys have the greatest resistance to marine environments. Moreover, good protective coatings and good design can further increase the resistance of a structure to marine environments. In fact, the US Navy has used 5000-series aluminum alloys combined with good design and good protective coatings, for the construction of ship hulls and ship superstructures.

The 5000-series alloys gain their strength from strain hardening, with higher strength is possible with increasing alloy content. However, with increasing magnesium content there is a chance that, over time, precipitate strings will form along the grain boundary resulting in sensitization of these grain boundaries. Grain boundary sensitization can result in intergranular corrosion, exfoliation corrosion or stress-corrosion cracking. Aluminum-magnesium-alloy products that have a continuous or nearly continuous grain boundary precipitate are susceptible to intergranular forms of corrosion, i.e., intergranular corrosion (IGC), stress-corrosion cracking (SCC), or exfoliation corrosion. Aluminum-magnesium alloys with magnesium content less than 3% are not susceptible to these forms of corrosion; however, at greater than 3% these alloys become potentially susceptible to intergranular forms of corrosion.

Aluminum-magnesium alloys with magnesium content greater than 3 percent must be certified to ASTM B928.[1] The Standard states that alloys 5059, 5083, **5086**, 5383, and 5456, which contain greater than 3% Mg, should not be used for service, which provides prolonged exposure to temperatures exceeding 150°F (65°C), whether continuous exposure or discontinuous exposure, because of the risk of sensitization and the resulting susceptibility to intergranular forms of corrosion. Cold forming also increases susceptibility to these forms of corrosion. The original aluminum-magnesium alloy selected for the canopy was Alloy Al-5086, because of it high strength-to-weight ratio and relatively good resistance to marine environments. However, due to prolonged exposure of the canopy to direct sunlight, it is deemed likely that cumulative exposure to temperatures exceeding 150°F (65°C) will sensitize the Al-5086 alloy, resulting in possible susceptibility to intergranular and exfoliation corrosion. This alloy will be particularly susceptible to intergranular attack along the panel edges and inside the fastener holes.

Thus, it is recommended that a similar alloy with magnesium content less than 3% is used for the canopy. The recommended alloy for this application is Al-5454, which has magnesium content between 2.4% and 3.0%. This alloy may somewhat less resistance to pitting corrosion in marine environments due to its lower alloy content, but it is not susceptible to intergranular corrosion. The use of a good protective coating, e.g. a Kynar 500 base coating, compensates for this lower pitting resistance.

2. Material of Construction for Secondary structure

The question has been posed whether the entire structure, including the secondary structure could be constructed of aluminum alloy. In making the decision, mechanical properties of the aluminum alloy such as strength, weight, and stiffness need to be considered as well as corrosion resistance and durability. The main advantage of aluminum alloys over steel is their high strength-to-weight ratio. However, steel has higher strength stiffness.

Galvanized steel is the correct material of construction for the secondary structure if certain rules are followed:

- Prevent dissimilar metal contacts.
- Prevent crevices and low spots where water can collect resulting is corrosion hot spots.
- Provide sloping surfaces and drain holes at low spots, so that water from condensate or leaks can drain off and corrosion hot spots can be avoided.

[1] ASTM B928/B928M-09 "High Magnesium Aluminum Alloy Sheet and Plate for Marine Service and Similar Environments

CANOPY METALS MEMO
(continued)

3. Corrosion Related Structural Issues

In addition to selection of the materials of construction, proper design rules must be followed to improve the corrosion resistance of a structure. Some of the most important issues to consider in a design are avoidance of metal-to-metal contact of galvanically incompatible metals, and avoidance of locations where water and salt can collect creating a corrosive environment.

Attachment of Aluminum Alloy Canopy Panels

The canopy panel specification calls for the use of 300 series stainless pop rivets (Type 304SS?). Stainless steel is cathodic with respect aluminum (regardless the aluminum alloy), which will likely lead to corrosion of the aluminum walls in the fastener holes. To avoid dissimilar metal-to-metal contact, it is recommended to use aluminum rivets. In order to further improve the corrosion resistance in the fastener holes, it is also recommend that the practice of wet riveting is applied. In this practice, the rivets are dipped in corrosion protective sealant or compound (Kynar?) prior to riveting. The practice of wet riveting, which is common in the aircraft industry, provides an excellent seal and prevents water to leak through the fastener holes. It provides good additional protection against corrosion in the fastener holes.

In order to prevent water from collecting and being trapped between overlapping panels, it is further recommended that the faying surfaces of the overlapping aluminum alloy panels are sealed, and that the aluminum panels are attached to aluminum sub-frame (C-channels) by wet riveting of aluminum rivets.

C-Channel Structure

In the current design, the sub frame consists of C-channels. The C-channel has the potential of trapping water and allowing for salt build-up. Therefore, it is recommended that the C-channel be replaced by a profile of equal strength and stiffness, where water and salt cannot be trapped. It is further recommended that drain holes are made in the bottom panels or channels to avoid any water build up inside the canopy box.

In the current design, the C-channel (aluminum) is fastened to the secondary structure (galvanized steel) with galvanized steel fasteners. Precautions must be taken to avoid metal-to-metal contact between dissimilar metals. Different kinds of structures are built with dissimilar metals, and with the proper precaution, problems related to galvanic corrosion can be avoided. Construction with dissimilar metals is an acceptable practice, as long as direct metal-to-metal contact is avoided or the cathodic driving force is reduced by minimizing the cathode-to-anode ratio. In other words a small anodic area metallic contact with a large cathodic area will results in high corrosion rates of the anode, whereas a large anode in contact with a small cathode will have low galvanic corrosion.

It should be noted that zinc and aluminum are galvanically compatible metals and contact between these two should not result in galvanic corrosion. However, contact between aluminum and steel (or stainless steel) must be avoided. If steel is in contact with aluminum, the steel will drive the galvanic corrosion of the aluminum, particularly if there is an unfavorable area ration.

4. General Materials of Construction Comments

The proposed pier can be designed for and built out of different materials of construction, such as reinforced concrete, fiber glass reinforced plastics (FRP), all metal, or a combination of the these materials. The decision on what material to use depends primarily on the structure's architecture and functionality. Within this design framework, material selection with respect to corrosion resistance, and attention to design and construction detail as outlined above will help towards ensuring the durability of the structure. The durability of the pier canopy structure can further be enhanced by regular inspection and maintenance during the life of the structure.

I trust that the above recommendations and explanations will contribute to the sustainability and durability of the canopy of the St Petersburg Pier.

I am looking forward to continuing our support of project.

Sincerely,

For Det Norske Veritas (U.S.A.), Inc.
Gerhardus H. Koch, Ph.D. FNACE

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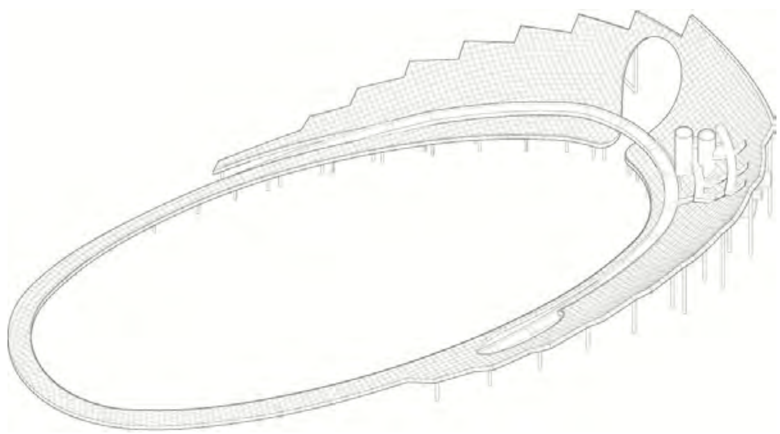
CANOPY PERFORMANCE MEMO

WJE

THE NEW ST. PETERSBURG PIER
Service Life Considerations for Metal Canopy

St. Petersburg, Florida



Final Report
April 22, 2013
WJE No. 2013.1555

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WJE

THE NEW ST. PETERSBURG PIER
Service Life Considerations for Metal Canopy

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WJE ENGINEERS ARCHITECTS MATERIALS SCIENTISTS

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EXECUTIVE SUMMARY

The current conceptual design developed by Michael Maltzan Architecture (MMA) for the new St. Petersburg Pier (the Pier) includes an iconic, sweeping canopy. The proposed system for the canopy currently includes coated aluminum panels on top of a structural steel frame. This system has been proposed to minimize structure weight and provide a cost-efficient design. To coincide with the Pier's design basis of a 75-year service life, Wiss, Janney, Elstner Associates, Inc. (WJE) was requested by MMA to evaluate the expected service life for the conceptual design of the canopy.

The service life of the pier should be considered both relative to serviceability and structural concerns. Serviceability concerns may include aesthetic, waterproofing, or other desirable performance attributes. Structural concerns may include deterioration which would reduce the capacity of the canopy's structural system to resist its intended design loads. To assess both of these effects, applicable deterioration mechanisms must be considered.

For the polyvinylidene fluoride-based PVDF coating intended for the aluminum panels, a number of potential deterioration mechanisms were considered. These included chalking, fading, gloss retention, and blistering, among others. For the aluminum material and steel superstructure, various corrosion mechanisms were considered. These included potential locations for crevice corrosion, dissimilar metal corrosion, pitting, uniform, and filiform corrosion. For consideration of these deterioration mechanisms, the Pier's location in Tampa Bay was categorized as moderately to severely corrosive in a subtropical marine environment.

A literature search of published test data was performed to identify test data or performance history of the intended materials in locations similar to the Pier's environment. Long-term outdoor exposure testing has been performed for both bare aluminum and for coated aluminum specimens in marine atmospheric exposures. Performance of bare aluminum is dependent on the aluminum alloy; the aluminum alloy chosen for the panels, Type 5454, is considered to be marine-grade aluminum with good resistance to corrosion by chlorides. In addition, published literature shows the proposed PVDF coating is the highest-performing type of coating system available for architectural metal elements and has also exhibited good performance in subtropical environments.

The service life of the coating is anticipated to be 20 to 30 years before significant maintenance operations will be needed. After the coating has reached the end of its serviceability, a new topcoat of PVDF material can be applied to the panels to restore their appearance and functionality. In this manner, the service life of the coating can be extended to provide the intended 75-year design life.

The steel superstructure for the canopy was shown as galvanized in the conceptual design. Galvanizing provides both a barrier coating and sacrificial protection to the underlying steel from corrosion. To achieve a 75-year service life, additional design considerations are required. To achieve this goal, a high-build epoxy and polyurethane coating system is proposed to be installed over the galvanizing. The combined protective effects of the coating and underlying galvanizing are expected to provide sufficient corrosion protection to the steel elements to achieve a 75-year design life with routine maintenance and touch-up of exposed coated surfaces.

The interior superstructure of the canopy will be protected from direct exposure to the marine environment by the aluminum panels. Recommendations are provided in the report to limit locations of crevice corrosion and dissimilar metal corrosion in the canopy construction. The conceptual design uses a

CANOPY PERFORMANCE MEMO (continued)

membrane below the aluminum panels to provide waterproofing for the structure. This membrane is expected to provide good performance as long as it is covered from direct exposure by the panels. However, like many roofing materials, it may need to be replaced after 30 to 40 years of service. We anticipate one reapplication of membrane would be required over the structure's 75-year design life. Alternatively, the membrane may be eliminated in conjunction with a fully vented system that permits the canopy panels to function as a barrier system. This approach requires the canopy assembly components to be robustly designed in a manner that is consistent with a 75-year service life.

Evaluated alternatives to the proposed system included 1) precast concrete panels over a steel superstructure; 2) monolithic cast-in-place concrete construction; and 3) stainless steel panels over a steel superstructure. Although these alternative approaches each provide some advantages and disadvantages, the chosen system of aluminum panels and steel superstructure provides a good mixture of performance and cost for the canopy. With consideration of the expected performance, design recommendations, and performance outlined in the report, the conceptual design should provide a 75-year service life for the project.

THE NEW ST. PETERSBURG PIER
Service Life Considerations for Metal Canopy

St. Petersburg, Florida

INTRODUCTION

At the request of Michael Maltzan Architecture (MMA), Wiss, Janney, Elstner Associates, Inc. (WJE) evaluated the anticipated service life of the metal canopy for the New St. Petersburg Pier (Pier) in St. Petersburg, Florida. This Pier is currently being designed by MMA as a replacement for the existing pier structure over Tampa Bay.

The metal canopy proposed for the Pier has a targeted design life of 75 years. The Pier is located in a marine environment and is subject to high UV exposure, heat, and humidity of the Gulf Coast of Florida. Many building materials are vulnerable to material degradation or corrosion from one or a combination of these exposures. It is our understanding that concrete was originally envisioned for the canopy structure; however, a metal option is currently being considered due to cost, serviceability, and weight concerns.

We understand that the City of St. Petersburg has expressed concerns whether the targeted design life is possible with a metal structure in this marine environment. To address these concerns, MMA requested that WJE evaluate the expected service life of the current design relative to corrosion-related concerns and identify the performance of other metal structures in similar marine environments. This report summarizes the results of our literature review, describes our evaluation of the expected service life, provides recommendations for changes to improve expected service life, and identifies potential laboratory testing that may be used ensure project expectations.

Project Background and Scope

The proposed design for the Pier is an oval-shaped canopy with a double-curvature shell that can be accessed by pedestrian and bicycle traffic (Figure 1). The overall dimensions of the canopy are approximately 650 feet by 310 feet. Corrosion is a primary concern at the project site because the Florida coastal environment features hot and humid weather, and structures on the Pier will be exposed to wetting and drying cycles and salt spray.

Based on the available conceptual drawings provided by MMA, the top of the canopy is formed by aluminum panels that are supported by open-web steel joists. The joists span between built-up, steel box girders and will be stabilized by bridging elements at intermediate locations. The girders bear on columns that are located around the site in a radial pattern. The columns are steel W-shapes that are encased in concrete and are supported by pile caps that are located near sea level. To resist lateral loads, diagonal kickers and X-bracing in the plane of the canopy are spaced around the structure. Hollow structural sections (HSS) are proposed for the kickers. To protect the superstructure, all steel elements are expected to be galvanized, while all aluminum panels are expected to be coated with a fluoropolymer coating. More detailed descriptions of the elements evaluated are provided below where each element is described separately.

CANOPY PERFORMANCE MEMO (continued)

Project Scope

The project scope included the superstructure and panel elements. The substructure, walkways, handrails, bike path, T-frames in the west structure, and other miscellaneous elements were not included in our review. To evaluate the expected service life of the canopy structure, we performed the following tasks:

- *Literature Review.* This included a search and review of published literature to identify the performance of proposed components of the canopy in a marine environment. We also reviewed relevant drawings, specifications, reports, and design information provided by MMA.
- *Service Life Assessment.* Based on the information identified in the literature review and our experience with similar structures, we evaluated the expected service life of the proposed canopy system. Considering that the system is in its conceptual design phase, review of individual components was performed on a generalized basis.
- *Report.* This report summarizes the findings of our literature review and service life assessment. It also includes recommendations for modifications to the design to improve service life, alternatives to proposed materials, and recommendations for laboratory testing that may be used to ensure product expectations.

A list of the published literature referenced for this evaluation is included in a bibliography at the end of the report. In addition to the literature listed, we also received the following documents from MMA for evaluation and review:

- Design documents
  - “Canopy Assembly - Draft” by MMA (no date)
  - “Section 074215 - Metal Plate Panel Systems,” by MMA, dated February 5, 2013
  - “Section 074215 - Metal Plate Panel Systems,” by MMA, dated March 27, 2013
  - “Basis of Design Book 1,” pages 3-70 to 3-71, by MMA (no date)
  - “Canopy Materials” (no date)
  - “Aluminum Canopy” (no date)
  - “Aluminum panel connection detail” by MMA, dated 4/3/13, revised 4/9/13 and 4/15/13
  - “St. Petersburg Pier Preliminary Cost Report” by Buro Happold, dated March 29, 2013

- Reports by others
  - Letter report regarding aluminum alloy selection, by Det Norske Veritas, dated March 25, 2013

- Product Information
  - “Kynar 500 FSF Case Studies in Performance,” by Arkema Inc.
  - “Pecora 531 Bond Breaker Tape,” by Pecora Corporation

Service Life Requirements

We understand that the Pier has an intended life span of 75 years. Service life in a given setting must be defined based on requirements specific to that structure in terms of performance and occupancy needs. These needs are balanced against the anticipated deterioration mechanisms that would reduce desired attributes of the elements of a structure. Depending on the exposure, material choice, and anticipated function, the definition of service life may be different for each element of the canopy. For the canopy, service life can be considered in terms of two broad categories as follows:

- *Structural Integrity*. This limit is reached when the load-carrying capacity of the canopy is compromised. This limit is dependent on the function of the structural element in question and may have a number of different criteria. Depending on the element, the critical limit or amount of damage allowed will likely vary. Allowable damage may also have different definitions, such as an amount of critical section loss or onset of corrosion over a critical area.
- *Serviceability*: This limit is reached when aesthetic features, waterproofing, or other defined performance attributes are degraded beyond an acceptable measure. A reduction in serviceability may be related to and often occurs before a reduction in structural integrity. For example, coating degradation may occur (as primarily an aesthetic concern) for a number of years before the underlying substrate is exposed to the elements.

Virtually all structures with design lives beyond a few years require routine maintenance over the course of their intended service life. Our review of the service life for the proposed structure was based on anticipated maintenance where described. For the purpose of this report, we have defined the end of service life as a major repair beyond normal and routine maintenance (e.g., full replacement of an element necessary due to deterioration).

This consideration of service life is limited to normally-anticipated weather, exposure, and use. It does not include extreme events, such as damage from hurricanes, boat impacts, or intentional damage from other parties.

Deterioration Mechanisms

Our evaluation of the service life of the canopy considered two main deterioration mechanisms for the skin and underlying superstructure: 1) corrosion and 2) coating failure. The general natures of these processes and their impact on serviceability are discussed in the following sections.

Corrosion

Corrosion is the electrochemical reaction involving oxidation of a metal or metal alloy. This reaction most commonly occurs as a transfer of charges in an aqueous solution. Corrosion can occur in many forms; brief definitions and descriptions of the forms most applicable for consideration in service life of the metal canopy are highlighted below:

Uniform Corrosion. Corrosion that causes regular, uniform removal of material from the surface. This occurs where the environment has consistent exposure to the material surface and the metal is uniform. Uniform corrosion is a potential deterioration mechanism where metallic surfaces are exposed to a marine atmosphere.

Galvanic Corrosion. Corrosion occurring as a result of an electrochemical potential difference between two metals that are electrically connected in the presence of an electrolyte. Electrochemically negative, or anodic, materials will corrode or donate electrons to electrochemically positive, or cathodic materials. Galvanic corrosion is accelerated when the area of the anodic material is small relative to the area of the cathodic material. For the canopy, galvanic corrosion is a potential deterioration mechanism where different alloys may be in contact.

Pitting Corrosion. Localized corrosion occurring in a confined area that results in pits or cavities. Pitting may be initiated by localized damage in a protective coating or the presence of nonuniformities in the

CANOPY PERFORMANCE MEMO (continued)

metal structure. Pits may penetrate deeply into the material and may be difficult to detect. For the canopy, pitting corrosion is a potential deterioration mechanism where holes in organic coatings are present or where bare, corrodible metal is exposed to the environment.

Crevice Corrosion. Corrosion occurring when a small volume of solution is trapped against a metal. When the solution is trapped, it becomes stagnant, oxygen is depleted, and acidic conditions predominate; this results in a localized corrosion cell. Crevice corrosion is a potential concern in the canopy where metallic elements are clamped together and exposed to moisture.

Filiform Corrosion. A particular form of crevice corrosion that occurs underneath a breach in a protective coating. Small breaches, or holidays, in the coating allow moisture to penetrate and proceed along tunnel-like paths under the coating surface. Coated elements, such as the decorative panel system, can be more susceptible to these breaches at fastener penetrations and material edges.

Coating Failure

Industry standard performance requirements and test procedures are published for architectural coatings by the American Architectural Manufacturers Association (AAMA). Currently, three main sets of standards are published for coated architectural aluminum:

- AAMA 2603-02, *Voluntary Specification, Performance Requirements, and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels*
- AAMA 2604-10, *Voluntary Specification, Performance Requirements, and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels*
- AAMA 2605-11, *Voluntary Specification, Performance Requirements, and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels*

Of these three standards, AAMA 2605 gives the most stringent for performance requirements and is the minimum that should be considered for coatings on the canopy structure. Even though AAMA 2605 is the most stringent, it does not provide an estimate or requirement for expected service life of the coatings that meet the standard; however, it does provide guidelines for testing and evaluation which have been performed by many architectural coating manufacturers.

Coating failures occur as a result of environmental exposure. These failures can be caused by any combination of UV exposure, heat, humidity, or chemical exposure (e.g. chlorides or cleaning agents). AAMA 2605 is the most applicable standard for the coatings proposed for the canopy skin. Brief definitions of applicable coating deterioration mechanisms, discussion of limits recommended by AAMA 2605, and some evaluation methods for these mechanisms are described below:

Chalkings. The formation on a pigmented coating of a friable powder evolved from the film itself at or just beneath the surface. Chalking is caused by deterioration of the resin in the coating and is similar to *erosion*, with the exception that the deteriorated product remains on the surface. Chalking is evaluated by ASTM D4214, *Standard Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films*, and AAMA 2605 recommends minimum values after weathering exposure.

Erosion. A phenomenon manifested in coatings by the wearing away of the finish to expose the substrate or undercoat. Erosion occurs as the result of *chalking* and is evaluated by ASTM D662, *Standard Test Method for Evaluating Degree of Erosion of Exterior Paints*. AAMA 2605 recommends no less than 10 percent of film loss after weathering exposure.

Color Fading. Color and lightness change is one of the most visible forms of change for a coating. Color is dependent on both the reference light source and the measuring instrument, and fading can be caused by changes in coating pigment or binders from light or chemical exposure. For uniformity, color change is often reported in terms of ΔE (a scalar value of the difference from a reference color), as defined by ASTM D2244, *Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates*. AAMA 2605 recommends a maximum change of 5 ΔE for acceptable performance after weathering exposure.

Blistering. A phenomenon marked by the appearance of bubbles on the surface. Blisters can occur as separations between the coating and substrate or within the coating material itself. Blistering is evaluated by ASTM D714, *Standard Test Method for Evaluating Degree of Blistering of Paints*. Depending on the accelerated test, acceptable performance is considered by AAMA 2605 to be formation of none or few blisters.

In addition to the deterioration mechanisms above, additional qualities of the coating can be evaluated for indications of material performance. These qualities include the following items.

Adhesion. The strength or tenacity of the bond of the coating to the substrate. For thin films, the test methods in ASTM D3359, *Standard Test Methods for Measuring Adhesion by Tape Test*, provides a qualitative measure of adhesion. AAMA 2605 recommends that no loss of film adhesion should be measured after accelerated testing with heat, humidity, salt spray, or chemical application.

Specular Gloss. The relative luminous reflectance factor of a specimen in the mirror direction. Specular gloss is measured with a defined angle and refers to the ratio of light reflected from a specimen relative to a standard surface. Gloss is evaluated by ASTM D523, *Standard Test Method for Specular Gloss*, and a minimum retention of 50 percent is recommended by AAMA 2605 after weathering exposure.

Description of Proposed System

The current conceptual design for the canopy calls for a system of coated aluminum panels to form the surface of the topside and underside of the canopy. The topside panels are attached directly to aluminum tees, which are in turn connected to the galvanized superstructure below. We understand that MMA is considering water-tight and weather-barrier systems for the topside of the canopy. The water-tight system was considered the primary design and reviewed in detail for this report. Alternatively, a weather-barrier system could be considered but was not completely vetted for this report.

Two revisions of a detail for the aluminum panel system have been transmitted by MMA for review. The first shows a single layer of panels with a lapped joint and to-be-determined fastener system (Figure 2). The fasteners could be exposed (such as a rivet) or concealed. The second detail shows a double layer of topside panels (Figure 3). The first layer has lapped joints and to-be-determined fasteners. A waterproofing membrane is shown between the first and second layer. No joints are shown for the second layer. Based on conversations with MMA, we understand the first detail (single layer of panels) is intended for the panels on the underside of the canopy, and the second detail (double layer with membrane) is intended for use on the topside.

The relevant materials chosen for the panel system have been described as follows:

- Panel material: ASTM B209, *Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate*, aluminum alloy 5454 marine-grade with magnesium content between 2.4 and 3.0 percent.

CANOPY PERFORMANCE MEMO (continued)

- Coating: Fluoropolymer coating with minimum 70 percent polyvinylidene fluoride-based PVDF resin (e.g. Kynar 500 or Hylar 5000). The system is currently designated as a two-coat system, with total thicknesses of 1.2 mils (1 mil = 0.001 inches) for extrusions and 1.6 mils for coil-coated products.
- Tertiary structure (aluminum tees): Marine-grade high corrosion resistance aluminum. No alloy has been designated. Most architectural extrusions are either aluminum alloy 6061 or 6063. For the purpose of this review, aluminum alloy 6061 (higher strength than 6063) has been assumed.
- Fasteners less than 1/2-inch diameter: Marine-grade series aluminum. No alloy designation has been specified.

The steel superstructure supporting the panels consists of the following general elements:

- Open-web steel joists spaced approximately 6 feet on-center support the aluminum tees. The open-web steel joists are approximately 3 feet in depth.
- A series of curved, built-up steel box sections, identified as raker beams, support the joists. These sections are similarly approximately 3 feet in depth.
- The supporting columns are rolled steel sections encased in concrete. The concrete encasement is intended to provide both stiffness and corrosion protection to the steel member.
- A series of HSS tube sections, identified as kickers, will be used to add lateral stability to the structure. Unlike the columns, these steel sections are not intended to be encased in concrete.

Exposure Conditions at the Pier

The new pier is situated in a difficult environment for building material performance. The climate on the Florida Gulf Coast (high humidity, high heat, high UV exposure) and the marine environment of Tampa Bay combine to reduce performance of organic materials (such as coatings) and increase corrosion rates of metals. To gauge the impact of this environment on the canopy, the climate, insolation, atmospheric composition, and surrounding seawater were tabulated.

The pier is located in a segment of Tampa Bay identified as Middle Tampa Bay. The water in this portion of the bay varies slightly in composition due to the influx of freshwater from rivers inland. The salinity of the water is generally around 26000 mg/l, which is slightly less than the 36000 mg/l in the adjacent Gulf of Mexico. This salinity is considered to be heavily brackish or nearly seawater.

The southern latitude of St. Petersburg combined with the high annual percentage of sunshine results in a high degree of insolation (i.e. UV exposure). The standard outdoor weathering test for organic coatings in AAMA 2605 is described as a "South Florida Exposure", located south of latitude 27 degrees North. The actual test site for many films tested according to this method is located south of Miami, Florida, approximately 10 miles from the coast. The UV exposure and hours of sunlight for St. Petersburg is nearly equal to that of the standard "South Florida Exposure" (Marion and Wilcox 1994).

ISO 9223, *Corrosion of Metals and Alloys - Corrosivity of Atmospheres - Classification, Determination, and Estimation*, provides a framework for categorizing the corrosivity of atmospheric environments, based on site temperature, humidity, pollution by sulfur dioxide, and airborne salinity (chloride deposition). These characteristics form the basis for defining corrosion ratings for materials ranging from C1 (low) to C5 (high). Applicable site characteristics were determined for the Pier location and are provided in Table 1. The ISO 9223 framework depends on knowledge of chloride deposition rates, which are highly variable and localized along a coast. Because the actual chloride deposition rate for the Pier is unknown, an estimated range was used for this evaluation. Based on the range of values, corrosion categories ranging from C3 to C5 are likely appropriate for assessing the risk of corrosion for carbon steel, zinc, and pure aluminum materials at the Pier. Another standard, ISO 9224, *Corrosion of Metals and Alloys - Corrosivity of Atmospheres - Guiding Values for the Corrosivity* Categories, provides estimated material corrosion rates for the first 10 years and then after 10 years for carbon steel, zinc, and pure aluminum. For reference, these rates are provided in Table 2.

The federal government has commissioned multiple studies to compare corrosion rates for metals on many of the military bases around the country. The environmental corrosivity at MacDill Air Force Base, located across the Bay, has been categorized in these studies. Although the test sites for the base are located on land (and not over water like the pier), the data is useful for considering the environment of the pier. One program, commissioned by the U.S. Air Force to develop an Environmental Severity Index, included test data for aluminum and steel corrosion rates at air force bases across the country (Abbott 1999). Steel and aluminum and corrosion rates at MacDill AFB were the third and fourth highest, respectively, out of almost fifty sites included in the study. Another report developed by the U.S. Army Corps of Engineers for materials selection ranked sites based on a corrosion severity index, with corrosion rates scaled relative to the most corrosive air force base in the country (i.e. corrosion rate at the most corrosive site was 100). The indices for MacDill AFB were as follows (Myers, Kumar and Stephenson 2002):

- Zinc: 27
- Aluminum: 27
- Steel: 71
- Copper: 40

Considering these environmental parameters and studies, the exposure at the Pier location will be very aggressive for corrosion of metals and deterioration of organic coatings.

EXPECTED PERFORMANCE OF PROPOSED MATERIALS

Coated Aluminum Panels and Tertiary Aluminum Supports

The aluminum elements of the canopy are subject to two main deterioration mechanisms: 1) corrosion and 2) coating failure. The performance history of fluoropolymer coatings, expected resistance of aluminum to corrosion in marine environments, and potential deterioration relative to the service life of the aluminum canopy elements are presented herein.

Coating Performance History

Fluoropolymer coatings, specifically polyvinylidene fluoride-based (PVDF) coatings, are the highest performing coatings available for architectural aluminum products. PVDF coatings cover a broad category for aluminum; they can be specified relative to a range of typical standards (e.g. AAMA 2603, 2604, or 2605), be applied as powder or liquid coatings, be applied with multiple layers, and have a range of film thicknesses. All of these factors influence the effective durability of the coating system.

PVDF coatings have been used for more than 30 years on commercial and architectural structures. Blends of coatings with 70 to 80 percent by weight PVDF with 20 to 30 percent by weight acrylic resin are used to obtain the best weatherability. Although the PVDF polymer is very resistant to UV radiation, the acrylic component of the resin is the "weak link" and is the first to deteriorate. Color fading and chalking occur gradually, as material is progressively lost from the near-surface regions (Wood 2005).

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As described above, AAMA 2605 provides the most stringent standards for this class of coatings. To meet AAMA 2605 requirements, the coatings must pass a series of weathering tests. These include: 4000 hours of accelerated weathering via salt spray (ASTM B117, *Standard Practice for Operating Salt Spray (Fog) Apparatus*); 4000 hours of accelerated weathering with high heat and humidity (ASTM D2247, *Standard Practice for Testing Water Resistance of Coatings in 100% Relative Humidity*, or D4585, *Standard Practice for Testing Water Resistance of Coatings Using Controlled Condensation*), and outdoor weathering in a South Florida Exposure for a minimum of 10 years. It should be noted that although the South Florida exposure is the most similar to the environment of the pier (high heat, humidity, and sunlight exposure), it does not have the chloride exposure expected for the Pier's elements.

Various studies have been performed for painted or coated aluminum specimens exposed to marine environments. One of these studies compared the performance of a number of different coating systems and metal substrates in marine environments. Overall, coated aluminum and coated stainless steel specimens exhibited the best performance. In addition, a two-coat PVDF aluminum system outperformed a single-coat PVDF system (King and O'Brien 1995; King and Norberg 2000). Another study compared the performance of various coil-coated products and identified PVDF coatings as having excellent weathering performance in comparison to other coatings (polyurethanes and polyesters); furthermore, PVDF-coated aluminum had the lowest corrosion rate for all materials tested after 5 years of outdoor exposure. The author postulated that the materials would perform well for 20 years or more (Tiemens 1998).

Overall, these studies show that PVDF-coated aluminum performs well in atmospheric marine exposures. Determining the specific service life for the PVDF-coated panels intended for the Pier is difficult, due to the variations in formulation, coating thickness, and substrate tested in the available literature; however, the studies do indicate that multi-coat, PVDF systems over aluminum should be expected to provide the best performance.

Aluminum Corrosion Resistance in Marine Environments

Although aluminum generally offers good corrosion resistance due to its rapidly-forming and stable oxide surface layer, corrosion resistance of aluminum in marine atmospheres is highly dependent on the choice of alloy. For sheet metal applications, 5xxx-series alloys are highly corrosion-resistant and typically considered suitable for marine exposure. For architectural extrusions, 6xxx-series are typically used; although still often used for marine exposure, they are somewhat less corrosion resistant than the 5xxx-series alloys.

Weathering data from a long-term ASTM exposure program started in 1958 compared the relative corrosion resistance of a number of alloys to an outdoor seacoast exposure (Davis 1999, p. 124). The program categorized both uniform corrosion and pitting corrosion on various aluminum alloys. Results for aluminum alloys 5454-H34 and 6061-T6 in this study are shown in Table 3. The outdoor exposure found that pitting corrosion has an initial, rapid rate (up to 4 mils per year), and then slows dramatically to 0.11 mil per year or less in a seacoast environment.

Unlike steel, aluminum corrosion tends to be more localized and does not occur uniformly across the specimen area. Consequently, estimating strength loss based on mass loss alone would underestimate the effective strength loss in the element. Two long-term seacoast exposure test programs have been performed by ASTM for multiple aluminum alloys (Davis 1999, pp. 138-139). Based on this data, the tensile strength loss for aluminum alloy 5454 was 0.5 to 1.5 percent after 7 years, and the tensile strength loss for aluminum alloy 6061-T6 was 4 to 8 percent after 10 years. Longer-term test data for other aluminum alloys indicates that the loss rate typically slows after the first 5 to 10 years.

Potential for Deterioration of Canopy Elements

The service life of the panels can be considered for both serviceability and structural integrity concerns. The most critical (and visible) aspect of serviceability is aesthetic and related to the coating integrity. A secondary serviceability concern would be leaks through panels creating unsightly stains. In contrast, aesthetic deterioration for the hidden elements (e.g. second layer panels or tertiary aluminum tees) is not considered to be detrimental to the service life of the structure.

The primary concern for structural integrity is unacceptable strength loss of the panels or supporting components due to corrosion. For example, the capacity of the aluminum panels would be degraded in its ability to resist wind pressure if uniform corrosion reduces the effective material strength. Likewise, the capacity of the fasteners would be reduced if crevice corrosion reduces the cross-section of the fastener. Corrosion for the panels or supporting elements may initiate where these elements are either directly exposed to the marine atmosphere, where leaks penetrate through the canopy, and, to a lesser extent, where condensation forms on the canopy interior.

The aluminum components are susceptible to uniform corrosion, pitting corrosion, filiform corrosion, crevice corrosion, and galvanic corrosion in a variety of locations. A summary of the potential locations of each of these types of corrosion and some mitigation strategies, relative to the conceptual design of the panel system, is provided in Table 4. These service life concerns are discussed separately for serviceability-related and structural integrity-related concerns below.

Serviceability

One serviceability concern relates to deterioration of the PVDF coating on the aluminum panels. The PVDF coating on the aluminum panels is subject to chalking and fading over time. This type of deterioration occurs first at the surface of the coating. This deterioration is initially aesthetic but can expose the aluminum substrate after sufficient weathering. This surface deterioration could be addressed over time by recoating the panels to restore the topcoat appearance and functionality.

In addition to the chalking and fading, blistering or filiform corrosion is a potential for the thin-film PVDF coating. Because this primarily occurs at defect locations (i.e. holidays or breaks in the coating), this concern could be mitigated by quality control and assurance measures, such as using a high-voltage holiday detector. This would ensure adequate coating installation and would include repair of defects as part of the fabrication and installation process.

Another serviceability concern relates to leakage through the panels. With a water-tight roof, the topside panels are expected to offer protection to the interior superstructure from corrosion. As long as this interior is kept relatively dry, the risk for corrosion of the superstructure elements greatly decreases. Leakage through the topside is most likely to occur at the following locations by the following processes.

- *Fastener Penetrations*. The proposed membrane in the topside panel systems may have some ability to self-seal around small penetrations; the ability of most membranes to seal is limited where holes are drilled through the membrane for larger fastener installation (such as rivets or screws). The leakage potential at these locations can be limited by wet sealing all fasteners (i.e., embedding the fasteners in sealant or fresh coating during installation). Alternatively, concealed fasteners could be

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used, limiting the direct access of water to the potential leak location. Conceptual considerations for concealed fasteners are further addressed in the Discussion and Expected Service Life for Canopy Elements section below. With proper detailing, leakage through fasteners can be eliminated as a serviceability concern for the design service life.

- *Expansion Joint Leakage.* Expansion or movement joints should be considered as potential locations for leaks in a waterproofing system. Daily thermal cycles fatigue the joint systems and eventually lead to failure. However, replacement of joint sealants at expansion joint locations can be considered and designed as a routine maintenance item. Depending on the joint detail, expansion joints may remain water-tight for 10 to 15 years before replacement or re-sealing is needed. By designing for easy maintenance of expansion joints, this serviceability concern can be mitigated for the design service life.
- *Panel Penetration by Pitting Corrosion*. Even though the aluminum alloy selected for the canopy roof is highly resistant to atmospheric corrosion in marine environments, slow corrosion will occur where the metal is exposed. The service life of the panel (relative to through-thickness pitting) can be extended by providing a barrier coating (such as the coating described above) or providing a sufficiently thick material. To conservatively estimate the water-tightness of the panel to pitting corrosion penetrations, the panel coating can be assumed to be ineffective. Considering pitting depth rates of 4 mils per year for 10 years, following by pitting depth of 0.11 mils per year, an expected pitting depth at 75 years would be 47 mils, or slightly less than 1/16 inch. Because this thickness is less than one-third of the overall section depth, panel penetration by pitting corrosion is not likely to be a serviceability concern for the design service life.

Structural Integrity

Structural integrity of the aluminum panels and tertiary aluminum elements can be considered to be controlled by two criteria: corrosion of the bulk material and corrosion of the fasteners. As long as the exposed aluminum is sufficiently protected by the organic coating, no corrosion is expected for the underlying metal; however, corrosion is possible for elements that remain uncoated and for the underlying metal if the surface coating has deteriorated. With those considerations, the service life of the main aluminum elements could be conservatively estimated relative to their corrosion rates in an uncoated condition. Potential locations where structural integrity is affected by corrosion are described as follows:

- *Strength Loss for Panels and Tees.* Long-term uniform corrosion of these elements would result in overall effective strength loss. For the aluminum panels and supporting aluminum tees, a loss in structural capacity can be considered relative to the loss in material tensile strength. To obtain the design service life, the section thickness could be “oversized” to account for potential material loss. Based on the data referenced previously for the long-term exposures on the coast, annual rate of tensile strength loss can be calculated. Assuming a linear rate of loss of the tensile strength, the strength reductions after 75 years of exposure are minimal:
  - Aluminum alloy 5454 (panels): 16 percent
  - Aluminum alloy 6016-T6 (tees): 30 to 60 percent
- *Corrosion at Exposed Fasteners*. The exposed fasteners are vulnerable to corrosion from moisture leaking from the topside between the rivet and panel penetration. Additionally, moisture could be trapped between the panel joints along the rows of fasteners. Both of these moisture sources could result in crevice corrosion at the fastener. Crevice corrosion can result in very rapid deterioration, and so potential crevice corrosion should be eliminated at the design stage. For the panel connections, this

potential can be reduced by sealing the crevice to prevent moisture ingress or by modifying connection geometry to use concealed fasteners.

- *Corrosion at Lapped Joints*. Because the laps provide a load path for attachment of the panel, corrosion in these areas presents a structural integrity concern. The lapped joints present similar crevice corrosion issues to the exposed fasteners, because moisture will be wicked into the joint due to surface tension. This crevice corrosion location could be eliminated by creating an intentional gap between panel surfaces and sealing the opening with an elastomeric or gasket-like material.
- *Corrosion at Dissimilar Metal Connection*. Potential for galvanic corrosion exists at the connection between the aluminum tees and the galvanized superstructure. Because corrosion rates for dissimilar metals can cause section loss at the fastener location, galvanic corrosion should be prevented by design detailing. The conceptual design shows insulators between the two types of metals, which will reduce the risk of a galvanic couple. Additionally, keeping the dissimilar metal connections dry will also reduce the risk of this type of corrosion.

Steel Elements of Superstructure

The steel elements of the structure are subject to deterioration by corrosion. The current design includes protection of the steel elements by galvanizing, coating, or encapsulating in concrete. With the exception of the steel columns, the primary protection for most of the steel elements is currently intended to be galvanizing. A background and performance history of galvanizing in marine environments, along with potential deterioration relative to the canopy elements, is discussed in the following sections.

Description of Galvanizing Process

Galvanizing is a widely used corrosion protection strategy. It protects the steel substrate by isolating the steel from the environment and provides sacrificial cathodic protection to the steel if the barrier coating of zinc is damaged or breached. Zinc is anodic compared to steel, which means the zinc metal will preferentially corrode to protect the underlying base steel.

Hot-dip galvanizing is the process of immersing fabricated steel into a bath, or kettle, of molten zinc. The most common specification for the control of hot-dip galvanizing is ASTM A123, *Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products*. The zinc bath chemistry consists of at least 98 percent pure zinc and is governed by ASTM B6, *Standard Specification for Zinc*. The zinc is maintained slightly above its melting point at approximately 830 degrees F. The steel is immersed in the bath long enough such that when the steel is heated, a multilayer zinc alloy is metallurgically bonded to the steel substrate. The galvanizing coating typically consists of three distinct layers of zinc, varying between 94 and 75 percent zinc. Prior to galvanizing, the steel surface is treated by a series of degreasing, acid pickling, and fluxing to clean the steel, remove all mill scale, and prevent any iron oxides from forming prior to galvanizing.

Zinc, like all metals, will corrode when exposed to the environment; however, unlike steel, zinc forms a natural patina of zinc oxide, zinc hydroxide, and zinc carbonate in a normal wetting and drying environment. The patina helps slow the corrosion rate of the underlying zinc.

Performance of Galvanizing in Marine Environments

Galvanizing has been used for over 250 years to protect steel in corrosive environments. According to the American Galvanizers Association (AGA), because of the low rate of corrosion associated with zinc,

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galvanized elements have been protected from corrosion for 50 to 75 years in many environments (Langill 2003). The performance of galvanized structures has been documented by corrosion-rate studies, which have been used to develop models for evaluating service life.

The corrosion rate for zinc was determined experimentally in a number of environments and the data was published in ASTM STP435, *Metal Corrosion in the Atmosphere* (1968). Based on the available data, the corrosion rate varied between 0.004 and 0.08 mils per year in rural environments, 0.04 to 0.16 mils per year in urban environments, 0.04 to 0.4 mils per year in industrial environments, and 0.03 to 0.4 mils per year in marine environments. Thus, for the corrosion rates associated with marine environments, the required range of the galvanizing thicknesses to achieve a 75-year service life varies between 3 and 30 mils. The large variation indicates that the local conditions significantly impact the behavior of the galvanized steel.

The corrosion rate for zinc varies greatly because it depends on a number of environmental conditions. For instance, the corrosion rate has been correlated to the amount of water vapor in the air (relative humidity), deposition of sulfur dioxide (SO_2), deposition of salts (NaCl), amount of rain, time of wetness, temperature, and many other factors. Because those environmental conditions can vary by location, anticipated corrosion rates should be adjusted to consider the local environment for the intended structure.

A number of service life models have been developed to predict the life of galvanized steels in atmospheric environments. The generalized approach based on published information developed by the AGA is the most common and describes the service life as a function of coating thickness in typical environments (Figure 4). The most applicable environment for the pier is the tropical marine environment; however, because environmental conditions in Mazatlan, Mexico, Cancun, Mexico, and Miami, Florida, were used to define the tropical marine environment, actual corrosion rates at the Pier location may vary. With those considerations, the average required galvanizing thickness to achieve a 75-year service life based on the published AGA graphs ranges between 4 and 8 mils (Langill 2003). Each graph published by the AGA varies slightly depending on the input parameters used to develop the graph.

An alternate corrosion rate can be estimated using the methods in ISO 9223 and 9224 described previously. These methods account for the local values for time of wetness, chloride deposition rate, and sulfur dioxide concentration. As shown in Table 2, the corrosion rate may be 0.07 to 0.4 mils per year for the first 10 years and 0.16 to 0.4 mils per year afterwards. Using values in the mid-point of these rates, the required galvanizing thickness is 20 mils for a 75-year service life.

A third method was also used to estimate the corrosion rate of galvanizing. The program is called the *Zinc Coating Life Predictor* and is offered on the International Zinc Association website (Zhang 2002). The program estimates the zinc service life based on six parameter inputs: amount of rain, relative humidity, temperature, chloride concentration, sulfur dioxide concentration, and time of exposure. Because many other factors affect service life, including wind direction, frequency drying, alloy composition, surface orientation, etc., the average error using the program is approximately 36 percent (Zhang 2002). The program calculates the service life that corresponds to 5 percent corrosion on the steel surface. Using average local conditions at the Pier (Table 5), the corrosion rate estimated by the *Zinc Coating Life Predictor* is 0.13 mils per year, the equivalent of a 9.3-mil galvanizing thickness for a 75-year service life.

Impact of Galvanizing Thickness

The expected service life of the system is directly correlated to the thickness of the galvanizing. An increase in the galvanizing thickness will result in an increased service life as a thicker protective barrier will result in increased protection against abrasion, wear, and damage. Furthermore, an increase in the amount of zinc will result in a larger sacrificial anode when a galvanic cell develops between the zinc and the steel.

The applied thickness of galvanizing is controlled primarily by the surface condition and chemical composition of the steel, namely the silicon and phosphorous content. Other factors, such as temperature and time in the bath and withdrawal rate, only moderately affect the galvanizing thickness. Additional galvanizing cannot be applied by re-dipping the steel into the bath, because the zinc alloy that forms on the steel has a higher melting temperature than the zinc bath. For these reasons, the thickness of galvanizing cannot be specified in the same method as an organic coating (American Galvanizers Association 2012).

ASTM A123 provides minimum average coating thicknesses based on the steel thickness of the member being galvanized. For structural steel shapes and plates greater than or equal to 1/4 inch thick, the minimum average galvanizing thickness is 3.9 mils. ASTM A123 states that the specified thicknesses represent "the minimum value obtainable with a high level of confidence" and "while most coating thicknesses will be in excess of these values…some articles may have a coating grade at or close to the minimum requirement." Typically, if a galvanizing thickness heavier than the ASTM A123 minimum is required, the galvanizing must be coordinated between the galvanizer and the purchaser at special request.

Based on the *Zinc Coating Life Predictor*, the expected service life for a 4-mil galvanizing was calculated to be 33 years, which is less than the desired 75-year service life. The 4-mil galvanizing is likely a conservative lower bound assumption as most galvanizing will be in excess of the 3.9-mil minimum established by ASTM A123. To extend the service life of the galvanized steel, additional protection methods are prudent, as discussed in the following section.

Impact of Coating over Galvanizing

As the technology for more sophisticated coating systems has improved in recent decades, coating over hot-dipped galvanized steel, known as a duplex system, has become more common to provide enhanced corrosion protection in aggressive environments and also for aesthetic reasons. Using a duplex system can extend both the service life of the coating and the galvanizing. The topcoat system provides an additional barrier coating to protect the galvanizing from the environment. When the topcoat system is breached, filiform corrosion of the top coating system is reduced by the presence of the zinc galvanizing, which mitigates the spread of corrosion by galvanic protection of the steel and prevents blistering or peeling of the topcoat system. Published data suggests that that the overall service life of a duplex system may be 1.5 to 2.3 the sum of the individual systems (Zamanzadeh, et al. 2006; American Galvanizers Association Specifier's Guide 2012).

Coating over galvanizing requires particular attention to the surface preparation of the galvanized steel to ensure that the applied coatings achieve sufficient adhesion to the galvanized substrate. Special pretreatments, such as alkaline cleaners, zinc-phosphate treatments, and/or acrylic passivation, may be required to properly prepare the galvanizing before top coating. ASTM D6386, *Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting*, describes methods of preparing surfaces of new and weathered hot-dip galvanized steel for

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painting. Upon completion of the cleaning, the galvanized surface will also be roughed to create an anchor profile to increase bond of the coating system. Care must be taken to not remove excess zinc during the profiling. Communication between the fabricator, specifier, galvanizer, and painter is essential prior to galvanizing the steel. The galvanizer must be aware that the steel will be top coated to avoid any processes, such as passivation, that may interfere with the coating. Surface inclusions, such as dross and skimming particles, should also be removed prior to coating.

The coating system itself must also be compatible with the galvanizing. Certain coating systems, such as alkyds, do not adhere well to the galvanizing. The alkaline zinc surface causes the alkyds to saponify, causing premature peeling of the coating. Typical coating systems that work well with galvanizing include zinc-rich paints, latex-acrylics, polyamide cured epoxies, and aliphatic polyurethanes (Zamanzadeh, et al. 2006).

Case studies of long-term exposure of different coating systems over galvanizing have shown that a polyamide cured epoxy with an aliphatic polyurethane topcoat provides the best corrosion protection when exposed to simulated laboratory test environments (Zamanzadeh, et al. 2006). The samples received between 2,000 and 3,500 hours of salt spray exposure in accordance with ASTM B117 and 3,000 hours of immersion in an acidic chloride solution. The samples were also tested for cathodic disbondment in accordance with ASTM G8, *Standard Test Methods for Cathodic Disbonding of Pipeline Coatings*.

Polyamide-cured epoxies, because of their excellent alkali resistance, typically have excellent adherence to a properly prepared galvanized surface. Because epoxies are not resistant to sunlight, they are typically used with a UV-stable paint, such as an aliphatic polyurethane topcoat. The polyurethane topcoat also has superior weathering and abrasion resistance. These galvanizing-epoxy-polyurethane systems have been identified as providing significant increases in service life when compared to stand alone galvanizing. As part of a life-cycle evaluation for moderate environmental exposures, galvanizing-epoxy-polyurethane systems had a practical service life of 84 years, compared to 33 years for stand-alone galvanizing (Hensel 2007). The moderate environment was defined as "urban and industrial atmospheres, areas with moderate sulfur dioxide pollution, and coastal areas with low salinity." Although the conditions at the Pier may be considered more aggressive than the previous definition, the significant increase in service life should be expected when considering duplex coating systems compared to stand-alone galvanizing. Although these systems typically have higher initial costs when compared to other coating systems or stand-alone galvanizing, they often have the lowest life cycle cost due to the increased service life (Hensel 2007).

Laboratory Testing and Analysis

For this project, laboratory testing may be used to evaluate performance of selected materials, coatings, or mock-ups of assemblies. Laboratory testing is often used to provide information about how a given material system will perform in service. Laboratory testing includes a variety of test methods/approaches, including artificial weathering intended to simulate exposures to certain environments and the evaluation of coatings for thickness and composition. While none of these tests can be used directly to predict performance, the results can be compared to published information to gain an indication if service life is anticipated to be satisfactory. For reference, a selected listing of standardized accelerated weathering tests and evaluation methods is provided in Appendix A.

Accelerated Weathering

The suitability of a materials system for use in a given environment is often tested using laboratory accelerated weathering tests. These tests involve exposing specimens to salt fog, ultraviolet light, high humidity, high temperature, or a combination of these. Accelerated weathering tests typically do not provide a direct correlation to anticipated lifetime in service, typically because the in-service conditions (ultraviolet exposure, temperature and temperature variations, salt exposure, exposure to industrial pollutants, etc.) vary substantially from location to location. The choice of appropriate accelerated weathering method(s) depends on ultimate selection of material type (for example, painted vs. unpainted), information available on in-service performance, and performance in accelerated weathering tests.

Salt Fog

In general, salt fog testing involves exposing a set of specimens to an atomized salt solution at elevated temperature. Several standard test methods exist, which vary in the type of salt used, including sodium chloride, simulated sea salt, and sodium chloride/ammonium sulfate mixtures; the temperature of exposure; and the degree of cycling between temperatures and salt fog and dry conditions. These methods are intended to provide relative rankings of materials, both uncoated metallic and coated metallic specimens to harsh conditions that relate, to some degree, to marine exposure. After exposure, the specimens are evaluated for degree of corrosion. Because continuous salt fog testing does not allow for wet-dry cycles, these accelerated tests may negatively impact the performance of hot-dip galvanized steel because the zinc patina is not able to form on the galvanized coating.

Ultraviolet Exposure

Ultraviolet exposure is typically performed in conjunction with condensation to evaluate the synergistic effect of both environmental factors on organic (carbon-chain) materials, particularly in painted metal. Ultraviolet radiation does not adversely affect metals and is not necessary for unpainted metal elements. Ultraviolet radiation can cause chemical changes in paint systems that leads to alteration and breakdown. The presence of moisture can cause swelling and other chemical changes in some paint systems. Each exposure affects paints in different ways and the effects of alternating ultraviolet exposure and condensation can lead to substantially more degradation than each exposure alone. Several standard exposure cycle conditions are provided in ASTM test methods. After exposure, specimens are evaluated for color change, coating thickness, coating degradation (blistering, flaking, scaling, chalking, etc.), and/or corrosion of the underlying metal substrate.

Combined Salt Fog and Ultraviolet Exposure

For painted metal specimens, the effects of the ultraviolet and condensation exposure on the paint and salt exposure on the metal substrate can cause a greater degree of damage than either alone. For this reason, testing can be combined where painted metal specimens are alternated between ultraviolet/condensation and salt fog exposures.

Comparison to Outdoor Exposures

Outdoor exposures of test coupons, either at the intended service site or at standard outdoor weathering sites, provide significant information about performance of a particular materials system. Historically, exposure tests have been performed in seacoast, industrial, urban, and rural environments. Kennedy Space Center on Florida’s east coast has a beach weathering site available. Data has indicated that the corrosion at this site is significantly greater than a similar (but now-closed) beach weathering site at Kure Beach, North Carolina. It has been speculated that exhaust from rocket launches affects the corrosion rate at the Kennedy Space Center site. A standard South Florida test site is available south of Miami, but is not considered a marine environment because it is 10 miles from the coast.

Outdoor exposures have the advantage of providing actual exposure conditions, where the effects of sun, rain, dryness, and sea salt (if located near a coast) act synergistically on the material specimens; however,

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outdoor exposure tests have two main drawbacks. The first drawback is that the variability between environments (distance from breaking waves for a sea site as well as angle of incidence to the sun, direction of exposure, etc.) means that the results from a given exposure site do not provide a direct correlation with anticipated service life in a different location. This can be alleviated by conducting exposure tests at the site of interest; however, the other main drawback to outdoor exposure testing is the duration required to provide meaningful results. Standard test methods typically recommend a minimum 2- to 10-year exposure, which is not feasible with a typical construction schedule.

Evaluation Tools

The effect of accelerated weathering tests can be evaluated in multiple ways. Methods for evaluating effects on metallic specimens (including galvanized steel) without an organic paint coating are different from those used to evaluate painted metal specimens.

Metal Specimens. Metal specimens are typically evaluated by removing corrosion product and calculating the weight loss as a result of corrosion from the accelerated weathering test. Degree of pitting can also be measured visually, microscopically and with localized metal thickness measurements.

Painted Specimens. Painted specimens are typically evaluated for the effect on the coating, particularly of ultraviolet exposure. Painted specimens can be evaluated for cracking, blistering, chalking, checking, debonding, compositional differences, and color change within the paint system. Certain evaluation methods can be performed at periodic intervals during accelerated weathering tests to determine the degree of degradation with duration of exposure.

General Coating Evaluation

Coatings applied to metal substrates, including paints or zinc galvanizing layers, should be evaluated to confirm thickness and composition. The following paragraphs provide a summary of test methods:

Coating Thickness. Coating thickness can be measured destructively or non-destructively. Destructive methods involve the substrate being sectioned or coating partially removed and the number of layers counted and thickness measured. This may be the most suitable for coatings with multiple layers. Non-destructive methods rely on an instrument that interacts with the substrate electrically or ultrasonically, from which the coating thickness is measured. These techniques have the advantage of being non-destructive, but the results can be difficult to interpret on coatings of multiple layers.

Coating Composition. The composition of a coating can be determined microscopically or using a chemical technique such as Fourier transform infrared spectroscopy (FTIR). Metal coatings, such as zinc galvanizing coatings, are best analyzed microscopically. Examining a polished cross-section can aid in confirming whether the zinc was applied using a hot-dip or other method. Elemental analysis using scanning electron microscopy with energy dispersive x-ray spectroscopy (SEM/EDS) can confirm that the layer is zinc, with minor quantities of other elements. Organic coatings, such as paint, are best analyzed for composition using FTIR.

Electrochemical Methods

Electrochemical methods are suitable for evaluating corrosion resistance and corrosion rate of metal specimens. Of particular interest for coated metal specimens is electrochemical impedance spectroscopy (EIS). EIS provides information about the ability of a coating to protect a substrate from corrosion, and the test can be run rapidly (within a few minutes). EIS testing requires that the portion of the specimen being tested is immersed in an electrolyte medium (such as a diluted salt solution). For this reason, EIS does not attempt to simulate atmospheric exposure. EIS can be performed periodically during the course of accelerated weathering tests. The data can be compared to data obtained on the specimens pre-exposure, and degradation of the coating may be detected prior to other methods.

DISCUSSION AND EXPECTED SERVICE LIFE FOR CANOPY ELEMENTS

Specific recommendations for the panel and superstructure elements are discussed in further detail below. Elements are identified where the desired service life can be reasonably attained with the current conceptual design. Recommendations are made for alternatives to improve performance where the expected service life is less certain.

Aluminum Panel Elements

Based on our review of the conceptual design for the panels, the expected service life of the coating is 20 to 30 years. This is primarily because the coating is key to the waterproofing of the system (particularly for the exposed fasteners) and is likely to be the first component to degrade. With a few modifications as discussed in the sections below, the expected service life of the coating system could be extended to 40 years or more.

In terms of anticipated performance for the canopy, all the different elements (e.g. coatings, rivets, panels, waterproofing membrane, etc.) of the proposed aluminum panel system should be considered as a whole. The system plays a critical role in protection of the supporting steel superstructure. If leaks develop through the panel system, the corrosion risk for the underlying elements increases. Because the water-tightness of the system is only as good as its weakest element, maintenance or replacement of the elements with the shortest expected life will be necessary to maintain water-tightness of the system as a whole.

Fluoropolymer Coating System

Review of available literature shows that PVDF-coated aluminum offers the best performance available for atmospheric marine exposure of coil-coated products. These studies have indicated that service lives of 20 years may be expected for standard-performing products of this type; consequently, the use of thicker films and multiple coats would likely extend the coating service life. With these improvements, the coating service life may be extended to 20 to 30 years before weathering effects are apparent. After weathering-related deterioration has occurred, the panels may be recoated with a new PVDF topcoat to restore their appearance and extend their service life.

Top Panel Detail Anchorage and Waterproofing

A conceptual detail of the connection between the top aluminum panel and the steel superstructure was provided for review. The detail showed a to-be-determined fastener system, either exposed or concealed, to be installed flush through two shingled aluminum panels, a waterproofing membrane, an aluminum sub-panel, and the aluminum “T” tertiary structure (Figure 3).

If an exposed fastener system is selected for the panel attachments, we recommend that a strip of EPDM be installed between the shingle-lapped aluminum panels and that butyl sealant be applied at all fastener penetrations. Installation of EPDM will create a gasket-like effect as rivets are installed, which will minimize the potential for water infiltration. Additionally, EPDM strips will prevent wind-driven water penetration at lap joints and prevent coating damage due to material rubbing between successive

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aluminum panels. Installation of butyl sealant will also prevent water infiltration at penetrations through the waterproofing membrane.

Because each exposed fastener represents a potential pathway for leakage through the canopy, long-term performance of this approach is dependent on the sealing provided by the sealant or coating installed with the fastener. The exposed fasteners also have the potential for crevice corrosion between the fastener and metal panel and filiform corrosion of the adjacent coating. The expected time before leakage through these fasteners is likely similar to the expected lifetime of the coating system. For the proposed rivets, we also recommend that any thickness limitations for the fastener are verified, because the current assembly appears to be over 1-inch in thickness.

Concealed or hidden fasteners for the panel attachments would avoid the potential deterioration associated with exposed fasteners and are recommended. This would likely involve fabrication of custom, interlocking extrusions or clips. These clips may be installed from the topside of the structure, and then covered by lapping the next panel over the joint (similar to a cleated flat-lock seam). It is possible that the waterproofing membrane and backup panels could be eliminated by this method, because the combination of panel laps and interlocking clips would provide a water-tight system. This method limits the number of penetrations through the panels, which benefits both the coating (limiting potential for filiform corrosion), fasteners (limiting potential for crevice corrosion), and underlying superstructure (limited leakage pathways).

With regard to the waterproofing membrane, we recommend use of a high-temperature waterproofing membrane, such as Grace Ultra, that is capable of withstanding increased aluminum panel surface temperatures due to solar radiation. We expect the integrity of waterproofing membrane to last longer than the coating system above, because the primary deterioration mechanism for this type of membrane is UV exposure. If the design of the waterproofing membrane accommodates thermal movement and associated damage from the panel system, the expected service life of the membrane will be extended. Nonetheless, the waterproofing membrane will likely need to be replaced at least once in a 75-year service life.

Bottom Panel Detail Drainage

For the detail at the bottom panel, we recommend that a method be developed for drainage of unintended moisture accumulation within the canopy structure due to leakage and/or condensation. One potential method to consider is to allow water to drain from joints between adjacent aluminum panels. This would require only a limited opening size because joints are spaced frequently and would therefore be responsible for drainage of a very small tributary area.

Ventilation

Proper air circulation will minimize the potential for condensation in the void space. As such, we recommend that the space within the canopy structure be adequately ventilated. In concept, this can be accomplished by introducing vents at the bottom and top edges of the canopy to promote air movement. It may also be worthwhile to discuss this topic with the mechanical engineer on the design team (particularly if a portion of this space is considerably larger) to determine if mechanical ventilation is recommended.

Exterior Drainage

It is our understanding that details related to exterior drainage systems (built-in gutters, downspouts, etc.) are currently being developed. We will be able to comment on these systems when details are provided.

Maintenance

Maintenance for the aluminum panel system is necessary to ensure serviceability over its 75-year design life and is similar to reroofing requirements for building structures. Considering the conceptual design and the deterioration mechanisms identified, a summary of potential maintenance items has been provided in Table 6. These items may include the following:

- Fresh water rinses for coated surfaces. This would be performed to remove salt build-up on the coating surface. Depending on the actual coating selected for the aluminum panels, this may be required as part of a warranty.
- Cleaning drains to remove debris. This is necessary to ensure that drainage paths are working as designed.
- Replacement of expansion joint seals. Depending on the specific detail for the expansion joints, removal and replacement of these seals may be necessary.
- Recoating aluminum panels. This item may be necessary as the coating degrades in the marine exposure, both for aesthetic reasons and to minimize leaks through exposed fasteners.
- Replacement of waterproofing membrane. To replace the waterproofing membrane, the panels will need to be uninstalled and then reinstalled. During this maintenance, select panels may need to be replaced due to localized damage.

Superstructure Elements

Currently, galvanized steel is proposed for the superstructure elements, which include the columns, girders, joists, and bracing elements. According to ASTM A123, the minimum average thickness of galvanizing that is obtainable with a high level of confidence will be approximately 4 mils for structural elements with a thickness greater than 1/4 inch. Using estimates for the exposure conditions at the site of the Pier based on similar environments, a 4-mil galvanizing thickness will result in a 30- to 40-year service life. Therefore, a duplex system (organic coating over galvanizing) is recommended to achieve the desired 75-year service life. As discussed above, the synergistic effects of the coating and galvanizing will result in an increased service life of approximately two times the sum of the individual systems. A conservative estimate of a 15-year service life for a stand-alone epoxy-polyurethane coating system will likely result in a net total service life of approximately 75 years (1.5 x (35 + 15) = 75 years). By galvanizing and then applying a coating system, the superstructure elements will likely reach the desired 75-year service life of the structure given proper design, installation, and maintenance of the system is achieved. Proper preparation of the galvanizing and application of the coating systems must be performed. Inspection and quality control testing during application of the galvanizing and coating system will help ensure a successful duplex system is installed.

Based on the design concepts reviewed to date, the superstructure framing is hidden behind the aluminum panel systems. The aluminum panel system, if properly designed, installed, and maintained as described above, will help mitigate corrosion of the superstructure elements within the aluminum panels and provide for additional long-term durability of the structure. Accordingly, significant maintenance is not expected with a water-tight canopy; however, if select panels are removed or the waterproofing membrane is replaced as part of maintenance to the canopy, the superstructure elements could be

CANOPY PERFORMANCE MEMO (continued)

inspected for localized areas of corrosion. As required, the localized areas should be addressed by performing touch up and repair of the polyurethane top coat, epoxy mid-coat, and/or galvanizing. By repairing the local areas, the service life of the structural elements can be extended beyond 75 years. Repairs to the galvanizing should be performed in accordance with ASTM A780, *Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings*.

If elements such as waterproofing and adequate ventilation are not properly designed or maintained, the environmental conditions within the aluminum panel system may become more aggressive than the exterior environment, resulting in the potential for higher relative humidity, localized ponding of water, and the potential for salt deposits as the moisture evaporates during drying. These conditions would result in a decreased service life of the superstructure elements. Depending on the functional performance of the aluminum panel system, one or two maintenance re-coats may be required within the desired 75-year service life.

Although no specific connection or design details were provided to WJE for the superstructure elements, these details will have a significant impact on the success and feasibility of installing a duplex galvanizing system and will impact the overall corrosion performance of the system. Localized areas requiring touch up repairs and maintenance will largely be determined by the detailing incorporated in the final design. Additional concerns for specific superstructure elements are discussed below.

General Detailing Practices

ASTM A385, *Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip)*, provides general design recommendations to ensure the flow of cleaning solutions, fluxes, air, and zinc during the galvanizing process. The following presents a summary of the pertinent detailing recommendations:

- All fabricated assemblies should be designed with vent and drain holes such that no air is entrapped during immersion.
- Free flow of cleaning solutions and zinc should be provided for in the assemblies of hot-rolled shapes by cropping the corners of all stiffeners, gussets, or bracing with a minimum opening of 0.3 square inches.
- Tubular assemblies should be properly vented.
- In box sections where gusset plates are used, the gusset plates should be clipped at the four corners. A center hole shall also be provided. Gusset plates should not be spaced closer than 36 inches apart.
- The shaft of columns with closed end plates should be vented.
- Weld flux should be removed at the time of fabrication.
- Shearing, cutting, and punching should be in accordance with ASTM A143, *Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement*.

Additional design details should be considered to ensure proper application is feasible for the top coating system and improve the corrosion performance of the structure. The following is a summary list of design details that should be taken into consideration for the coating application:

- In general, the structure should be kept as simple as possible and reduce the surface area to be coated as small as practical.
- Edges and corners should be ground smooth and an additional stripe coat be specified.
- Skip-welded areas should be seal-welded in order to prevent crevice areas.

- Field welding should not be performed at shop-applied coating surfaces.
- Interior surfaces that cannot be coated (e.g. interior built-up boxes) should have openings sealed to prevent water intrusion.

In some instances, the general recommendations to ensure high-quality hot-dip galvanizing are in conflict with the general recommendations for proper coating application. For example, venting of a tube or box section is required for proper galvanizing but presents a challenge for coating application as the exposed interior of the member will be difficult to coat. The specifics of each of these scenarios should be evaluated as the specific design details become finalized.

Steel Columns Encased in Concrete

Because concrete will absorb contaminants, i.e. chlorides, from marine environments, the concrete must be properly designed to mitigate corrosion of any embedded ferrous elements, including the reinforcing steel and the steel columns. For the column elements, multiple methods can be used to add corrosion resistance and service life. These may include some or all of the following, which can be considered as the column design progresses:

- Surface coatings
- Low-permeability concrete
- Increased cover depth
- Corrosion-resistant reinforcing (galvanizing, epoxy-coated, or stainless)
- Cathodic protection (e.g. arc-sprayed zinc)

When galvanized steel without a passivation layer is embedded into concrete, there is a chance of a reaction between the zinc metal and the water in the concrete that will release small quantities of hydrogen gas which could compromise the concrete surface. This can be avoided by allowing embedded galvanized elements to weather for a few weeks prior to placement.

Open-web Steel Joists

The proposed open-web steel joists present certain difficulties from a coating perspective. Some of these problems include a high amount of surface area, numerous joints, and the difficulty with coating back-to-back angles or channels. The space between the back-to-back angles is nearly impossible to properly clean, and it is extremely difficult to adequately apply a coating to such a deep crevice. A potential design alternate for back-to-back angles would be the use of a WT steel shape, although this may require a custom truss design in lieu of prefabricated joists. If feasible from a design perspective, simple structural steel shapes should be considered rather than open-web steel joists. A life-cycle cost analysis, including the service-life implications, should be considered to evaluate the feasibility of open-web steel joists and structural steel shapes.

Alternative Materials and Methods

In addition to the proposed coated aluminum, other material choices are possible for the panel elements. Two possibilities, precast reinforced concrete and stainless steel, are discussed below. A monolithic concrete system is also discussed as an alternative to the galvanized steel for the canopy superstructure. Finally, the influence of water-tight and weather-barrier systems on the service life of the canopy elements is discussed.

CANOPY PERFORMANCE MEMO (continued)

Precast Reinforced Concrete

We understand a cast-in-place reinforced concrete system was originally envisioned for the canopy; however, cost, serviceability, and weight concerns compelled the design team to consider a metal system. If service life concerns related to the coating cannot be satisfied by the aluminum panels, reinforced-concrete should be re-considered as a panel material.

Precast concrete panels could be used for the canopy skin. The panels would likely be thin, modular pieces, similar in dimension to the aluminum panels, and on the order of 3 inches thick. The concrete could be either lightweight or normal weight, depending on structure loading requirements. To obtain the desired service life, a combination of low-permeability concrete and corrosion-resistant reinforcing would be used. For the thin element, the corrosion resistant reinforcing would likely be stainless steel mesh or fiber-reinforced polymer (FRP) material.

Because concrete acts like a sponge and absorbs water, one inherent drawback of the concrete surface is eventual growth of and discoloration by biofilms. To limit this growth, activated titanium-dioxide cements have been used, which feature a lighter-colored surface and self-cleaning ability (Barbesta and Schaffer 2009). This cement was developed in Europe and has recently been made available to the US market. Although the titanium-dioxide cement has benefits, it has limited documented long-term performance.

WJE has developed an in-house model for estimating the expected service life for corrosion in reinforced concrete. The model uses probabilistic models to estimate the probability of corrosion for different design considerations, including cover, concrete design, and environmental conditions. This model could be used to assist in verification of service life for these reinforced concrete elements.

Stainless Steel

Stainless steels provide good resistance to corrosion with little evidence of corrosion products; however, design limitations of the material may limit its use in the canopy structure. For instance, specialty grades of stainless steel must be specified when the material is exposed to marine environments. In addition, to maintain a clean appearance in a corrosive environment, a smooth finish is needed. Stainless steel also requires special provisions when welding to retain corrosion resistance at welded locations.

If the stainless steel panels are coated with an organic paint, little inherent advantage is obtained over aluminum panels because the organic coating is subject to the same demands and limitations. Consequently, we would only recommend exploring the stainless steel alternative if the panels are used in an uncoated condition.

Monolithic Reinforced Concrete

As an alternative to galvanized steel, a monolithic concrete system could be reconsidered for the canopy superstructure. Reinforced concrete structures have been utilized along coastal regions with success for many years, although construction cost and weight considerations could limit their use at the Pier site. To reach the desired service life, a combination of surface coatings, low-permeability concrete, corrosion-resistance reinforcing (galvanized, FRP, stainless steel, or epoxy-coated), increased cover depth, and cathodic protection could be considered. The expected service life could then be estimated using the WJE in-house probability models.

The use of concrete for the superstructure would create secondary concerns for the design of the canopy. For instance, a concrete superstructure would increase the weight of the entire structure, which would necessitate a larger foundation and increase the required footprint of the canopy; however, techniques such as lightweight concrete and reduced sections could be employed. In addition, construction of a monolithic system might be difficult considering it is located on the water. Finally, surface spalling of the concrete becomes a safety concern if corrosion of the reinforcement occurs in the superstructure.

As discussed above, one inherent drawback of a concrete superstructure is the eventual growth of and discoloration of elements by biofilms. Low-permeability concrete or titanium-dioxide cements can be used to minimize growth of biofilms; however, once biofilms have developed, the surface condition remains, impacting the overall aesthetic appearance of the canopy.

Water-tightness of Canopy

Whether a water-tight roof or a weather-barrier system is used for the topside of the canopy will impact the expected service life of the canopy elements. With a water-tight roof, and assuming the canopy is properly ventilated, the atmospheric conditions that promote corrosion of the superstructure elements and connections will be less severe than if the elements were directly exposed to the atmosphere. As such, the service-life of the superstructure will be longer with a water-tight system than without one; however, a water-tight roof will require periodic maintenance of the aluminum panel assemblies, including the waterproofing membrane (Table 6), which would be expected of typical roofing systems in a marine environment.

With a weather-barrier system, the waterproofing membrane is eliminated and leakage of some water would be expected. If leakage occurs and the canopy is not properly ventilated or drained, the superstructure elements could be exposed to more severe atmospheric conditions, such as a higher relative humidity and deposition of salts from moisture evaporation, and lead to increased corrosion. As such, the drainage and ventilation systems will have to be carefully detailed to ensure that water and debris cannot accumulate at the superstructure elements. Additionally, the design of the connections of the superstructure elements requires more attention to eliminate possible crevices than if the roof were water-tight. Because these systems impact the performance of the superstructure, the drainage and ventilation systems will require periodic maintenance. The weather-barrier system could also require more periodic inspection and maintenance to the superstructure elements and connections as compared to a water-tight system.

CONCLUSIONS

The proposed St. Petersburg Pier is confronted with challenging environmental conditions and a demanding expectation of service life. The canopy is comprised of two primary systems, the supporting superstructure and the canopy structure. Each of these principal systems is comprised of many materials and connections. In general, the service life of each combined system will be limited to the weakest link of that particular system. As such, to reach a 75-year service life for the entire structure, the owner should be prepared with a thorough maintenance program while recognizing elements within the system will require replacement within the anticipated service life. Some elements will likely have to be replaced over the life of the structure. In addition, the design and construction teams should be advised that service lives of this magnitude require careful detailing in design and comprehensive quality control during construction.

CANOPY PERFORMANCE MEMO (continued)

To date, only conceptual drawings have been developed. As with many projects, the details themselves will likely influence the service life longevity. At this time there are many unknowns; however, the details should be developed with the same thought process as with the systems we have addressed herein. In a marine environment, water is a destructive force that must be considered and addressed; accordingly, the details should be designed to shed water and avoid crevices that can promote corrosion. Connectivity and integration of systems will also require significant attention. To ensure that these objectives are realized, third party peer review is encouraged throughout the design process.

The construction of each part of the canopy is an important consideration on the service life performance of the structure. For instance, though a component might be properly detailed, the service life can be limited if coating systems are not properly applied. From application of galvanizing and coating procedures to material handling to final placement, there is the potential for nicks and scratches in the coating, which compromises the entire protection scheme. As such, a higher level quality control and quality assurance is mandatory to ensure the design integrity is realized during each phase of the construction process.

Based on our understanding of the project requirements stated herein, the owner and the design team should understand that thorough maintenance of each system is required to ensure the project service life goals are realized. The aluminum panel system and this system's ability to mitigate water infiltration are key to the service life of the galvanized steel superstructure. As such, it is likely that the panels and panel assemblies will require reroofing maintenance, as detailed in Table 6, over the expected service life of 75 years. During maintenance, select panels may also need to be replaced due to localized damage. Additionally, the coating system may need to be re-applied to the superstructure when panel assemblies are replaced to ensure continued performance. Nonetheless, a 75-year service life is achievable with careful detailing, sound construction, and thorough maintenance.

WORKS CITED

AAMA. *2603: Voluntary Specification, Performance Requirements, and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels.* Schaumberg: American Architectural Manufacturers Association, 2002.

—. *2604: Voluntary Specification, Performance Requirements, and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels.* Schaumberg: American Architectural Manufacturers Association, 2010.

—. *2605: Voluntary Specification, Performance Requirements, and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.* Schaumberg: American Architectural Manufacturers Association, 2011.

Abbott, W.H. "Corrosion Monitoring of Air Force Field Sites." *AM026020.* Tri-Service Corosion Conference, 1999.

American Galvanizers Association. *Frequently Asked Questions: Can I Specify How Much Zinc to Put on Steel?* n.d. http://www.galvanizeit.org/about-hot-dip-galvanizing/what-is-hot-dip-galvanizing/faq/#26 (accessed April 9, 2013).

—. "Hot-Dip Galvanizing for Corrosion Protection: A Specifier's Guide." 2012. http://www.galvanizeit.org/images/uploads/publicationPDFs/Galvanized_Steel_Specifiers_Guide.pdf?tracked=yes (accessed April 9, 2013).

ASTM. *A123: Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.* West Conshohocken: ASTM International, 2012.

—. *A143: Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement.* West Conshohocken: ASTM International, 2007.

—. *A385: Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip).* West Conshohocken: ASTM International, 2011.

—. *A780: Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.* West Conshohocken: ASTM International, 2009.

—. *B117: Standard Practice for Operating Salt Spray (Fog) Apparatus.* West Conshohocken: ASTM International, 2011.

—. *B209: Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.* West Conshohocken: ASTM International, 2010.

—. *B6: Standard Specification for Zinc.* West Conshohocken: ASTM International, 2013.

—. *D2244: Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates.* West Conshohocken: ASTM International, 2009.

—. *D2247: Standard Practice for Testing Water Resistance of Coatings in 100% Relative Humidity.* West Conshohocken: ASTM International, 2011.

—. *D3359: Standard Test Methods for Measuring Adhesion by Tape Test.* West Conshohocken: ASTM International, 2009.

—. *D4214: Standard Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films.* West Conshohocken: ASTM International, 2007.

—. *D4585: Standard Practice for Testing Water Resistance of Coatings Using Controlled Condensation.* West Conshohocken: ASTM International, 2007.

—. *D523: Standard Test Method for Specular Gloss.* West Conshohocken: ASTM International, 2008.

—. *D6386: Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting.* West Conshohocken: ASTM International, 2010.

—. *D662: Standard Test Method for Evaluating Degree of Erosion of Exterior Paints.* West Conshohocken: ASTM International, 1993.

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—. *D714: Standard Test Method for Evaluting Degree of Blistering of Paints.* West Conshohocken: ASTM International, 2002.

—. *G8: Standard Test Methods for Cathodic Disbonding of Pipeline Coatings.* West Conshohocken: ASTM International, 2010.

Barbesta, M, and D Schaffer. "Concrete that Cleans Itself and the Air." *Concrete International*, February 2009: 31-33.

Bitcon, J.C, and S. G. Russo. *Modification of the Geographic Corrosivity Index and Its Application to Overseas Bases.* Australia: Maritime Platforms Division, 2008.

Davis, J. R. *Corrosion of Aluminum and Aluminum Alloy.* ASM International, 1999.

Hensel, J L. "Practical Considerations for the Life Cycle Evaluation of Zinc Rich Coatings, Galvanized Steel and Thermal Sprayed Metals for Industrial Structures in Moderate Environmental Exposures." *The Society for Protective Coatings.* 2007.

ISO. *9223: Corrosion of Metals and Alloys -- Corrosvity of Atmospheres -- Classification, Determination, and Estimation.* International Organization for Standardization, 2012.

—. *9224: Corrosion of Metals and Alloys -- Corrosivity of Atmospheres -- Guiding Values for the Corrosivity Categories.* International Organization for Standardization, 2012.

King, G. A., and D. J. O'Brien. "The Influence of Marine Environments on Metals and Fabricated Coated Metal Products, Freely Exposed and Partially Sheltered." In *Atmospheric Corrosion, ASTM STP 1239*, by W. W. Kirk and H. H. Lason, 167-192. 1995.

King, G. A., and P. Norberg. "A Methodology for Quantifying the Atmospheric Corrosion Performance of Fabricated Metal Products in Marine Environments." In *Marine Corrosion in Tropical Environments, ASTM STP 1399*, by S. Dean, G. Delgadillo and J. Bushman. 2000.

Langill, T. *Predicting the Service Life of Galvanized Steel.* May 29, 2003. http://thefabricator.com (accessed April 1, 2013).

Marion, William, and Stephen Wilcox. *Solar Radiation Data Manual for Flat-Plate and Concentrating Collectors.* National Renewable Energy Laboratory, 1994.

Meira, G. R., and et al. "Modeling sea-salt transport and deposition in marine atmosphere zone - a tool for corrosion studies." *Corrosion Science*, 2008: 2724-2731.

Myers, J. R., A. Kumar, and L. D. Stephenson. *Materials Selection Guide for Army Installations Exposed to Severely Corrosive Environments.* Engineer Research and Development Center: US Army Corps of Engineers, 2002.

Poor, Noreen D, et al. "Tampa Bay Atmospheric Deposition Study (TBADS)." Final Interim Report, 2000.

Pribble, J. R., and A. J. Janicki. *Atmospheric Deposition Contributions to Nitrogen an Phosphorus Loadings in Tampa Bay.* Interim Data Report, Tampa Bay Estuary Program, 1999.

Wood, K. "The advantages of networking." *European Coatings Journal*, 2005: 48-55.

Zamanzadeh, M, G T Bayer, G Kirkwood, and C Kempkes. "Using Electrochemical Impedance Spectroscopy to Evaluate Corrosion Behavior of Painted Galvanized Steel in Atmosheric and Soil Exposure." *Paint and Coatings Expo.* 2006.

Zhang, X G. *Zinc Coating Life Predictor.* 2002. http://www.galvinfo.com:8080/zclp/index.html (accessed April 4, 2013).

TABLES

Table 1. Average Environmental Parameters for Tampa Bay

Parameter	Value	Units	ISO 9223 Classification
Sulfur dioxide deposition rate [1]	10-11	mg / m^2 day	P1
Chloride deposition rate [2]	100-1000	mg / m^2 day	S2 or S3
Time of wetness [3]	3593	hr	T4
	41	percent of year	
Annual precipitation [4]	50	in. / yr.	N/A
Temperature [4]			
Annual mean	73	F	
Summer: average high	90	F	
Summer: average low	70	F	
Winter: average high	70	F	
Winter: average low	55	F	

[1] Value obtained from (Poor 2000)
[2] Actual loading rate may vary widely, depending on local conditions. Range estimated based on values from (Meira and et al 2008).
[3] Value obtained for MacDill AFB from (Bitcon and Russo 2008).
[4] Weather data obtained from www.wunderground.com

Table 2. ISO 9223/9224 Material Corrosion Category and Rates [1]

Material	Corrosion Category	Corrosion rate, first 10 years (µm/yr)	Corrosion rate, after 10 years (µm/yr)
Carbon steel	C4 to C5	12 to 100	6 to 90
Zinc	C4 to C5	2 to 10	4 to 10
Aluminum (99.5% pure)	C3 to C5	0.025 to 0.20 [2]	0.020 to 0.20 [2]

[1] Rain protected but atmospherically exposed surfaces in marine environments become concentrated with chlorides and may have much higher corrosion rates than freely exposed surfaces.
[2] Values provided for corrosion Category C3. For Categories C4 and C5, because localized corrosion effects (e.g. pitting) may dominate, average rates are not provided.

Table 3. Corrosion Resistance of Aluminum Alloys in Seacoast Exposure [1]

Alloy	Corrosion rate, mil/yr (uniform)	Maximum depth of attack in 7 years (pitting), mils	Average depth of attack in 7 years (pitting), mils	Loss of tensile strength
Alloy 5454-H34	0.014	4.1	1.2	0.5 to 1.5 percent over 7 years
Alloy 6061-T6	0.017	3.9	1.7	4 to 8 percent over 10 years

[1] Data from (Davis 1999)

CANOPY PERFORMANCE MEMO (continued)

Table 4. Aluminum Panel Corrosion Concerns and Mitigation Techniques

Element	Corrosion Mechanism	Serviceability		Structural Integrity	
		Concern	Potential Mitigation Techniques	Concern	Potential Mitigation Techniques
Coated panel (exposed surface)	Pitting	Water leakage through deep pits	- Protective coating - Adequate material thickness	Loss of material section at fastener locations	- Use concealed fasteners - Seal fastener penetrations
Coated or uncoated panels	Uniform			Loss of material strength	- Protective coating to prevent corrosion - Provide additional material thickness
Uncoated tees	Uniform			Loss of material strength	- Provide additional material thickness
Crevice corrosion	Lap joints between panels	Water leakage through joint	- Allow water to drain from crevice - Seal cavity to prevent water intrusion		
Fastener locations	Crevice & Filiform	Water leakage through fastener hole	- Use concealed fasteners - Seal fastener penetrations	Loss of capacity at fastener from section loss in fastener	- Use concealed fasteners - Seal fastener penetrations
Lapped joints	Crevice corrosion			Section loss in lapped area	- Provide gasket or stand-off between panel surfaces
Dissimilar metals	Galvanic corrosion			Loss of capacity from section loss in material	- Provide insulator between material surfaces - Keep connections dry

Table 5. Parameters for Zinc Coating Life Predictor

Parameter	Value
Sheltering condition	Open air
Rain	50 in./year
Salinity (Chlorides)	100 $mg/m^2/day$
Sulfur dioxide	10.5 $mg/m^2/day$
Relative humidity	80%
Temperature	73 F

Table 6. Anticipated Maintenance Intervals for Aluminum Canopy

Item	Anticipated Maintenance	Anticipated Interval
Drainage system	Cleaning drains to remove debris	6 months
Expansion joint seals	Removal and replacement	10 to 15 years
Panel coating	Fresh water rinses for coated surfaces	6 months
Panel coating	Recoat panels	20 to 30 years
Waterproofing membrane	Removal and replacement	30 to 40 years

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FIGURES

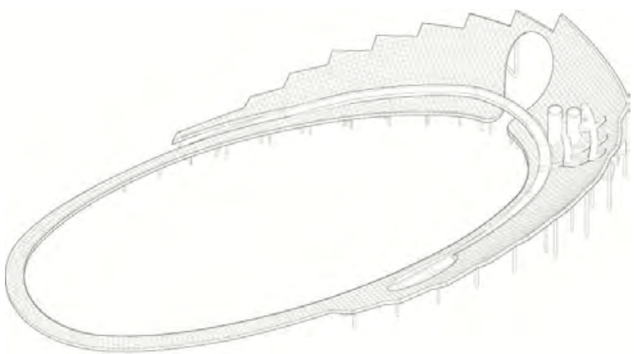

Figure 1. Axonometric of Proposed Canopy.

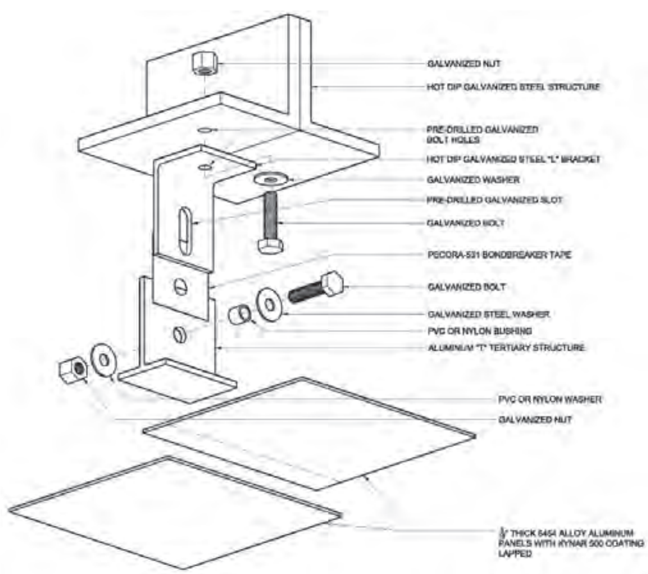

Figure 2. Single-layer aluminum panel detail intended for underside of canopy.

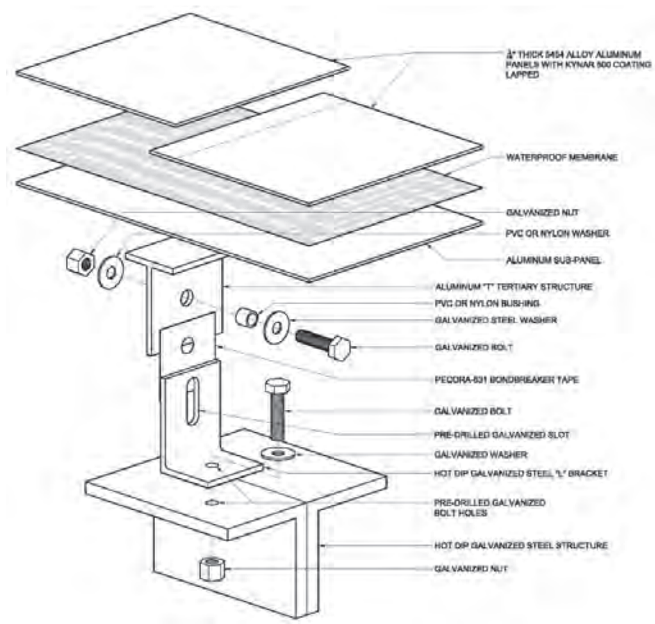

Figure 3. Double-layer aluminum panel detail intended for topside of canopy.

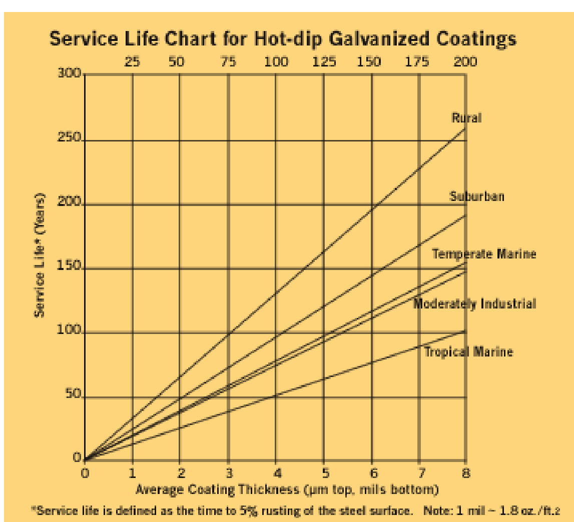

Figure 4. Service Life Chart (Langill 2003)

CANOPY PERFORMANCE MEMO (continued)

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Appendix A - Standard Test Methods for Accelerated Weathering and Material Evaluation Potential Test Methods

Several standard test methods are available to use to evaluate specimens. The selection of the appropriate methods will depend on the system(s) selected (for example, coating evaluation and ultraviolet accelerated weathering testing would not be needed for an uncoated metal such as stainless steel). Selection of methods will also depend on what information is available to relate material properties to anticipated lifetime. This information will be identified in a literature search to be performed after initial materials selection and prior to beginning laboratory testing.

A brief listing of potential ASTM test methods is provided below. Other non-standardized test and evaluation methods may also be appropriate.

Accelerated Weathering Tests

Salt Fog

- ASTM B117, *Standard Practice for Operating Salt Spray (Fog) Apparatus*
- ASTM G85, *Standard Practice for Modified Salt Spray (Fog) Testing*

Ultraviolet Exposure

- ASTM D4587, *Standard Practice for Fluorescent UV-Condensation Exposures of Paint and Related Coatings*
- ASTM G151, *Standard Practice for Exposing Nonmetallic Materials in Accelerated Test Devices that Use Laboratory Light Sources*
- ASTM G154, *Standard Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Nonmetallic Materials*

Combined Salt Fog and Ultraviolet Exposure

- ASTM D5894, *Standard Practice for Cyclic Salt Fog/UV Exposure of Painted Metal, (Alternating Exposures in a Fog/Dry Cabinet and a UV/Condensation Cabinet)*

Outdoor Weathering Tests

- AAMA 2605, *Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels*
- ASTM G50, *Standard Practice for Conducting Atmospheric Corrosion Tests on Metals*
- ASTM G7, *Standard Practice for Atmospheric Environmental Exposure Testing of Nonmetallic Materials*

Evaluation Methods after Weathering Tests

Metal Specimens

- ASTM G1, *Standard Practice for Preparing, Cleaning, and Evaluating Corrosion Test Specimens*
- ASTM G46, *Guide for Examination and Evaluation of Pitting Corrosion*

Painted Specimens

- ASTM D1654, *Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments*

CANOPY PERFORMANCE MEMO (continued)

- ASTM D610, *Practice for Evaluating Degree of Rusting on Painted Steel Surfaces*
- ASTM D659, *Method of Evaluating Degree of Chalking of Exterior Paints*
- ASTM D662, *Test Method for Evaluating Degree of Erosion of Exterior Paints*
- ASTM D714, *Test Method for Evaluating Degree of Blistering of Paints*
- ASTM D772, *Test Method for Evaluating Degree of Flaking (Scaling) of Exterior Paints*
- ASTM D3359, *Test Methods for Measuring Adhesion by Tape Test*
- ASTM D 4214, *Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films*
- ASTM E1347, *Test Method for Color and Color-Difference Measurement by Tristimulus Colorimetry*

General Coating Evaluation

Coating Thickness

- ASTM B487, *Standard Test Method for Measurement of Metal and Oxide Coating Thickness by Microscopical Examination of Cross Section*
- ASTM D1186, *Test Methods for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to a Ferrous Base*
- ASTM D1400, *Test Method for Nondestructive Measurement of Dry Film Thickness of Nonconductive Coatings Applied to a Nonferrous Metal Base*
- ASTM D6132, *Standard Test Method for Nondestructive Measurement of Dry Film Thickness of Applied Organic Coatings Using an Ultrasonic Gage*
- ASTM D4138, *Standard Practices for Measurement of Dry Film Thickness of Protective Coating Systems by Destructive, Cross-Sectioning Means*

Coating Composition

- ASTM E1252, *Standard Practice for General Techniques for Obtaining Infrared Spectra for Qualitative Analysis*

Electrochemical Methods

- ASTM G106, *Standard Practice for Verification of Algorithm and Equipment for Electrochemical Impedance Measurements*

CODE MEMO

March 8, 2013

Buro Happold

Tim Williams
Michael Maltzan Architecture, Inc.
2801 Hyperion Avenue, Studio 107
Los Angeles, California 90027

Re: St. Petersburg Pier
Construction Code Determination for Structural Design

Dear Tim:

Following my discussions with Tom Gibson, Director of Engineering and Capital Improvements at City of St. Petersburg, I am confirming the City's direction concerning governing structural codes for the St. Petersburg Pier project. The project will be designed to the Florida State Building Code (2010). The Promontory will be filed with the City of St. Petersburg Department of Buildings. The two bridge structures - the Over Water Drive and the Over Water Bridge - will not be submitted to the DOB, but will be reviewed by Mr. Gibson's group.

In addition, Mr. Gibson also would like assurances that the Over Water Drive and Over Water Bridge conform to key provisions of the Florida State Department of Transportation Structures Design Guidelines (January 2013) and appropriate AASHTO references, including the AASHTO LRFD Guide Specifications for Design of Pedestrian Bridges, 2nd Edition (December 2009). This would include the HS-20 loading specified in the BOD and the required AASHTO temperature range for expansion/contraction. As design proceeds we will develop separate calculations verifying these requirements for review by the City Engineering Department.

He also requested that appropriate details from FDOT design standards be incorporated into the bridge designs, in the interest of durability. We have already reviewed the new FDOT 2013 Design Standards and are selecting important components for the bridge structures.

Please confirm this understanding with the City. We are available to discuss with you at your earliest convenience.

Regards,

on behalf of Buro Happold Consulting Engineers, P.C.

Neil Porto, PE
Principal

Buro Happold Consulting Engineers, P.C.
100 Broadway
New York, NY 10005 USA

Telephone: +1 212 334 2025
Facsimile: +1 212 334 5528

SEA LEVEL RISE MEMO

April 15, 2013

Buro Happold

Tim Williams
Michael Maltzan Architecture, Inc.
2801 Hyperion Avenue, Studio 107
Los Angeles, California 90027

Re: St. Petersburg Pier
Incorporation of Sea Level Rise in Structural Design

Dear Tim:

The City of St. Petersburg Engineering Department has inquired about the Design Team's incorporation of provisions from possible sea level rise in the design of the St. Petersburg Pier project. The following is a summary of our approach:

Design Criteria for Sea Level Rise

The rate of sea level rise used in the McLaren wave study report was based on data obtained from the National Oceanic and Atmospheric Administration (NOAA) for St. Petersburg. This data is published online and updated yearly, located at:

(http://tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtml?stnid=8726520).

The rate of sea level rise established by NOAA for this site is 2.36 mm (0.1 inches) per year, amounting to approximately 10 inches of total sea level rise over 100 years. This increase in water level was taken into account in determining design water levels and design wave heights. The 100-year water level and 100-year storm surge water level were determined to be 5.76 feet NAVD and 5.75 feet NAVD, respectively. For design, the 100-yr water level of 5.76 feet NAVD was used.

Other sources, such as the 2011 USACE publication EC 1165-2-212 "Sea-Level Change Considerations for Civil Works Programs", consider the NOAA trend as a base trend which would then need to account for regional and global considerations. These regional and

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global considerations vary wildly between publications from no deviation on the NOAA baseline trend to values over 3 feet above the baseline.

There is a wide range of opinions and estimates regarding the rate of sea level rise, with estimates ranging from 10 inches to 40 inches for 100 years. Because there is not a consensus on these values, and research is still on going, the sea level rise trend as given by NOAA was used.

Calculation of Wave Forces and Levels

The current pier design has the lowest horizontal member of the deck approximately 6" above the 100 year wave crest elevation when we factor in the current NOAA sea level trends. This means that we have a built in freeboard of 6" for the sea level to rise without the need to account for wave forces.

Evaluation of FEMA 100-year Flood Plain

Applying the NOAA data to the schematic design, and adding the depth of the structural components of the Over Water Drive and Promontory, leads to a top of deck height of approximately 14.75’ (NAVD 88 datum). This is 6.75’ above the current FEMA flood plain of 8.0’ NAVD. Thus, in the Design Team’s professional opinion, which is backed by the Florida Building Code edition 2010, Florida Accessibility Code edition 2012 and all applicable codes not herein listed, we believe that the currently designed deck heights meet or exceed the currently known requirements established by the Federal Emergency Management Agency (FEMA) and its current Flood Insurance Rate Maps (FIRM) maps.

The project team contacted FEMA and they stated that revision of the FIRM maps for St. Petersburg is at a very early stage, with results not expected for another 3 to 5 years from now, well beyond the expected construction completion date of the new pier. We do not recommend waiting for final determination of the new FEMA flood levels, given that our top of deck will be 6.75’ above the current FEMA flood plain.

Please confirm this approach with the City. We are available to discuss with you at your earliest convenience.

Regards,

on behalf of Buro Happold Consulting Engineers, P.C.

Neil Porto, PE
Principal

A/E TEAM ORGANIZATIONAL CHART

CITY OF ST. PETERSBURG
ST. PETERSBURG, FL

PETE KARAMITSANIS
PROJECT ADVISOR / TAMPA, FL

MOFFAT & NICHOL ENGINEERS
ENVIRONMENTAL PLANNING / TAMPA, FL

MICHAEL HERRMAN

WILLIS CONSTRUCTION
OPERATING EXPENSE ANALYSIS / MAITLAND, FL

SKANSKA USA BUILDING, INC.
CONSTRUCTION MANAGER / TAMPA, FL

CHUCK JABLON
OPERATIONS VICE PRESIDENT

- BRIAN COAKLEY
  VICE PRESIDENT OF PRECONSTRUCTION
- SARAH VASCONI
  ASSISTANT PROJECT MANAGER

MICHAEL MALTZAN ARCHITECTURE, INC.
ARCHITECT OF RECORD / LOS ANGELES, CA

MICHAEL MALTZAN, FAIA
DESIGN PRINCIPAL

- TIM WILLIAMS
  PROJECT DIRECTOR
- HIROSHI TOKUMARU
  SENIOR TECHNICAL COORDINATOR
- NIEL PRUNIER, AIA, LEED AP
  PROJECT ARCHITECT
- SARAH BLAHUT
  PROJECT COORDINATOR
- ANDREW SMITH-RASMUSSEN
  JOB CAPTAIN

BURO HAPPOLD
SMEP, CIVIL, CODE CONSULTING / FIRE AND LIFE SAFETY ENGINEER
NEW YORK, NY / LOS ANGELES, CA

CRAIG SCHWITTER
PRINCIPAL IN CHARGE

- NEIL PORTO
  PRINCIPAL STRUCTURE
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- CARL KEOGH
  ASSOCIATE

MCLAREN ENGINEERING GROUP
MARINE STRUCTURAL / ORLANDO, FL

WANNEMACHER JENSEN ARCHITECTS, INC.
ASSOCIATE ARCHITECT / ST. PETERSBURG, FL

LISA WANNEMACHER
PRINCIPAL

- SEAN WILLIAMS, AIA, LEED BD+C
  PROJECT ARCHITECT

APPLIED TECHNOLOGY & MANAGEMENT
MARINA / GAINESVILLE, FL

ROBERT SEMMES
PRINCIPAL

PETE PETERSON
ENGINEER

JANICKI ENVIRONMENTAL
ENVIRONMENTAL CONSULTING / ST. PETERSBURG, FL

TONY JANICKI
PRESIDENT

- MIKE WESSEL
  VICE PRESIDENT

L'OBSERVATOIRE
LIGHTING DESIGNER / NEW YORK, NY

HERVE DESCOTTES
PRINCIPAL

- ALDRIN SODARTO
  PROJECT MANAGER
- SOCORRO SPERATI
  SENIOR LIGHTING DESIGNER

WISS, JANNEY, ELSTNER ASSOCIATES, INC.
MATERIAL TESTING AND ANALYSIS / NORTHBROOK, IL

CHUCK LAROSCHE
PRINCIPAL

- JONAH KURTH
  ASSOCIATE III
- STEPHEN FOSTER
  ASSOCIATE III
- JEREMIAH FASL
  ASSOCIATE II

COST SUMMARY

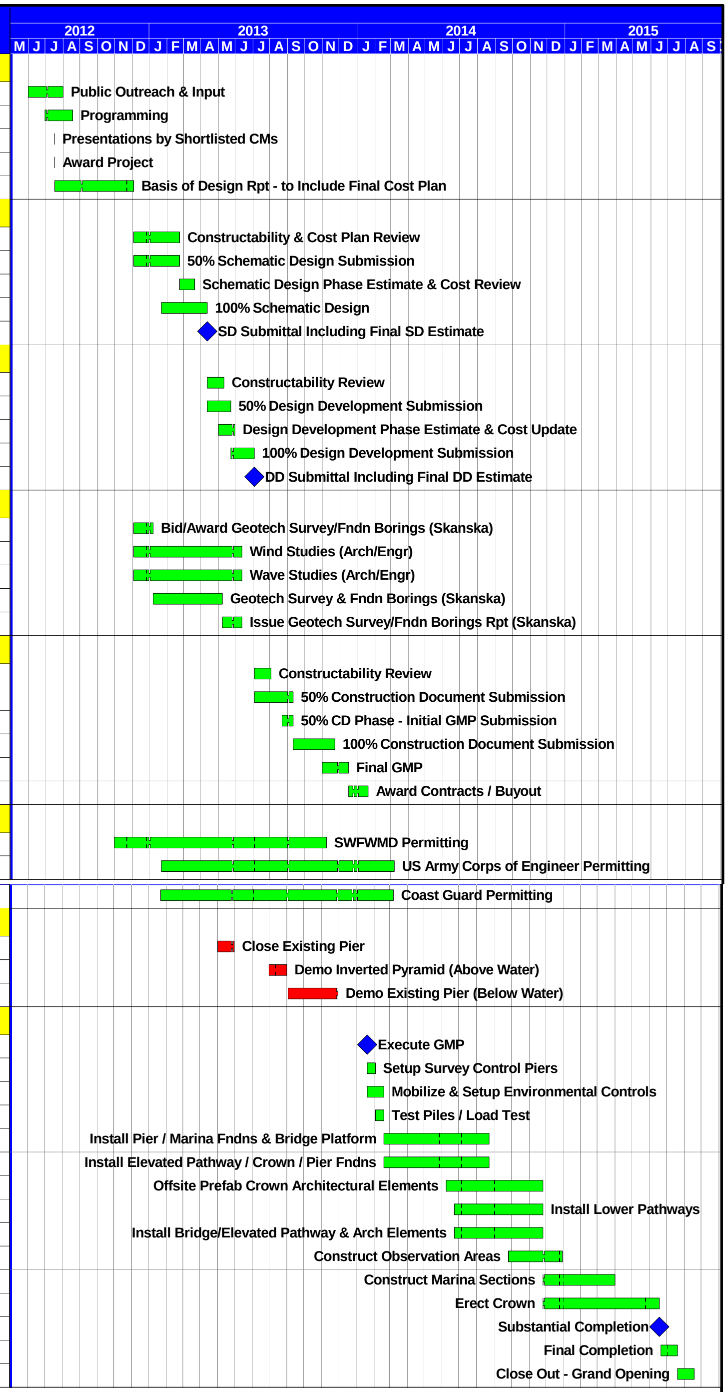
SKANSKA

4/24/2013

Index	Description	Quantity		Unit Cost	Amount
1	01 - General Requirements	2,920.00	LF	107.88	315,000
2	02 - Existing Conditions	2,920.00	LF	102.12	298,188
3	03 - Concrete	2,920.00	LF	2,868.52	8,376,074
4	04 - Masonry	2,920.00	LF	23.67	69,125
5	05 - Metals	2,920.00	LF	2,311.42	6,749,339
6	06 - Wood, Plastics, And Composites	2,920.00	LF	85.85	250,685
7	07 - Thermal And Moisture Protection	2,920.00	LF	1,670.20	4,876,978
8	08 - Openings	2,920.00	LF	3.22	9,389
9	09 - Finishes	2,920.00	LF	30.35	88,611
10	10 - Specialties	2,920.00	LF	32.61	95,211
11	12 - Furnishings	2,920.00	LF	9.86	28,777
12	13 - Special Construction	2,920.00	LF	500.98	1,462,875
13	14 - Conveying Equipment	2,920.00	LF	45.74	133,571
14	21 - Fire Suppression	2,920.00	LF	2.85	8,310
15	22 - Plumbing	2,920.00	LF	27.40	80,000
16	23 - Heating, Ventilating, And Air-Conditioning (Hvac)	2,920.00	LF	1.39	4,048
17	26 - Electrical	2,920.00	LF	745.87	2,177,935
18	27 - Communications	2,920.00	LF	92.98	271,499
19	28 - Electronic Safety And Security	2,920.00	LF	19.18	56,000
20	31 - Earthwork	2,920.00	LF	1,484.22	4,333,911
21	32 - Exterior Improvements	2,920.00	LF	239.34	698,872
22	33 - Utilities	2,920.00	LF	149.35	436,099
23	**TOTAL DIRECT CONSTRUCTION COST**	2,920.00	LF	10,554.96	30,820,497

PROJECT SCHEDULE

Activity ID	Activity Description	Dur	Start	Finish
Basis of Design Phase				
BD-0010	Public Outreach & Input	42	01JUN12*	31JUL12
BD-0020	Programming	34	02JUL12*	17AUG12
BD-1010	Presentations by Shortlisted CMs	1	17JUL12*	17JUL12
BD-1011	Award Project	1	18JUL12	18JUL12
BD-0060	Basis of Design Rpt - to Include Final Cost Plan	97	19JUL12	04DEC12
Schematic Design Phase				
SD-0020	Constructability & Cost Plan Review	55	05DEC12	21FEB13
SD-0010	50% Schematic Design Submission	55	05DEC12	21FEB13
SD-0030	Schematic Design Phase Estimate & Cost Review	20	22FEB13	21MAR13
SD-0040	100% Schematic Design	57	23JAN13	11APR13
SD-0050	SD Submittal Including Final SD Estimate	0		11APR13
Design Development Phase				
DD-0020	Constructability Review	21	12APR13	10MAY13
DD-0010	50% Design Development Submission	30	12APR13	23MAY13
DD-0030	Design Development Phase Estimate & Cost Update	20	03MAY13	31MAY13
DD-0040	100% Design Development Submission	28	24MAY13	03JUL13
DD-0050	DD Submittal Including Final DD Estimate	0		03JUL13
Geotechnical / Wind / Wave Studies				
SD-0015	Bid/Award Geotech Survey/Fndn Borings (Skanska)	22	05DEC12	07JAN13
SD-0065	Wind Studies (Arch/Engr)	132	05DEC12	11JUN13
SD-0070	Wave Studies (Arch/Engr)	132	05DEC12	11JUN13
SD-0025	Geotech Survey & Fndn Borings (Skanska)	88	08JAN13	09MAY13
SD-0035	Issue Geotech Survey/Fndn Borings Rpt (Skanska)	22	10MAY13	11JUN13
Construction Document Phase				
CD-0020	Constructability Review	21	05JUL13	02AUG13
CD-0010	50% Construction Document Submission	46	05JUL13	09SEP13
CD-0030	50% CD Phase - Initial GMP Submission	12	22AUG13	09SEP13
CD-0040	100% Construction Document Submission	53	10SEP13	21NOV13
CD-0050	Final GMP	32	01NOV13	17DEC13
CD-0051	Award Contracts / Buyout	22	18DEC13	20JAN14
Permitting				
SD-0055	SWFWMD Permitting	261*	01NOV12*	08NOV13
SD-0045	US Army Corps of Engineer Permitting	289	21JAN13*	07MAR14
SD-0060	Coast Guard Permitting	289	21JAN13*	07MAR14
Demolition Phase				
DE-0010	Close Existing Pier	22	01MAY13*	31MAY13
DE-0011	Demo Inverted Pyramid (Above Water)	27	03AUG13	30AUG13
DE-0012	Demo Existing Pier (Below Water)	63	03SEP13	29NOV13
Construction Phase				
CO-0010	Execute GMP	0	21JAN14	
CO-0022	Setup Survey Control Piers	10	21JAN14	03FEB14
CO-0021	Mobilize & Setup Environmental Controls	20	21JAN14	17FEB14
CO-0023	Test Piles / Load Test	10	04FEB14	17FEB14
CO-0024	Install Pier / Marina Fndns & Bridge Platform	132	18FEB14	22AUG14
CO-0026	Install Elevated Pathway / Crown / Pier Fndns	132	18FEB14	22AUG14
CO-0031	Offsite Prefab Crown Architectural Elements	120	09JUN14	25NOV14
CO-0025	Install Lower Pathways	110	23JUN14	25NOV14
CO-0027	Install Bridge/Elevated Pathway & Arch Elements	110	23JUN14	25NOV14
CO-0028	Construct Observation Areas	66	25SEP14	29DEC14
CO-0029	Construct Marina Sections	88	26NOV14	01APR15
CO-0030	Erect Crown	144	26NOV14	19JUN15
CO-0032	Substantial Completion	0		19JUN15
CO-0034	Final Completion	20	22JUN15	20JUL15
CO-0040	Close Out - Grand Opening	20	21JUL15	17AUG15



3

REPORT

INTRODUCTION

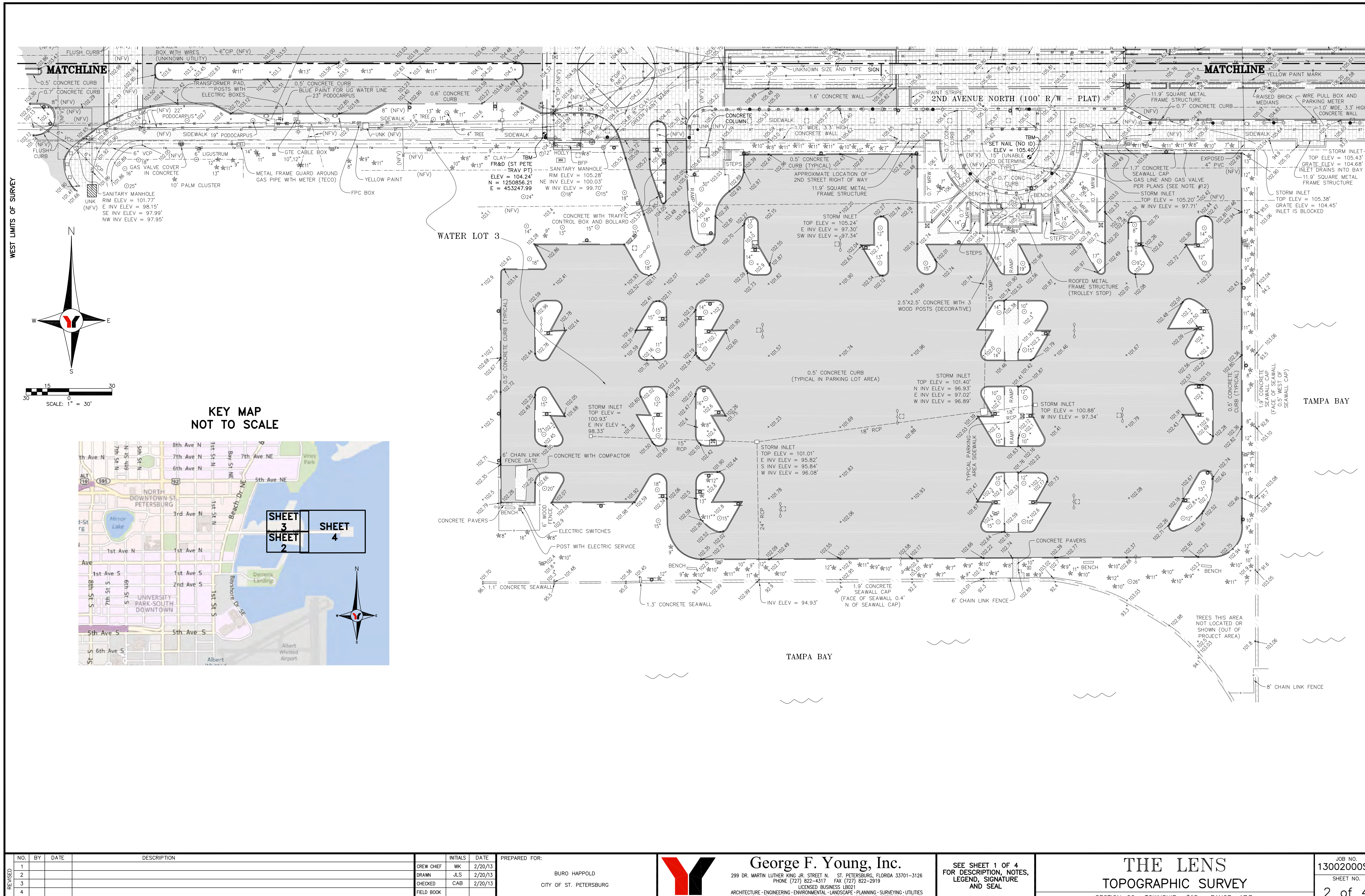
This section is a compilation of the various reports, studies, and assessments that the design team has commissioned or created to inform the design process. These documents supply the design team with a thorough understanding of all existing and natural conditions of the site and surrounding environment. When all the studies are understood collectively, they provide a complete understanding that enables the design team to create a responsive, holistic, and comprehensive solution.

Each of the following studies, reports, or assessments is an individual analysis that respond to a specific design constraint.

- **Survey: Land**
  Survey mapping the location of the existing piers.
- **Survey: Water**
  Survey mapping the existing contour and condition of the sea bed below the existing pier.
- **Geotechnical Report**
  Geotechnical exploration of the subterranean conditions 80 to 115 feet below the existing ground surface or existing pier deck.
- **Wind and Wave Report**
  Assessment of the estimated lateral wind and wave loads acting on the new St. Petrsburg Pier Overwater Bridge and Overwater Drive structures.
- **Structure Wind Assessment Study**
  Assessment of the estimated overall wind loads acting on the steel structural framing of the new St. Petersburg Pier canopy.
- **Clad Wind Assessment Study**
  Assessment of the estimated overall wind loads acting on the metal skin surface of the new St. Petersburg Pier canopy.
- **Caisson Inspection Report**
  Analysis of the physical condition of the five existing pier caissons that may potentially be reused to support the new St. Petersburg Pier.
- **Life Safety Report**
  Analysis of the fire threat potential on the new St. Petersburg Pier and how emergency egress for all occupants can be safely accommodated.
- **Schematic Design Report: Canopy, Bridge & Drive**
  Update regarding the engineering and development of the metal canopy framing sub-structure as well as the Overwater Bridge and Overwater Drive.
- **Precast Beam Options: Matrix**
  Matrix describing the pre-cast beams that were considered for the Overwater Bridge and Overwater Drive by weighing depth, width, potential span, cost, and availability.

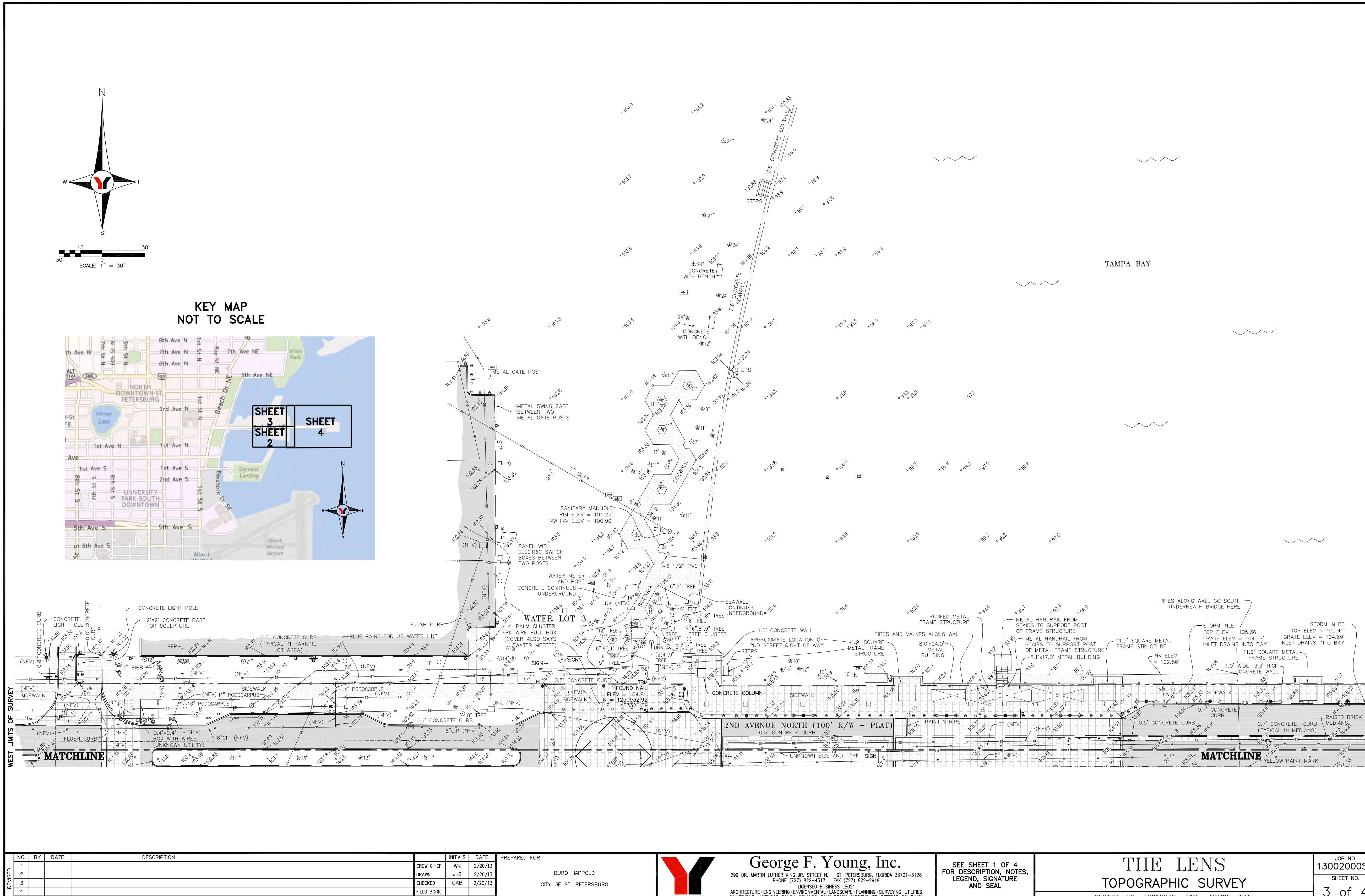
INTRODUCTION (continued)

- **Precast Beam Options: Sections**
  Graphical representation of the various pre-cast beams and corresponding assemblies that were considered for the Overwater Bridge and Overwater Drive structures.
- **Underwater Feature Grant Application**
  Grant application submitted to the United States Army Corps of Engineers for funds to develop the Underwater Feature.
- **Building Code Review**
  Summary of applicable codes and summary of discussions with building officials.
- **Schematic Design Report: Marina**
  Update regarding the engineering and development of the marina floating dock structure.
- **Canopy Design Analysis: 3D Images**
  Three-dimensional images and graphical design analysis of the new St. Petersburg Pier metal canopy.
- **Balcony Design Analysis: 3D Images**
  Three-dimensional images and graphical design analysis of the balconies structure and egress pathways of the new St. Petersburg Pier metal canopy.

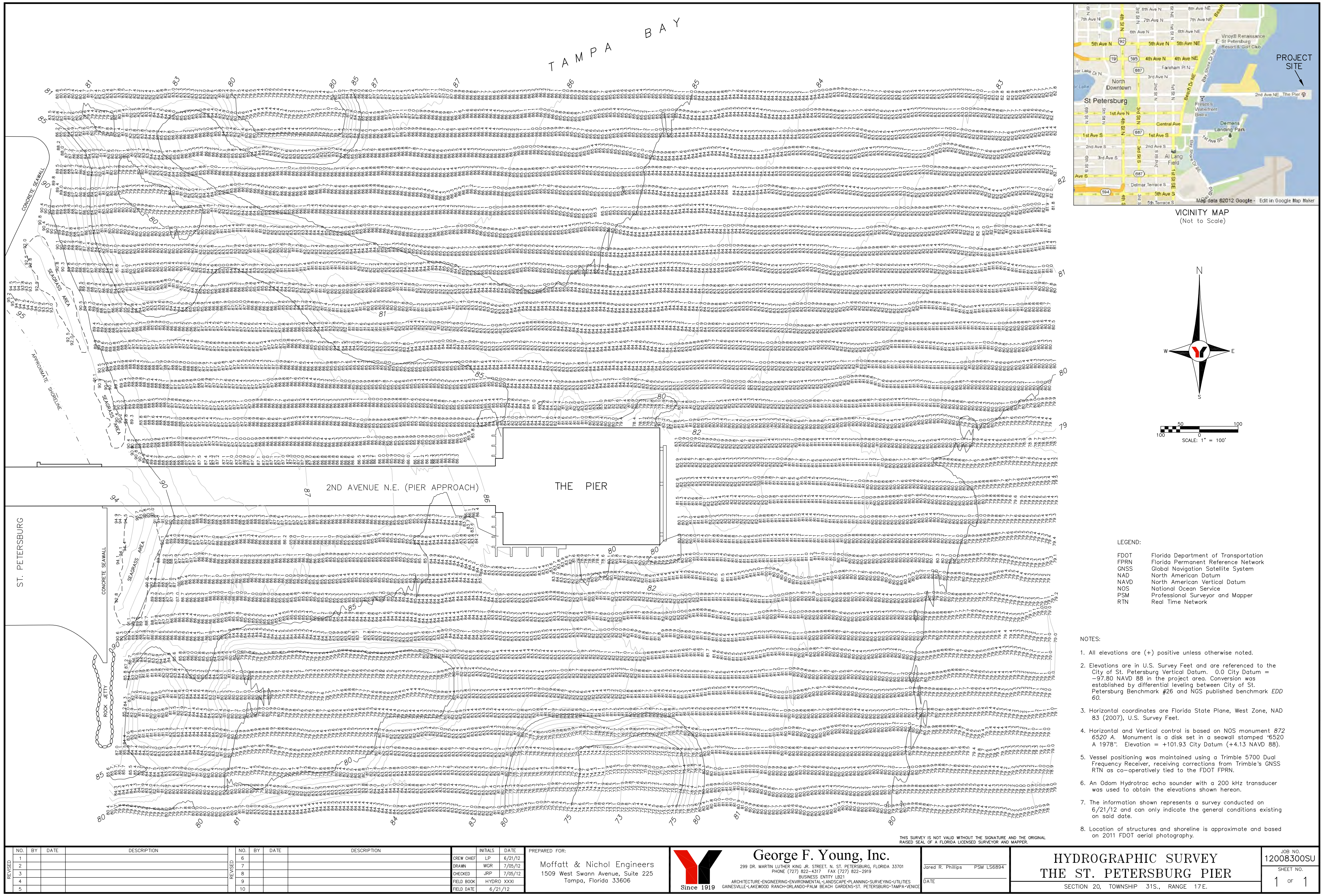

MATCHLINE
2ND AVENUE NORTH (100' R/W - PLAT)
WEST LIMITS OF SURVEY
EAST LIMITS OF SURVEY
WATER LOT 3
TAMPA BAY
SCALE: 1" = 30'
KEY MAP
NOT TO SCALE
SHEET 3
SHEET 2
SHEET 4
0.5' CONCRETE CURB (TYPICAL IN PARKING LOT AREA)
STORM INLET
ROOFED METAL FRAME STRUCTURE (TROLLEY STOP)
2.5'X2.5' CONCRETE WITH 3 WOOD POSTS (DECORATIVE)
CONCRETE PAVERS
1.1' CONCRETE SEAWALL
1.3' CONCRETE SEAWALL
6' CHAIN LINK FENCE
8' CHAIN LINK FENCE
TREES THIS AREA NOT LOCATED OR SHOWN (OUT OF PROJECT AREA)
PREPARED FOR:
BURO HAPPOLD
CITY OF ST. PETERSBURG
George F. Young, Inc.
299 DR. MARTIN LUTHER KING JR. STREET N. ST. PETERSBURG, FLORIDA 33701-3126
PHONE (727) 822-4317 FAX (727) 822-2919
LICENSED BUSINESS LB021
Since 1919
SEE SHEET 1 OF 4 FOR DESCRIPTION, NOTES, LEGEND, SIGNATURE AND SEAL
THE LENS
TOPOGRAPHIC SURVEY
SECTION 20, TOWNSHIP 31S., RANGE 17E.
JOB NO. 13002000SC
SHEET NO. 2 of 4
CREW CHIEF WK 2/20/13
DRAWN JLS 2/20/13
CHECKED CAB 2/20/13
FIELD BOOK
FIELD DATE

SURVEY: LAND

(continued)



SURVEY: WATER



SURVEY: WATER
(continued)

A TOPOGRAPHIC SURVEY OF:

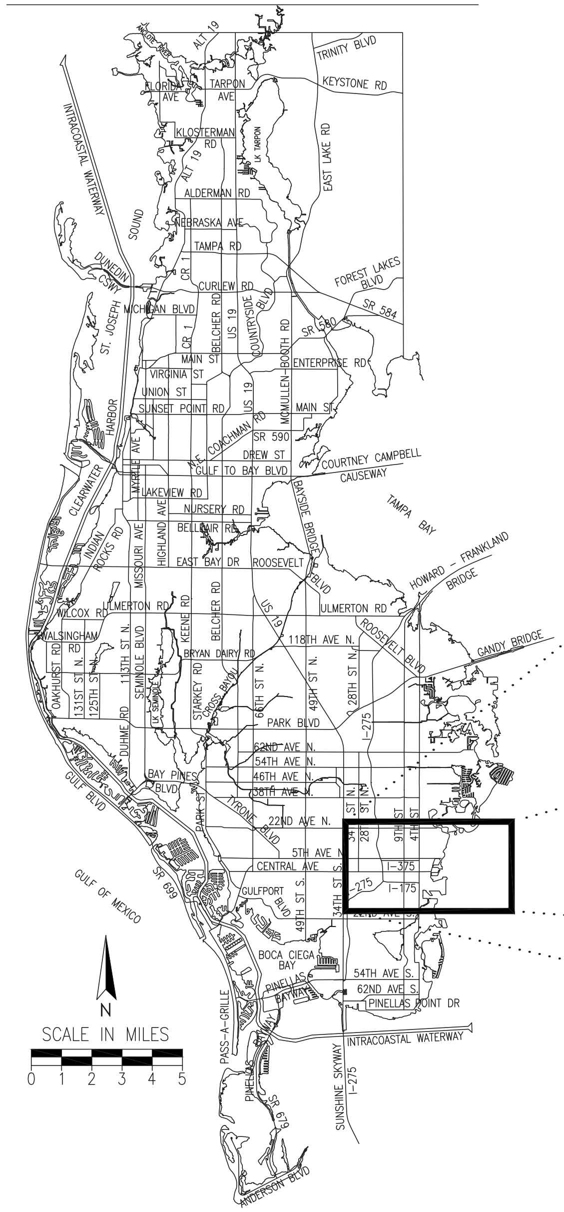
A PORTION OF WATER LOT NO. 3 AND A PORTION OF WATER LOT NO. 4, REVISED MAP OF THE CITY OF ST. PETERSBURG AS RECORDED IN PLAT BOOK 1, PAGE 49, PUBLIC RECORDS OF HILLSBOROUGH COUNTY, FLORIDA, OF WHICH PINELLAS COUNTY WAS FORMERLY A PART.

TOGETHER WITH

A PORTION OF 2ND AVENUE NORTHEAST RIGHT OF WAY LYING EAST OF BAYSHORE DRIVE NORTHEAST AND WEST OF THE CITY OF ST. PETERSBURG MUNICIPAL PIER.

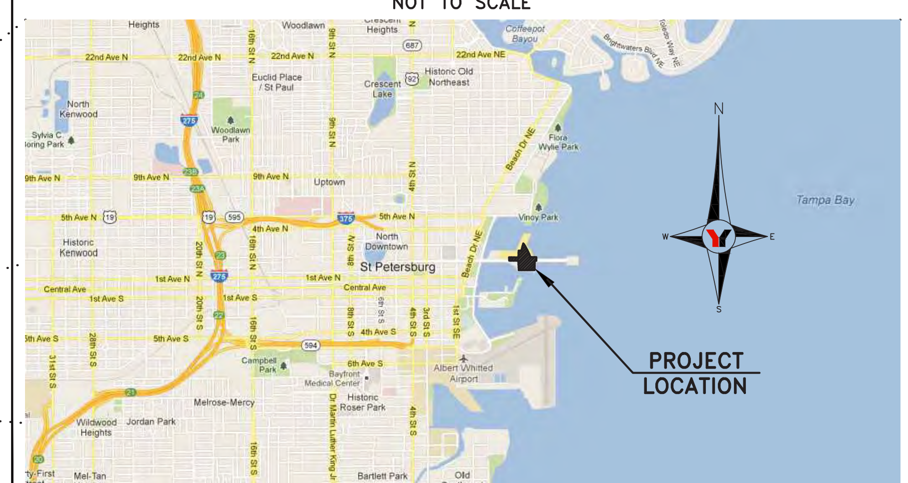
ST. PETERSBURG, FLORIDA

PINELLAS COUNTY MAP



VICINITY MAP

NOT TO SCALE



SHEET INDEX

LEGEND

BFP	BACK FLOW PREVENTER
CIP	CAST IRON PIPE
CMP	CORRUGATED METAL PIPE
CONC	CONCRETE
COSP	CITY OF ST. PETERSBURG
DIP	DUCTILE IRON PIPE
ELEV	ELEVATION
FM	FORCE MAIN
FR&D	FOUND RIVET AND DISK
ID	IDENTIFICATION
INV	INVERT
LB	LICENSED BUSINESS
LS	LICENSED SURVEYOR
MRW	MASONRY RETAINING WALL
NAVD	NORTH AMERICAN VERTICAL DATUM
NFV	NOT FIELD VERIFIED, AS PER UTILITY PRINTS BY OTHERS (SEE NOTE #'S 9–14)
NO.	NUMBER
OCC	OCCUPIED
PLS	PROFESSIONAL LAND SURVEYOR
PSM	PROFESSIONAL SURVEYOR AND MAPPER
PVC	POLYVINYL CHLORIDE
RCP	REINFORCED CONCRETE PIPE
R/W	RIGHT OF WAY
SR&D	SET RIVET & DISK
TBM	TEMPORARY BENCH MARK
UG	UNDERGROUND
UNK	UNKNOWN UTILITY STRUCTURE (PER PLANS ONLY)
VCP	VITRIFIED CLAY PIPE
W/	WITH
#	NUMBER

UG GAS LINE WITNESS POST
GUARD POST
WIRE PULL BOX
IRRIGATION CONTROL VALVE
POST
PARKING METER
WATER METER
GAS VALVE COVER
SANITARY SEWER MANHOLE
SIGN
SIGN FACING TWO DIRECTIONS
OAK TREE WITH TRUNK SIZE UNLESS OTHERWISE NOTED
PALM TREE WITH TRUNK SIZE
PLASTIC LIGHT POLE
METAL LIGHT POLE
CONCRETE LIGHT POLE
PARKING PAY BOX
ELECTRIC BOX
WATER VALVE
RECLAIMED WATER VALVE
3' HIGH FLOODLIGHT
TELEPHONE PEDESTAL

ASPHALT
BRICK
CONCRETE
HEXBLOCK
WATER

HANDRAIL
FENCE LINE
EXISTING TOP OF BANK AND TOE OF SLOPE
DRAINAGE (STORM SEWER) PIPE
GAS LINE AS MARKED BY OTHERS
BURIED COMMUNICATION CABLE PER VERIZON
BURIED CABLE TV CABLE PER COSP — BTV —
BURIED TELEPHONE CABLE PER COSP — BT —
ELECTRIC POWER LINE/CABLE
BURIED ELECTRIC AS PER PROGRESS ENERGY — BE —
WATER LINE AS MARKED BY OTHERS
WATER LINE AS PER COSP AND FIELD OBSERVATION — W —
RECLAIMED WATER LINE
RECLAIMED WATER LINE AS PER COSP — RCW —
SANITARY SEWER LINE AS MARKED BY OTHERS
SANITARY SEWER LINE AS PER COSP AND FIELD OBSERVATION — FM —

NOTES

1. NOT A BOUNDARY SURVEY.
2. GEORGE F. YOUNG, INC. AND THE UNDERSIGNED MAKE NO REPRESENTATIONS OR GUARANTEES PERTAINING TO EASEMENTS, RIGHTS OF WAY, SET BACK LINES, RESERVATIONS, AGREEMENTS AND/OR OTHER MATTERS PERTAINING TO SURVEY.
3. COORDINATE VALUES SHOWN HEREON ARE RELATIVE TO THE FLORIDA STATE PLANE COORDINATE SYSTEM, TRANSVERSE MERCATOR PROJECTION, WEST ZONE, NORTH AMERICAN DATUM (NAD 83, 2011). NATIONAL GEODETIC SURVEY (NGS) MONUMENTS USED TO ESTABLISH THE CONTROL FOR THIS SURVEY ARE 872 6520 A (HAVING A NORTHING OF 1,250,329.23 AND AN EASTING OF 453,318.77), AND T 733 (HAVING A NORTHING OF 1,251,304.31 AND AN EASTING OF 453,401.18), WITH THE BEARING BETWEEN SAID POINTS BEING SOUTH 04°49'51" WEST.
4. THIS SURVEY IS MADE FOR THE EXCLUSIVE USE OF THE CURRENT OWNERS OF THE PROPERTY AND ALSO THOSE WHO MORTGAGE OR GUARANTEE THE TITLE THERETO WITHIN ONE (1) YEAR FROM THE DATE HEREOF.
5. SURVEY PREPARED WITHOUT THE BENEFIT OF A TITLE REPORT OR COMMITMENT FOR TITLE INSURANCE.
6. THE LOCATION OF 2ND AVENUE NORTHEAST RIGHT OF WAY AND THE WATER LOTS AS SHOWN HEREON ARE FOR INFORMATIONAL PURPOSES ONLY AND ARE TO BE CONSIDERED APPROXIMATE.
7. THE LOCATION OF FOOTERS, FOUNDATIONS AND STRUCTURES BENEATH THE GROUND SURFACE HAS NOT BEEN DETERMINED.
8. AS PER THE FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA) FLOOD INSURANCE RATE MAP (FIRM) NUMBER 12103C0219G, COMMUNITY NUMBER 125148, PANEL 0219, SUFFIX G, EFFECTIVE DATE OF SEPTEMBER 3, 2003, THE ABOVE–DESCRIBED PROPERTY APPEARS TO BE IN ZONE AE, BASE FLOOD ELEVATION 8 FEET (NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88)) AND ZONE VE, COASTAL FLOOD WITH VELOCITY HAZARD (WAVE ACTION), BASE FLOOD ELEVATION 8 FEET (NAVD 88). 8 FEET NAVD 88 CONVERTS TO 105.79 FEET, CITY OF ST. PETERSBURG DATUM.
9. UTILITIES AS SHOWN HEREON ARE AS PER FIELD INSPECTION AND INFORMATION PROVIDED BY OTHERS AND DO NOT NECESSARILY INDICATE AVAILABILITY. ADDITIONAL UTILITIES MAY EXIST.
10. APPROXIMATE LOCATION OF BURIED ELECTRIC LINES AS SHOWN HEREON ARE PER MUNICIPAL PIER DEMOLITION 25% PLANS, PROJECT NUMBER 11024–316, PEF MARKUPS, PROVIDED ON CD TO THE UNDERSIGNED BY PROGRESS ENERGY ON FEBRUARY 8, 2013.
11. APPROXIMATE LOCATION OF BURIED TELEPHONE LINES, CABLE LINES, WATER LINES, RECLAIMED WATER LINES, SANITARY SEWER LINES AND APPURTENANCES SHOWN HEREON ARE AS PER PDF DOCUMENTS OF UTILITIES FOR THE PIER REPLACEMENT PROJECT FURNISHED TO THE UNDERSIGNED BY THE CITY OF ST. PETERSBURG VIA FTP SITE: "FTP://FTP2.STPETE.ORG/ENGINEERING/", FOLDER "PIER DEMOLITION\PIER UTILITY CHECK\" ON FEBRUARY 1, 2013.
12. APPROXIMATE LOCATION OF GAS LINES AS SHOWN HEREON ARE AS PER AERIAL PRINT DEPICTING GAS APPURTENANCES WITHIN THE PROJECT AREA, DATED FEBRUARY 1, 2013, PROVIDED TO THE UNDERSIGNED BY TECO / PEOPLES GAS.
13. APPROXIMATE LOCATION OF VERIZON LINES AS SHOWN HEREON ARE AS PER PRINTS FURNISHED BY VERIZON ON FEBRUARY 20, 2013.
14. PAINT MARKS AS LOCATED AND SHOWN HEREON WERE PAINTED BY OTHERS.
15. FORTY–EIGHT (48) HOURS BEFORE DIGGING, BORING, PILE–DRIVING, PLANTING, ETC. CALL SUNSHINE STATE ONE CALL SYSTEM, 1–800–432–4770 SO THAT UNDERGROUND UTILITIES MAY BE FIELD SPOTTED.
16. ELEVATIONS SHOWN HEREON REFER TO THE CITY OF ST. PETERSBURG DATUM, MEAN SEA LEVEL = 97.00 FEET. . BENCHMARK USED: CITY OF ST. PETERSBURG #23 LOCATED AT BAYSHORE DRIVE AND 2ND AVENUE NORTHEAST AT THE SOUTHWEST CORNER AT THE BACK CORNER OF THE SIDEWALKS. ELEVATION = 102.77'. BASED ON THE NATIONAL GEODETIC SURVEY (NGS) MONUMENT T 733, PID DL7630, (LOCATED IN EAST SEAWALL 0.1 MILE NORTHEAST OF THE ENTRANCE OF THE CITY OF ST. PETERSBURG MUNICIPAL PIER NORTHERLY PARKING LOT, HAVING AN ELEVATION OF 5.91 FEET, NAVD 88), THE ELEVATIONS SHOWN HEREON CAN BE CONVERTED FROM THE CITY OF ST. PETERSBURG DATUM TO NAVD 88 BY SUBTRACTING 97.79 FEET FROM THE ELEVATIONS SHOWN HEREON.
17. AERIAL PHOTOGRAPHY AS SHOWN HEREON WAS TAKEN FROM FLORIDA DEPARTMENT OF TRANSPORTATION WEBSITE, DATED MARCH 28, 2012.
18. THIS MAP IS INTENDED TO BE DISPLAYED AT A SCALE OF 1" = 30' OR SMALLER FOR SHEETS 2 AND 3 AND 1" = 60' OR SMALLER FOR SHEET 4.
19. ADDITIONS OR DELETIONS TO SURVEY MAPS OR REPORTS BY OTHER THAN THE SIGNING PARTY OR PARTIES ARE PROHIBITED WITHOUT WRITTEN CONSENT OF THE SIGNING PARTY OR PARTIES.
20. CERTIFICATION IS UNDERSTOOD TO BE AN EXPRESSION OF PROFESSIONAL OPINION BY THE SURVEYOR AND MAPPER BASED ON THE SURVEYOR AND MAPPER'S KNOWLEDGE AND INFORMATION, AND THAT IT IS NOT A GUARANTEE OR WARRANTY, EXPRESSED OR IMPLIED.
21. THIS SURVEY IS NOT VALID WITHOUT THE SIGNATURE AND THE ORIGINAL RAISED SEAL OF A FLORIDA LICENSED SURVEYOR AND MAPPER.

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	INITIALS	DATE
CREW CHIEF	WK	2/20/13
DRAWN	JLS	2/20/13
CHECKED	CAB	2/20/13
FIELD BOOK		
FIELD DATE		

PREPARED FOR:
BURO HAPPOLD
CITY OF ST. PETERSBURG

Since 1919
George F. Young, Inc.
299 DR. MARTIN LUTHER KING JR. STREET N. ST. PETERSBURG, FLORIDA 33701–3126
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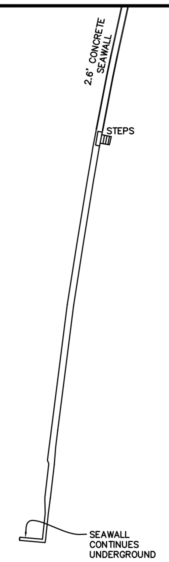
GAINESVILLE • LAKEWOOD RANCH • ORLANDO • PALM BEACH GARDENS • ST. PETERSBURG • TAMPA

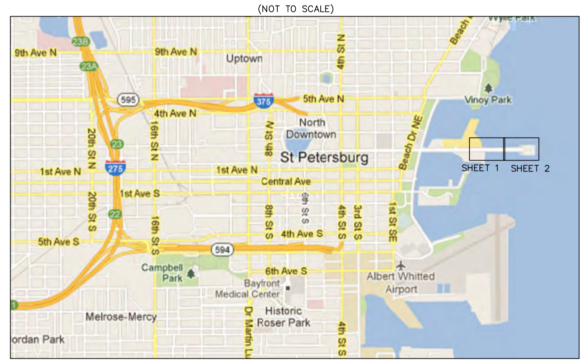
CATHERINE A. BOSCO PSM No. 6257
FEBRUARY 20, 2013
DATE

THE LENS
TOPOGRAPHIC SURVEY
SECTION 20, TOWNSHIP 31S., RANGE 17E.

JOB NO. 13002000SC
SHEET NO. 1 of 4



VICINITY MAP
(NOT TO SCALE)



LEGEND:

CONCRETE PILING

WOOD PILING

FDOT	FLORIDA DEPARTMENT OF TRANSPORTATION
FPRN	FLORIDA PERMANENT REFERENCE NETWORK
GNSS	GLOBAL NAVIGATION SATELLITE SYSTEM
NAD	NORTH AMERICAN DATUM
NAVD	NORTH AMERICAN VERTICAL DATUM
PSM	PROFESSIONAL SURVEYOR AND MAPPER

NOTES:

1. SPECIFIC PURPOSE SURVEY TO MAP PILINGS SUPPORTING AND SURROUNDING THE ST. PETERSBURG PIER.
2. HORIZONTAL COORDINATES ARE FLORIDA STATE PLANE, WEST ZONE, NAD 83 (2011 ADJUSTMENT), U.S. SURVEY FEET.
3. ELEVATIONS SHOWN HEREON REFER TO THE CITY OF ST. PETERSBURG DATUM. 0.00 CITY DATUM = 97.79 NAVD 88 IN THE PROJECT AREA. CONVERSION WAS ESTABLISHED BY DIFFERENTIAL LEVELING BETWEEN CITY OF ST. PETERSBURG BENCHMARK #23 AND NGS BENCHMARK T 733.
4. HORIZONTAL AND VERTICAL CONTROL IS BASED ON THE FOLLOWING NGS MONUMENTS:

   872 6520 A
   - NORTHING 1,250,329.23
   - EASTING 453,318.77
   - ELEVATION (NAVD 88) 4.13

   T 733
   - NORTHING 1,251,304.31
   - EASTING 453,401.18
   - ELEVATION (NAVD 88) 5.91
5. VESSEL ATTITUDE AND POSITIONING WAS DETERMINED USING A CODAOCTOPUS F180, RECEIVING CORRECTIONS FROM FPRN GNSS REFERENCE STATION ST PETERSBURG 1.
6. A CODAOCTOPUS ECHOSCOPE 3D SONAR SYSTEM WAS USED TO LOCATE THE PILINGS SHOWN HEREON.
7. PILINGS LOCATIONS WERE DETERMINED FROM 0.0 NAVD 88 TO THE APPROXIMATE SEAFLOOR. THE HORIZONTAL AND VERTICAL POSITIONS OF THE TOP CENTER (AT 0.0 NAVD 88) AND BOTTOM CENTER (AT THE SEAFLOOR) OF EACH PILING ARE ACCURATE TO WITHIN +/−1 FOOT AT A 95% CONFIDENCE LEVEL.
8. ONLY PILINGS WERE MAPPED FOR THIS PROJECT. POSSIBLE DEBRIS FOUND ON THE SEAFLOOR HAS BEEN NOTED ON THE DRAWING. THERE IS A POSSIBILITY THAT OTHER DEBRIS EXISTS BUT WAS NOT FOUND DUE TO SONAR LIMITATIONS.
9. SHAPES AND DIMENSIONS OF PILINGS ARE BASED ON DESIGN INFORMATION PROVIDED BY THE CITY OF ST. PETERSBURG AND WERE NOT FIELD VERIFIED.
10. SPOT ELEVATIONS, CONTOURS, AND APPROXIMATE SEAGRASS LOCATIONS SHOWN HEREON WERE TAKEN FROM GEORGE F. YOUNG, INC. HYDROGRAPHIC SURVEY DATED 7/05/12, PROJECT NUMBER 12008300SU.
11. LOCATION OF SEAWALL WAS TAKEN FROM GEORGE F. YOUNG, INC. TOPOGRAPHIC SURVEY DATED 2/20/13, PROJECT NUMBER 13002000SC.
12. FOOTPRINT OF EXISTING PIER IS APPROXIMATE AND BASED ON 2010 FDOT AERIAL PHOTOGRAPHY.

THIS SURVEY IS NOT VALID WITHOUT THE SIGNATURE AND THE ORIGINAL RAISED SEAL OF A FLORIDA LICENSED SURVEYOR AND MAPPER.

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NO.	BY	DATE	DESCRIPTION
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	INITIALS	DATE
CREW CHIEF	JRP	2/14/13
DRAWN	WGR	3/6/13
CHECKED	JRP	3/6/13
FIELD BOOK		
FIELD DATE	2/14/13	

PREPARED FOR:
SKANSKA
4950 W. Kennedy Blvd.
Tampa, Florida 33609
813-282-7100

George F. Young, Inc.
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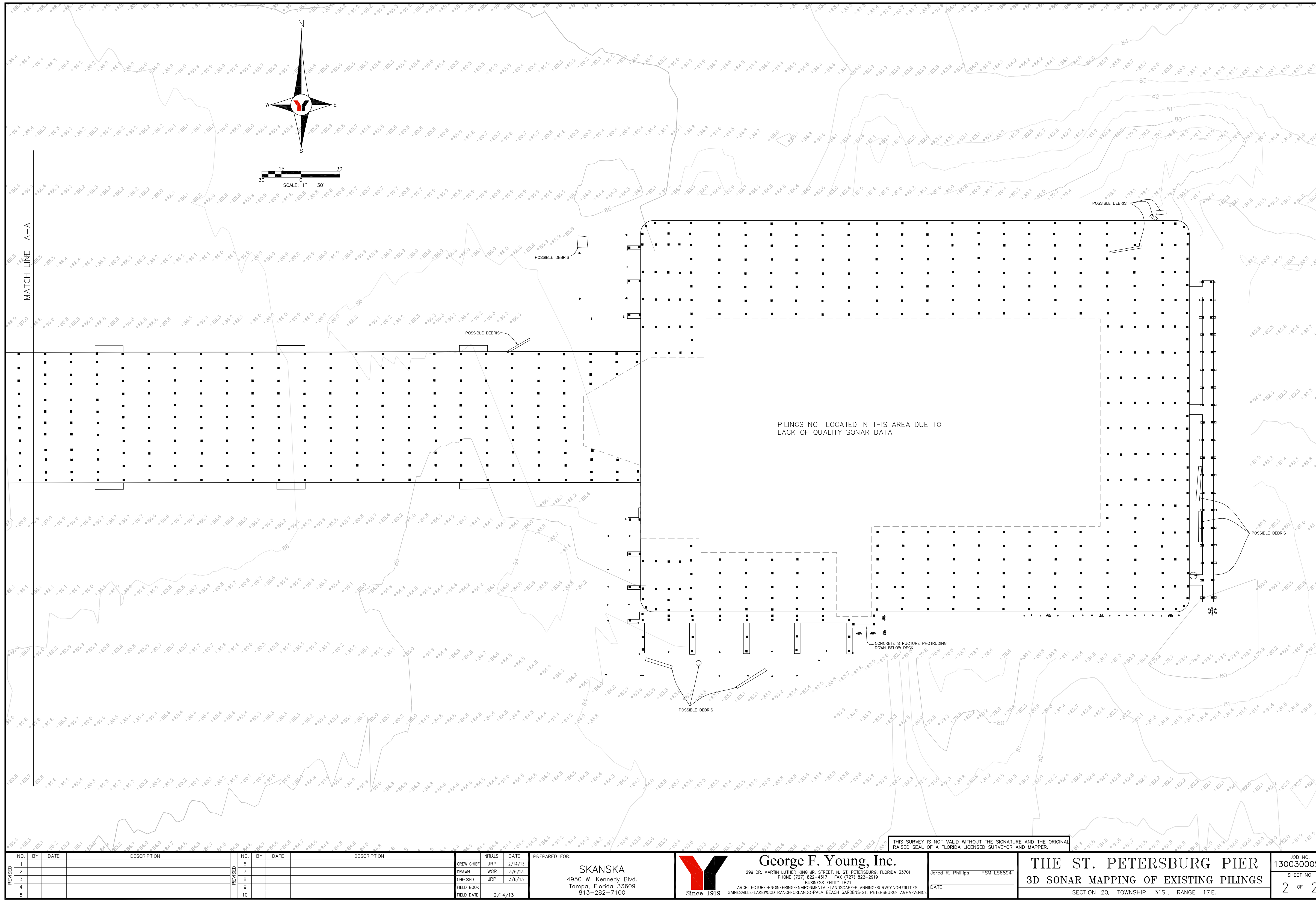
GAINESVILLE•LAKEWOOD RANCH•ORLANDO•PALM BEACH GARDENS•ST. PETERSBURG•TAMPA•VENICE

Jared R. Phillips PSM LS6894
DATE

THE ST. PETERSBURG PIER
3D SONAR MAPPING OF EXISTING PILINGS
SECTION 20, TOWNSHIP 31S., RANGE 17E.

JOB NO. 13003000SU
SHEET NO. 1 OF 2

SURVEY: WATER
(continued)



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	INITIALS	DATE
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CHECKED	CAB	2/20/13
FIELD BOOK		
FIELD DATE		

PREPARED FOR:
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SEE SHEET 1 OF 4 FOR DESCRIPTION, NOTES, LEGEND, SIGNATURE AND SEAL

THE LENS
TOPOGRAPHIC SURVEY
SECTION 20, TOWNSHIP 31S., RANGE 17E.

JOB NO. 13002000SC
SHEET NO. 4 of 4

Geotechnical Engineering Report

The Lens

St. Petersburg, Florida

April 24, 2013

Terracon Project No. H4135006

Prepared for:

Michael Maltzan Architecture, Inc.
Los Angeles, California

Prepared by:

Terracon Consultants, Inc.
Tampa, Florida

GEOTECHNICAL REPORT (continued)

April 24, 2013

Terracon

Michael Maltzan Architecture, Inc.
2801 Hyperion Avenue, Studio 107
Los Angeles, California 90027

Attn: Mr. Tim Williams
P: 323 913 3098
F: 323 913 5932

Re: Geotechnical Engineering Report
The Lens
St. Petersburg, Florida
Terracon Project Number: H4135006

Dear Mr. Williams:

Terracon Consultants, Inc. (Terracon) has completed the geotechnical engineering services for the above referenced project. This study was performed in general accordance with our proposal number PH 4120528 Rev1 dated January 11, 2013.

This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction of foundations for the proposed project.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report, or if we may be of further service, please contact us.

Sincerely,
Terracon Consultants, Inc.
Certificate of Authorization Number 8830

CRAIG M. ANSTETT LICENSE No. 60850 STATE OF FLORIDA PROFESSIONAL ENGINEER

Craig M. Anstett, P.E.
Regional Manager, Principal
Florida PE-60850

Stephen C. Knauss, P.E., D.GE
Senior Project Engineer
Florida PE-28202

Enclosures
cc: 1 – Client (PDF)
1 – File

Terracon Consultants, Inc. 1675 Lee Road Winter Park, Florida 32789
P [407] 740 6110 F [407] 740 6112 terracon.com

Geotechnical ■ Environmental ■ Construction Materials ■ Facilities

TABLE OF CONTENTS

GEOTECHNICAL REPORT
(continued)

TABLE OF CONTENTS (continued)

GEOTECHNICAL ENGINEERING REPORT
THE LENS
ST. PETERSBURG, FLORIDA
Terracon Project No. H4135006
April 24, 2013

1.0 INTRODUCTION

A geotechnical exploration has been performed for The Lens which is proposed to replace the St. Petersburg Pier located at the east terminus of 2nd Avenue NE in downtown St. Petersburg, Florida. Nineteen (19) borings, designated B-1 through B-19, have been performed to depths of between 80 and 115 feet below the existing ground surface or existing pier deck. This report specifically addresses the recommendations for the proposed structure. Logs of the borings along with a site location plan, soil survey map and boring location plans are included in Appendix A of this report.

The purpose of these services is to provide information and geotechnical engineering recommendations relative to:

- subsurface soil conditions
- earthwork
- groundwater conditions
- foundation design and construction

2.0 PROJECT INFORMATION

The proposed development area consists of the existing St. Petersburg Pier which was originally constructed in the 1920's. The end of the Pier was renovated in the early 1970's. The majority of the structure extends approximately 1450 feet into the bay. It is estimated the structure is 10 feet above the normal water level and that the water depth is on the order of 10 feet.

GEOTECHNICAL REPORT
(continued)

2.1 Project Description

Item	Description
Site layout	See Appendix A, Exhibit A-4: Boring Location Plan
Proposed Lens Components	Pier with several components including: Welcome Mat, Hub, Overwater Drive, Overwater Bridge, Lens Canopy, Promontory, and Marina.
Structural System	Precast and cast-in-place concrete supported by drilled shafts and driven piles.
Maximum loads (provided)	Drilled Shafts: 250 Tons Compression 12.5 Tons Lateral at 37 feet above mud line (Maximum 2 inches of deflection) Driven Piles: 90 - 150 Tons Compression Lateral load applied at 28 feet above mud line
Scour Depth (estimated)	Drilled Shafts: 6 feet below mud line Driven Piles: 3 feet below mud line

2.2 Site Location and Description

Item	Description
Location	East terminus of 2nd Avenue NE in downtown St. Petersburg. The Pier overlooks Tampa Bay to the east. More accurately described as 800 2nd Avenue Northeast, St. Petersburg, FL 33701
Existing improvements	The proposed development area consists of the existing St. Petersburg Pier which was originally constructed in the 1920's. The end of the Pier was renovated in the early 1970's. The majority of the structure extends approximately 1450 feet into the bay. It is estimated the structure is 10 feet above the normal water level and that the water depth is also 10 feet.
Current ground cover	The landside of the Pier primarily consists of asphaltic concrete on the south side and sand on the northern side.
Existing topography	The limited landside portions of the project site appear nearly level. The southern landside portion consists of a parking lot and the northern landside portion consists of a beach area. The beach area appears to have a slight downward slope towards Tampa Bay. The USGS topographic quadrangle maps Saint Petersburg, Florida (1998) and Port Tampa, Florida (1981) depict the ground surface elevation of about +5 feet referencing the National Geodetic Vertical Datum of 1929 (NGVD29). However, note that the elevations in this report will refer to the St. Petersburg datum where elevation 0 feet NGVD equals approximately +98 feet.

3.0 SUBSURFACE CONDITIONS

The geology of the site is presented in the following report section. A discussion of subsurface conditions encountered in our borings follows the geology section.

3.1 Regional Geology

The subject property is located in southeastern Pinellas County within the Gulf Coastal Lowlands Physiographic Province of Florida (Puri and Vernon, 1964 and White, 1970). The Gulf Coastal Lowlands Province is characterized as marine karstic plain of low relief with poor drainage, extending north-south adjacent to the Gulf of Mexico, ranging in width from 2 to 45 miles and composed of sand and clayey sands of varying thickness overlying limestone and or dolomite. Elevations range from sea level to approximately 100 feet.

The three major geologic units that have influenced the development of karst in the vicinity of the project site are, in order of age from youngest to oldest; the undifferentiated sediments of Pleistocene/Pliocene age overlying the Oligocene-Pliocene age Hawthorn Group sediments overlying the Upper Oligocene to lower Miocene Arcadia Formation and the Oligocene age Suwannee Limestone.

The undifferentiated Pleistocene sediments are light gray, tan, brown to black siliciclastics; unconsolidated to poorly consolidated, clean to clayey, silty, unfossiliferous, variably organic-bearing sands to blue green to olive green, poorly to moderately consolidated, sandy, silty clays. Organics occur as peat, plant debris and roots (Scott, 2001). Thicknesses range from approximately 10 to 60 feet in the project area (FGS Bulletin No. 68, 2008).

The Upper Oligocene to Lower Miocene Arcadia Formation includes the Tampa Member of the Arcadia Formation. According to Scott (2001), the Tampa Member is variable in thickness throughout its extent. North of the project site, the Tampa Member is absent due to erosion or non-deposition. The Tampa Member consists primarily of limestone with subordinate dolostone, sands and clays. The limestones are variably quartz sand and clay with minor to no phosphate. Colors range from white to yellowish gray. Sand and clay beds occur sporadically within the Tampa Member (Scott, 2001). In the vicinity of the project site, thicknesses range from approximately 200 to 250 feet. (FGS Bulletin No. 68, 2008).

3.2 Soil Survey

The Soil Survey of Pinellas County, Florida as prepared by the United States Department of Agriculture (USDA), Soil Conservation Service (now renamed the Natural Resource Conservation Service - NRCS), identifies the soil type at the subject site as Urban Land and Coastal Beaches. It

GEOTECHNICAL REPORT
(continued)

should be noted that the Soil Survey is not intended as a substitute for site-specific geotechnical exploration; rather it is a useful tool in planning a project scope in that it provides information on soil types likely to be encountered. Boundaries between adjacent soil types on the Soil Survey maps are approximate (included in Appendix as Exhibit A-2). Descriptions of the mapped soil units are included in Appendix A as Exhibit A-3.

According to the soil survey, the risk of corrosion pertains to potential soil-induced electrochemical or chemical action that corrodes or weakens concrete or uncoated steel. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The risk for corrosion of concrete and uncoated steel at this site is high. Corrosion protection is discussed in Section 4.4 of this report.

3.3 Typical Profile

The various soils encountered have been consolidated into 3 groups; cohesionless (Group A), cohesive (Group B) and Limestone (Group C). Based on the results of the borings, subsurface conditions on the project site can be generalized as follows:

Soil Group	Strata	Approximate Depth to Bottom of Stratum (feet)	Material Description	Consistency/ Density
		6 to 10	Air[1,3]	N/A
		17 to 20	Water[2,3]	N/A
Group A	1, 2, 3	47 to 62	Fine sand with trace to many shell fragments (SP), Fine sand to fine sand with silt (SP, SP-SM), Clayey fine sand (SC)	Very loose to Dense
Group B	3, 4, 5	63 to Termination of the Borings	Clayey fine sand (SC) Sandy clay (CL), Clay (CH)	Loose to very dense or soft to very hard
Group C	6	Termination of the Borings	Weathered Limestone Formation	

1. Approximate depth to water from top of Pier deck.
2. Approximate depth to mud line from top of water surface.
3. Not present in borings B-1 to B-4 which were drilled on land.

Conditions encountered at each boring location and results of laboratory testing are indicated on the individual boring logs. Stratification boundaries on the boring logs represent the approximate location of changes in soil types; in-situ, the transition between materials may be gradual. Details for each of the borings can be found on the boring logs in Appendix A of this report. Descriptions of our field exploration are included as Exhibit A-5 in Appendix A. Descriptions of our laboratory testing procedures are included as Exhibit B-1 in Appendix B.

3.4 Groundwater

The landside boreholes (Borings B-1, B-2, B-3, and B-4) were observed during drilling for the presence and level of groundwater. Groundwater was observed in these borings, between depths of 6 inches and 4 feet below existing grade, corresponding to elevations ranging from +97 to +99 feet. Longer term monitoring in cased holes or piezometers, possibly installed to greater depths than explored under this project scope, would be required to better define groundwater conditions at the site.

It should be recognized that fluctuations of the groundwater table will occur primarily due to tidal fluctuations of Tampa Bay and to a lesser degree seasonal variations in the amount of rainfall, runoff and other factors not evident at the time the boring was performed.

We estimate that during the normal wet season with rainfall and recharge at a maximum, groundwater levels will be about elevation +100 feet. Our estimate of the seasonal groundwater conditions are based on the USDA Soil Survey, available survey data, the encountered soil types, recent weather conditions, and the encountered water levels.

This seasonal water table estimate does not represent the temporary rise in water table that occurs immediately following a storm event, including adjacent to other stormwater management facilities. This is different from static groundwater levels in wet ponds and/or drainage canals which can affect the design water levels of new, nearby ponds. The seasonal high water table may vary from normal when affected by extreme weather changes, localized or regional flooding, karst activity, future grading, drainage improvements, or other construction that may occur on or around the site following the date of this report.

4.0 RECOMMENDATIONS FOR DESIGN AND CONSTRUCTION

4.1 Geotechnical Considerations

The following evaluations and recommendations are based on the project characteristics previously described, the data obtained during our field exploration and our experience with similar subsurface conditions and construction methods. If the project information contained in this report is incorrect or if additional information becomes available, a review must be made by our office to determine if any modifications in the recommendations are necessary.

GEOTECHNICAL REPORT
(continued)

The proposed construction will include a new Pier with multiple components. Two types of foundations will be utilized to support the structure; drilled shafts and driven piles. Design and construction recommendations for foundation systems and other earth connected phases of the project are outlined below.

4.2 Driven Piles

4.2.1 Axial Capacity

We understand that 18-inch square pre-stressed concrete pile sections have been chosen for this project. The computer software FBDeep Version 2.01c was used to evaluate estimated Davisson capacities (ultimate axial capacities) for the 18-inch square pre-stressed concrete piles. The input soil parameters for FBDeep were obtained from the SPT borings (B-1 through B-19) performed for this evaluation. We also assumed 3 feet of scour in our analysis. The Davisson capacities versus pile tip elevations (axial capacity curves) for the 18-inch square pile section for each boring are presented in the Appendix as Exhibits C-3, C-4 and C-5. The axial capacity curves were used to estimate approximate pile tip elevations for the required axial design capacity of 90 tons (ultimate axial capacity of 180 tons using factor of safety of 2.0).

Based on the FB Deep results and review of the SPT borings performed, the piles are anticipated to achieve the required axial design capacity of 90 tons between elevations +20 feet and +30 feet. Piles in vicinity of borings B-8 and B-15 will require deeper penetration to achieve the required capacity. Piles in the vicinity of Boring B-8 will need to be driven to an approximate elevation of +10 feet and those in the vicinity of B-15 to an approximate elevation of +5 feet.

The estimated settlement of the driven piles is expected to be 0.5 inches of permanent settlement plus any elastic shortening of the piles that may occur. Differential settlement is expected to be on the order of 50% of the total settlement. This estimated settlement can be further evaluated following the load tests.

A minimum center to center pile spacing of three pile diameters is recommended to help minimize group capacity reduction effects so that a reduction in pile capacity is not necessary. An allowable uplift capacity of 30 tons per pile may be considered where tension (uplift) capacity is required.

Set-checks and Re-drives instrumented with PDA (Pile Driving Analyzer) may be required to determine if axial capacities have been achieved in some areas during the test and/or production pile installation. Set-checks and Re-drives are utilized because the capacity of piles may increase after driving has stopped and the soils stabilize. By re-driving the pile for a short distance it is possible to observe the increase in pile capacity after the soils have stabilized. Set-Checks and Re-drives shall be in conducted in accordance with FDOT Specification Section 455-1.1.

4.2.2 Pile Load Testing

We recommend a dynamic load testing program using PDA, including the driving of several test piles (i.e. approximately 5% of total number of production piles) in production pile locations spaced across the site to provide an indication of the potential variability in driving conditions and to confirm that the required axial capacity can be achieved in these variable conditions with the contractor's pile driving equipment. The purpose of the test pile program is to provide the contractor a recommended production pile driving criteria to be utilized across the site based on the results and subsequent analyses of test pile program. This will also allow the contractor to order piles of an appropriate length, thus minimizing wastage of the piles.

Our experience with the PDA indicates that a significant cost savings (over static load testing of piles) may be realized if the PDA is properly utilized to monitor the installation as to pile driving stresses, capacities and integrity.

Pile driving inspection is recommended for all production piles based on driving criteria developed based on the results of test pile program. Continuous driving and installation records should be maintained for each test and production pile for the Geotechnical Engineer's review.

In addition, prior to installing the test piles, the geotechnical engineer should be informed of the specific equipment proposed for use by the pile contractor. The contractor should submit a description of the following for review and preliminary evaluation of the proposed hammer system by the geotechnical engineer:

- List and size of proposed equipment including proposed hammer system and predrilling/preforming equipment and their manufactures' data sheet
- Size, thickness and material type of proposed capblock (hammer) and pile cushions.
- Sequence of driving of piles for each different configuration of pile layout
- Proposed schedule for test pile program and production pile driving.

The geotechnical engineer should be retained to perform preliminary Wave Equation analyses that validate the selection of the proposed equipment. The geotechnical engineer should also observe the initial test pile driving operations to determine if the pile driving installation is being performed according to the recommendations in the report.

4.2.3 Preliminary WEAP Analyses on Selected Hammer Systems

The three hammer systems were selected based on our experience in this area and consideration of chosen pile type (i.e. 18 inch square pre-stressed pile) and dimension and summarized as follows:

GEOTECHNICAL REPORT
(continued)

1. An APE Model D25-42 open-ended (i.e. single acting) diesel impact hammer has a rated energy of 62.0 kip-feet and a ram weight of 5.5 kips.

2. An APE Model D30-42 open-ended (i.e. single acting) diesel impact hammer has a rated energy of 74.4 kip-feet and a ram weight of 6.6 kips.

3. An APE Model D36-42 open-ended (i.e. single acting) diesel impact hammer has a rated energy of 89.3 kip-feet and a ram weight of 7.9 kips.

To evaluate the suitability of these selected hammer systems for driving 18-inch square precast, pre-stressed piles for the referenced project, a Wave Equation Analysis of Piles (WEAP) using the program 2010 GRLWEAP™ was performed. The wave equation analysis models the hammer-pile-soil system using the one-dimensional wave equation. For the preliminary analyses, we have used hammer input values for the driving systems in the manufacture's specifications for each hammer system, quake and damping values based on the soil information of the generalized subsurface profile in the following table and default hammer efficiency of 80% for an open ended diesel hammer.

Generalized Subsurface Profile Used for WEAP Analyses

Depth (ft)	Material Encountered
0 to 20 feet	Air/Water
20 to 45 feet	Very Loose SAND
45 to 50 feet	Loose SAND
50 to 60 feet	Very Soft CLAY
60 to 70 feet	Stiff CLAY
70 to 90 feet	WEATHERED LIMESTONE

The preliminary wave equation analyses indicate that all three selected pile driving hammer systems, APE D25-42, D30-42 and D36-42, appear to be suitable and generally capable of driving the 18-inch square pre-stressed concrete piles to the required ultimate capacity of 360 kips (= Factor of Safety of 2.0 X Design Load of 180 kips) at a blow count ranging from 36 blows to 120 blows per foot per FDOT Section 455-5.2 without reaching practical refusal (20 blows per inch) or over-stressing the piles in compression or tension per Section 455-5.11.2 of the FDOT Specifications. The preliminary WEAP results also indicate that the hammer may need to operate at a hammer stroke height of 5 feet or less to maintain a minimum required blow count of 36 blows per foot.

The results of the preliminary wave equation analyses (Bearing Graph for various ultimate axial loads including required ultimate axial bearing capacity of 360 kips and Inspector's Chart for required ultimate axial bearing capacity of 360 kips) for each hammer system are attached in the Appendix as Exhibit C-7.

Please note that the results above are preliminary. Acceptance of all equipment and procedures are subject to satisfactory field performance as detailed in the specifications.

4.2.4 Lateral Analysis

Based on an evaluation using the computer program *LPILE Plus 4.0*, we determined the lateral capacity for an 18-inch square prestressed concrete pile for various pile head deflections. Our evaluation assumed a free head condition. The following assumptions and criteria were utilized in our analysis:

A series of analysis (cases) were conducted utilizing a constant axial load. The analysis varied the deflection from 0.25 inches to 2.5 inches in 0.25 inch increments and the resulting shear stress vs. depth for those defections was calculated.

- 18-inch square prestressed concrete pile extending 28 feet from the mud line.
- Modeled as a Free Head Condition.
- Assumed 3 feet of scour.
- Lateral load applied at top of pile which is 28 feet above the mud line (elevation +114 feet).
- Axial compression load of 90 tons applied.
- Assume B-15 soil profile

Our Findings/Conclusions are as follows:

The lateral capacity of an 18-inch square prestressed concrete pile under the assumptions noted above ranges from 0.1 kips with 0.25 inches of deflection to 1 kip with 2.5 inches of deflection. The Shear Force vs. depth curves for various pile head deflections ranging from 0.25 inches to 2.5 inches (in increments of 0.25 inches) are presented in the Appendix as Exhibit C-6. The point of fixity for this project is defined as the depth/elevation where the pile deflection equals zero for the first time. The point of fixity was determined to be approximately elevation +73'. The maximum bending moment generated by the L Pile analysis is 6.8 kip-ft occurring at approximately elevation +81 feet.

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4.2.5 Driven Pile Summary

Summary of 18" x 18" Prestressed Concrete Driven Pile Results					
Piles in Vicinity of Boring	**Est. Required Pile Tip Elevation[1]**	**Elevation[1] of Point of Fixity[2] with 0.25 in. Deflection**	**Axial Capacity**	**Lateral Capacity with 0.25 inches Deflection**	**Maximum Bending Moment with 0.25 inches Deflection**
B-1	+25'	-	90 Tons	0.1 kips	-
B-2	+30'	-	90 Tons	0.1 kips	-
B-3	+20'	-	90 Tons	0.1 kips	-
B-4	+35'	-	90 Tons	0.1 kips	-
B-5	+30'	-	90 Tons	0.1 kips	-
B-6	+30'	-	90 Tons	0.1 kips	-
B-7	+20'	-	90 Tons	0.1 kips	-
B-8	+10'	-	90 Tons	0.1 kips	-
B-9	+25'	-	90 Tons	0.1 kips	-
B-10	+20'	-	90 Tons	0.1 kips	-
B-11	+20'	-	90 Tons	0.1 kips	-
B-12	+25'	-	90 Tons	0.1 kips	
B-13	+30'	-	90 Tons	0.1 kips	-
B-14	+25'	-	90 Tons	0.1 kips	-
B-15	+5'	+73'	90 Tons	0.1 kips	6.8 kip-ft
B-16	+30'	-	90 Tons	0.1 kips	-
B-17	+35'	-	90 Tons	0.1 kips	-
B-18	+30'	-	90 Tons	0.1 kips	-
B-19	+25'	-	90 Tons	0.1 kips	-

[1]The elevations utilized refer to the City of St. Petersburg Datum. 0.00 City Datum = 97.79 NAVD 88. The forces are applied at the top of the pile which corresponds to elevation +114 feet. The unscoured mudline is at elevation +86 feet and the scoured mudline is at elevation +83 feet.

[2]Point of Fixity is defined as the first depth or elevation at which the deflection of the pile equals zero.

4.2.6 150 Ton Axial Capacity

As an alternative to utilizing 18-inch square pre-stressed concrete pile sections with a design capacity of 90 tons, higher capacity 18-inch square concrete pile sections can be utilized or larger 24-inch square concrete pile sections can be utilized. We analyzed these pile sections with a design capacity of 150 tons. We have prepared a table showing the estimated pile tip elevations for both the 18 and 24 inch square piles based on Axial capacity analysis (FBDeep), consideration of soil variation, assumption of soil conditions below the terminated boring depth, and Terracon's pile driving experience in similar soil/rock conditions. The table is included in the Appendix as Exhibit C-8. However, in order to confirm these tip elevations additional deeper borings will need to be performed.

4.3 Drilled Shafts

4.3.1 Axial Capacity

The Over Water Pedestrian Bridge will be supported by drilled shafts with a maximum compression column load of 250 tons and maximum lateral load of 12.5 tons applied approximately 37 feet above the unscoured mud line. We have assumed 6 feet of scour in our analysis.

In general, most of the drilled shaft capacity will be derived between elevations +50 feet to +35 feet in the harder and denser soils. Although some nominal capacity will be derived above that elevation range it is generally ignored. Drilled shafts in Florida are generally considered to obtain their capacity through side friction because they will be drilled using the “wet” method and while the bottom of a shaft must be cleaned, the capacity obtained from the bottom of a shaft is generally not included in the capacity due to strain incompatibility between the side friction and end bearing. Pending the results of a load test and pilot borings, we have utilized an average allowable frictional capacity on the order of 1.5 tsf. The numbers presented in the table are a guideline and the depth for the desired capacity may need to be adjusted based on the actual conditions at that drilled shaft location. This is particularly true at sites like this one where there is some variability in the soil conditions across the site. In Florida, when drilled shafts are the utilized, pilot hole borings are drilled at each proposed shaft location to identify the actual soil conditions. The pilot boring consists of an SPT boring drilled to at least 3 diameters beyond the preliminary or proposed tip elevation. The tip elevation of the shaft is then determined at that location. Below are the preliminary tip elevations corresponding to borings that are in the vicinity of proposed shaft locations:

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(continued)

Shaft Diameter (in)	Drilled Shaft Minimum Tip Elevation (Depth) (Allowable Capacity 250 Tons)							
	B-3	B-6	B-7	B-8	B-10	B-11	B-13	B-15
60	+29(73)	+36.5(69)	+38(67)	+29(76)	+26(79)	+43.5(62)	+30.5(75)	+25(81)

In general, the drilled shafts are cased to the top of the bearing surface with temporary steel casing. However for this project it is expected that the usual temporary casing will be permanent. This casing is typically installed either with the drill rig or with a vibratory hammer.

The estimated settlement of the drilled shafts is expected to be 0.5 inches of permanent settlement plus any elastic shortening of the shafts that may occur. Differential settlement is expected to be on the order of 50% of the total settlement. These estimates can be further evaluated following the load test.

4.3.2 Lateral Analysis

We evaluated the lateral capacity of the drilled shaft foundations using the computer program LPILE Plus 4.0. The following assumptions and criteria were utilized in our analysis:

- 48-inch diameter superstructure column extending from approximate water surface up to elevation of +123.1 (27 feet long)
- Modeled as a Free Head Condition.
- 1.3 percent steel in superstructure column (23 #9 bars).
- Drilled shaft extending from approximate water surface downward. Water surface elevation is approximately +96.1.
- Assumed 6 feet of scour (scoured mud line elevation of +80.1 feet).
- Lateral load of 25 kips applied at top of superstructure column at el. +123.1 feet in addition to axial load of 500 kips.
- Assume B-15 soil profile

General Findings/Conclusions:

- Modeling of a 54-inch diameter drilled shaft with 2% steel (minimum % for this analysis to run) and 5 ksi concrete, resulted in top of superstructure column deflection of 3.8 inches.
- Modeling of drilled shaft with 60-inch diameter, 1.3% steel, 5 ksi concrete, resulted in top of superstructure column deflection of 1.7 inches. The point of fixity for this project is defined as the depth/elevation where the pile deflection equals zero for the first time. The point of fixity was determined to be approximately elevation +54 feet. The maximum bending moment generated by the L Pile analysis is 1322 kip-ft occurring at approximately elevation +69 feet

The output file for the 60 inch shaft is presented in the Appendix as Exhibits C-8.

4.3.3 Drilled Shaft Summary

Summary of 60-inch Diameter Drilled Shaft Results

Drilled Shaft in Vicinity of Boring	Est. Drilled Shaft Depth Tip Elevation	Point of Fixity Elevation	Axial Capacity	Lateral Capacity with 1.7 inches Deflection	Maximum Bending Moment with 1.7 inches Deflection
B-3	+29'	-	250 tons	25 Kips	-
B-6	+36.5'	-	250 tons	25 Kips	-
B-7	+38'	-	250 tons	25 Kips	-
B-8	+29'	-	250 tons	25 Kips	-
B-10	+26'	-	250 tons	25 Kips	-
B-11	+43.5'	-	250 tons	25 Kips	-
B-13	+30.5'	-	250 tons	25 Kips	-
B-15	+25'	+54'	250 tons	25 Kips	1322 Kip-ft

[1]The elevations utilized refer to the City of St. Petersburg Datum. 0.00 City Datum = 97.79 NAVD 88. The forces are applied at the top of the 48-inch diameter column which corresponds to elevation +123.1 feet. The unscoured mudline is at elevation +86 feet and the scoured mudline is at elevation +80 feet.

[2]Point of Fixity is defined as the first depth or elevation at which the deflection of the pile equals zero.

4.3.4 Construction Considerations

Based on subsurface conditions, the drilled shafts will be installed using the "wet" method. This essentially means that the shaft will be filled with slurry (manufactured liquid) that will stabilize the hole (hold the hole open). Generally the "wet" method includes a natural slurry, however since the bearing layers contain zones of clayey sand we recommend that either a polymer or mineral slurry be utilized. The following recommendations are applicable for the wet method of drilled shaft construction.

- Casing of the top portion of shaft excavations on land is recommended to help maintain stability and reduce the potential for caving at the top of the excavation.

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(continued)

- A slurry displacement method drilled shaft is constructed by excavating with a drill rig equipped with appropriately sized tooling (earth augers, clean-out buckets, etc.) beneath drilling mud slurry which stabilizes the excavated shaft walls above the tooling.

- Typically, the slurry is introduced into the excavation after the groundwater table has been penetrated and/or the soils on the sides of the excavation are observed to cave.

- When the design shaft depth is reached, fluid concrete is placed through a tremie pipe at the bottom of the excavation and the slurry is displaced out of the top of the shaft excavation as the shaft fills with concrete.

- The slurry level in the shaft excavation should be maintained at a minimum of 5 feet or one shaft diameter (whichever is greater) above the subsurface water level.

- Observation during drilled shaft excavation should include verification of plumbness, maintenance of sufficient slurry head, monitoring the density, viscosity, pH and sand content of the drilling slurry, and monitoring any changes in the depth of the excavation between initial approval and prior to concreting using a weighted tape measure. The following drilling fluid properties are recommended:

Recommended Drilling Slurry Specifications (AASHTO, 2008)

Property of Slurry (Units)	Requirement	Test Method (API Standard Method)
Density (lb/ft^3)	Mineral: 64.3 to 72 Polymer: ≤ 64	Mud Weight Density Balance (API 13B-1)
Viscosity (sec/quart)	Mineral: 28 to 50 Polymer: 32 to 135	Marsh Funnel and Cup
pH	Mineral: 8 to 11 Polymer: 8 to 11.5	Glass Electrode pH Meter or pH Paper Strips
Sand Content Immediately Prior to Concrete Placement (% by Volume)	Mineral: < 4.0 Polymer ≤ 1.0	Sand Content (API 13B-1)

- The specific gravity or relative density of the drilling mud slurry should be periodically monitored from the initial mixing to the completion of the excavation of each shaft. An increase in the specific gravity or density of the drilling slurry at the bottom of the shaft by as much as 10 percent could be indicative of soil particles settling out of the slurry onto the bottom of the excavation. Excessive accumulation of loose particles in the bottom of the shaft prior to concrete placement could result in discontinuities in the shaft cross section if loose soil becomes suspended in the fluid concrete mass during concrete placement.

- The required fabricated reinforcing steel cage should be placed in the drilled shaft excavation after the shaft has reached the required depth and the drilling slurry has been cleaned/modified as necessary to meet specification requirements, and as close to the initiation of shaft concrete placement as feasible. The reinforcing cage should be designed to allow fluid concrete to flow freely between and around the individual bars and provide concrete cover of at least 6 inches between the reinforcing steel elements and the surrounding soil.

- Following approval of the shaft excavation depth and drilling slurry properties, the drilled shaft should be concreted as soon as practically possible using tremie methods. The concrete should have a 7- to 10-inch slump prior to discharge into the tremie. The bottom of the tremie pipe should be set at about one tremie pipe diameter above the bottom of the shaft excavation. A closure flap at the bottom of the tremie should be used, or a sliding plug introduced into the tremie before the fluid concrete, to reduce the potential for the concrete being contaminated by the slurry. The bottom of the tremie pipe must be completely embedded (typically at least 5 feet) in fluid concrete during placement, which should be a continuous operation.

Due to the inherent variability in the subsurface materials, a representative of the Geotechnical Engineer should verify the design parameters are valid during construction. Some modification to the design values presented in this report could be required in the field.

4.3.5 Pilot Borings

Because the drilled shafts will be installed using the "wet" method it is not possible to visually inspect the materials that the shaft is penetrating. As a result, it is necessary to determine the nature of the material prior to drilling the shaft and establish the shaft tip elevation based upon the results of the "pilot" hole or boring. This can be a problem where the soil conditions vary across a site such as we have on this site. To alleviate this problem, pilot holes are drilled at each shaft location. This is generally performed prior to mobilization by the drilled shaft contractor and accomplished using a geotechnical drilling rig. The Geotechnical Engineer of Record then reviews the boring logs (along with the load test data) and adjusts the tip depths or elevations of the shafts as needed to achieve the required capacity. Procedures for the installation of drilled shafts in Florida sometimes use the Florida Department of Transportation publication "Standard Specifications for Road and Bridge Construction" (SSRBC), Section 455, as a reference for drilled shaft installation.

4.3.6 Load Test

We also recommend that a load test be conducted prior to the start of the installation of production shafts to refine the shaft lengths. Two common methods include the Osterberg Cell® and a Statnamic® load test. This Osterberg Cell® method utilizes a jack embedded into the shaft. The Statnamic® load test, involves the use of a controlled explosive charge and with it a brief loud noise. For either test method, the shaft is instrumented with strain gages so that it can be determined where the capacity is obtained and thus allows for adjustments to be made

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(continued)

to the length of the shaft to account for the actual load carrying capacity of the soils at this site. A static load test could also be conducted, but requires a reaction force consisting of a frame anchored to the ground or a mass equivalent to the desired maximum test load. This method can be labor intensive and impractical for high capacity load tests.

A single load test will provide sufficient information to prove the design criteria is met. We recommend that the test shaft be a non-production shaft to allow it to be tested well above the design capacity. This will provide data for us to evaluate whether the frictional capacity can be increased somewhat over that which we have recommended.

4.3.7 Inspection and Additional Testing

Testing and inspection during construction should include a qualified drilled shaft inspector to monitor the drilling operations and the concrete placement. In addition, other inspection techniques can be used to inspect a completed shaft for the integrity of the concrete. What are commonly referred to as Crosshole Sonic Logging (CSL) tubes may be installed to check the integrity of the concrete in the shaft within the reinforcing cage. These tubes consist of steel pipes, usually 1½ inches in diameter, installed by tying them to the reinforcing cage. The number of tubes varies with the diameter of the shaft and usually there is one tube for each foot of diameter of shaft used. CSL uses sound waves to check for concrete integrity between the tubes and thus checks the concrete inside of the reinforcing cage. Thermal Integrity testing can use these same tubes. Thermal Integrity testing checks the concrete utilizing the variability of the heat of hydration that the concrete emits while curing. This method checks around a radius from the CSL tubes and is thus able to determine differences in the concrete outside of the reinforcing cage. While CSL testing can be conducted anytime following 2 to 3 days after concrete placement, Thermal Integrity testing has to be conducted within several days after concrete placement. We recommend CSL or Thermal Integrity tubes be installed on all shafts so that they can be tested in the event there is a question of shaft integrity.

4.4 Corrosion Protection

The Florida Department of Transportation has considerable experience with the construction of structures in corrosive marine environments. Current practice is to protect the steel with sufficient concrete with a low permeability. The DOT has tried utilizing epoxy coated reinforcing steel but has found that even minor imperfections in the coating can lead to significant corrosion of the steel. Corrosion is usually concentrated at the point of the defect in the coating and can result in significant reduction in the cross-sectional area at that location.

FDOT specifications require a minimum concrete cover of 6 inches where corrosion potential is high. This includes piles, drilled shafts as well as the superstructure. Concrete mixed for corrosive environments utilize Type II of Type II (MH) cement. In addition, pozzolans such as fly ash or slag are used to create a less permeable but workable mix. To further reduce the permeability of the concrete, silica fume, metakaoline or ultra-fine fly ash may be also added to the concrete mix. A corrosion inhibitor add mixture may also be used.

Concrete mix criteria for corrosive environments is discussed in greater detail in Section 346 of the FDOT SSRBC.

4.5 Earthwork (Dry Land Construction)

4.5.1 Site Preparation

Prior to placing any fill, all vegetation, topsoil, pavements, concrete, possible fill material and any otherwise unsuitable material should be removed from the construction areas. Wet or dry material should either be removed or moisture conditioned and re-compacted. After stripping and grubbing and achieving cut grades, the exposed surface should be proofrolled where possible to aid in locating loose or soft areas. Proof-rolling can be performed with appropriate heavy equipment to obtain a minimum compaction as defined in Section 4.4.3. Unstable soil (pumping) should be removed or moisture conditioned and compacted in place prior to placing fill.

Where fill is placed on existing slopes, we recommend that fill slopes be over filled and then cut back to develop an adequately compacted slope face. Slopes should be provided with appropriate erosion protection.

4.5.2 Material Requirements

Compacted structural fill should meet the following material property requirements:

Fill Type [1]	USCS Classification	Acceptable Location for Placement	Maximum Lift Thickness (in.)
General [1]	SP (fines content < 5%)	All locations and elevations	12[3]
	SP-SM (fines content between 5 and 12%)[2]	All locations and elevations, except strict moisture control will be required during placement, particularly during the rainy season.	8 to 12[3]

1. Controlled, compacted fill should consist of approved materials that are free of organic matter and debris. Strata Numbers 1 and 2 meet the requirement for structural fill.
2. If fines contents are greater than 12%, special design and construction procedures may be necessary.
3. Loose thickness when heavy compaction equipment is used in vibratory mode. Lift thickness should be decreased if static compaction is being used, typically to no more than 8 inches, and the required compaction must still be achieved. Use 4 to 6 inches in loose thickness when hand-guided equipment (i.e. jumping jack or plate compactor) is required.

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4.5.3 Compaction Requirements-Mass Fill Areas

Item	Description
Minimum Compaction Requirements [1]	95 percent of the material's maximum modified Proctor dry density (ASTM D 1557).
Moisture Content[2]	Within ±3 percent of optimum moisture content as determined by the Modified Proctor test, at the time of placement and compaction.
Minimum Testing Frequency	One field density test per 10,000 square feet or fraction thereof per 1-foot lift.

1. We recommend that engineered fill be tested for moisture content and compaction during placement. Should the results of the in-place density tests indicate the specified moisture or compaction limits have not been met, the area represented by the test should be reworked and retested as required until the specified moisture and compaction requirements are achieved.
2. Specifically, moisture levels should be maintained low enough to allow for satisfactory compaction to be achieved without the cohesionless fill material pumping when proofrolled.

4.5.4 Utility Trench Backfill

All trench excavations should be made with sufficient working space to permit construction including backfill placement and compaction. Utility trenches are a common source of water infiltration and migration.

4.5.5 Grading and Drainage

Final surrounding grades should be sloped away from the structure on all sides to prevent ponding of water. Gutters, downspouts, or other appropriate methods that direct water a minimum of 10 feet beyond the footprint of the proposed structures are recommended. Site grades should be set considering the estimated seasonal high groundwater presented in Section 3.4.

4.5.6 Earthwork Construction Considerations

After initial proofrolling and compaction, unstable subgrade conditions could develop during general construction operations, particularly if the soils are wetted and/or subjected to repetitive construction traffic. Upon completion of filling and grading, care should be taken to maintain the subgrade moisture content prior to construction of floor slabs and pavements. Construction traffic over the completed subgrade should be avoided to the extent practical. The site should also be graded to prevent ponding of surface water on the prepared subgrades or in excavations. If the subgrade should become desiccated, saturated, or disturbed, the affected material should be removed or these materials should be scarified, moisture conditioned, and re-compacted prior to floor slab and pavement construction.

Trees or other vegetation whose root systems have the ability to remove excessive moisture from the subgrade and foundation soils should not be planted next to the structure. Trees and shrubbery should be kept away from the exterior edges of the foundation element a distance at least equal to 1.5 times their expected mature height.

As a minimum, all temporary excavations should be sloped or braced as required by Occupational Health and Safety Administration (OSHA) regulations to provide stability and safe working conditions. Temporary excavations will probably be required during grading operations. The grading contractor, by his contract, is usually responsible for designing and constructing stable, temporary excavations and should shore, slope or bench the sides of the excavations as required, to maintain stability of both the excavation sides and bottom. All excavations should comply with applicable local, state and federal safety regulations, including the current OSHA Excavation and Trench Safety Standards.

Terracon should be retained during the construction phase of the project to observe earthwork and to perform necessary tests and observations during subgrade preparation; proof-rolling; placement and compaction of controlled compacted fills; backfilling of excavations into the completed subgrade, and just prior to construction of building floor slabs.

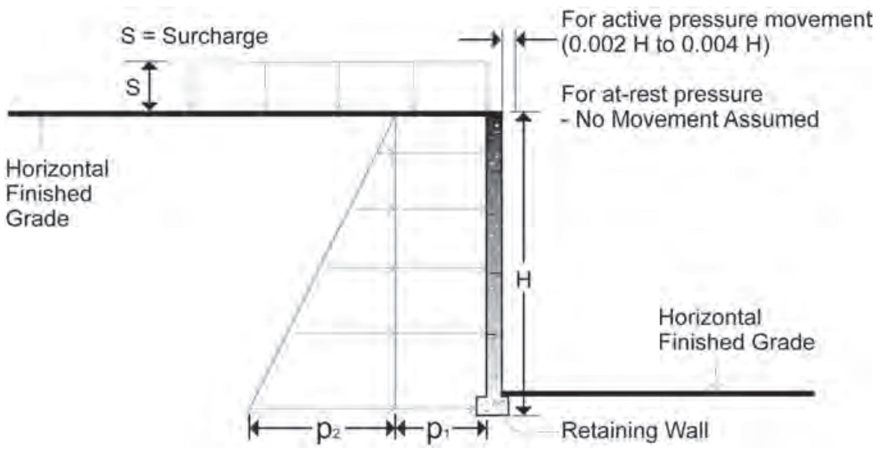
4.6 Seismic Considerations

Florida is under the jurisdiction of its own building code as opposed to the International Building Code. The Florida Building Code does not have a requirement or provision for evaluating seismic potential. Florida is generally regarded to be in a zone of low seismic risk. Therefore we do not consider seismic effects to be a concern at this site.

4.7 Lateral Earth Pressures

Reinforced concrete walls with unbalanced backfill levels on opposite sides should be designed for earth pressures at least equal to those indicated in the following table. Earth pressures will be influenced by structural design of the walls, conditions of wall restraint, methods of construction and/or compaction and the strength of the materials being restrained. Two wall restraint conditions are shown. Active earth pressure is commonly used for design of free-standing cantilever retaining walls and assumes wall movement. The "at-rest" condition assumes no wall movement, such as a wall that is structurally confined at both the top and bottom of the wall. The recommended design lateral earth pressures do not include a factor of safety and do not provide for possible hydrostatic pressure on the walls.

GEOTECHNICAL REPORT
(continued)



Earth Pressure Coefficients

Earth Pressure Conditions	Coefficient for Backfill Type	Equivalent Fluid Density (pcf)	Surcharge Pressure, p_1 (psf)	Earth Pressure, p_2 (psf)
Active (Ka)	Granular - 0.33	40	(0.33)S	(40)H
At-Rest (Ko)	Granular - 0.46	55	(0.46)S	(55)H
Passive (Kp)	Granular - 3.0	360	---	---

Applicable conditions to the above include:

- Uniform surcharge, where S is surcharge pressure
- In-situ soil backfill weight a maximum of 120 pcf
- Horizontal backfill, compacted between 95 and 98 percent of modified Proctor maximum dry density
- Loading from heavy compaction equipment not included
- No hydrostatic pressures acting on wall
- No dynamic loading
- No safety factor included in soil parameters

Backfill placed against structures should consist of granular soils. For the granular values to be valid, the granular backfill must extend out from the base of the wall at an angle of at least 45 and 60 degrees from vertical for the active and passive cases, respectively. To calculate the resistance to sliding, a value of 0.32 should be used as the ultimate coefficient of friction between the footing and the underlying soil.

To control hydrostatic pressure behind the wall we recommend that a drain be installed at the foundation wall with a collection pipe leading to a reliable discharge. For granular backfill, an equivalent fluid weighing 85 and 90 pcf should be used for active and at-rest, respectively. These pressures do not include the influence of surcharge, equipment or floor loading, which should be added. Heavy equipment should not operate within a distance closer than the exposed height of retaining walls to prevent lateral pressures more than those provided

5.0 GENERAL COMMENTS

Terracon should be retained to review the final design plans and specifications so comments can be made regarding interpretation and implementation of our geotechnical recommendations in the design and specifications. Terracon also should be retained to provide observation and testing services during grading, excavation, foundation construction and other earth-related construction phases of the project.

The analysis and recommendations presented in this report are based upon the data obtained from the borings performed at the indicated locations and from other information discussed in this report. This report does not reflect variations that may occur between borings, across the site, or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. If variations appear, we should be immediately notified so that further evaluation and supplemental recommendations can be provided.

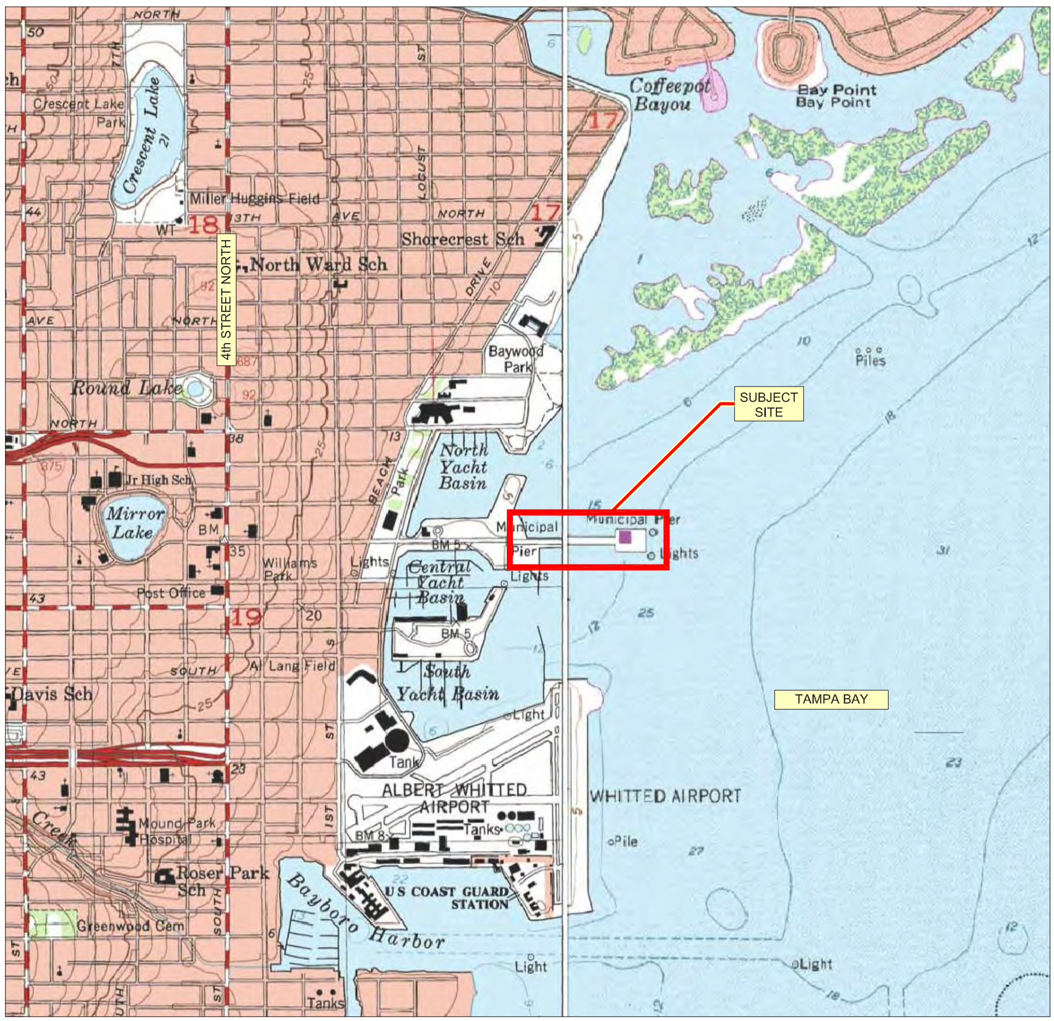
The scope of services for this project does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

This report has been prepared for the exclusive use of our client for specific application to the project discussed and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranties, either expressed or implied, are intended or made. Site safety, excavation support, and dewatering requirements are the responsibility of others. In the event that changes in the nature, design, or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered valid unless Terracon reviews the changes and either verifies or modifies the conclusions of this report in writing.

GEOTECHNICAL REPORT
(continued)

APPENDIX A
FIELD EXPLORATION

UNITED STATES — DEPARTMENT OF THE INTERIOR — GEOLOGICAL SURVEY



SCALE 1:24 000

KILOMETERS

MILES

FEET

CONTOUR INTERVAL 5 FEET

NATIONAL GEODETIC VERTICAL DATUM OF 1929

SECTION: 19
TOWNSHIP: 31 SOUTH
RANGE: 17 EAST

SAINT PETERSBURG, FLORIDA 1998 | PORT TAMPA, FLORIDA 1956; PHOTOREVISED 1981

7.5 MINUTE SERIES (QUADRANGLE)

N

N:\Projects-Other Offices\Tampa\2013\H4135006\Cad\H4135006-Exhibit-A-1.dwg

Project Mngr:	CA	Project No.	37117134
Drawn By:	MG	Scale:	AS SHOWN
Checked By:	CA	File No.	37117134
Approved By:	CA	Date:	2-28-13

Terracon
Consulting Engineers and Scientists

504 E. TYLER STREET TAMPA, FLORIDA 33602
PH. (813) 221-0050 FAX. (813) 221-0051

TOPOGRAPHIC VICINITY MAP
GEOTECHNICAL ENGINEERING REPORT
THE LENS
ST. PETERSBURG, PINELLAS COUNTY, FLORIDA

EXHIBIT
A-1

GEOTECHNICAL REPORT
(continued)

SCALE 1" = 2000'

1000 0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10000

U.S.D.A. SOIL SURVEY FOR PINELLAS COUNTY, FLORIDA
ISSUED: 1970

N

SECTION: 19
TOWNSHIP: 31 SOUTH
RANGE: 17 EAST

SOIL LEGEND

Co COASTAL BEACHES
Ub URBAN LAND

N:\Projects-Other Offices\Tampa\2013\H4135006\Cad\H4135006-Exhibit-A-2.dwg

Project Mngr: CA	Project No. 37117134	Terracon Consulting Engineers and Scientists	SOILS MAP
Drawn By: MG	Scale: AS SHOWN	504 E. TYLER STREET TAMPA, FLORIDA 33602	GEOTECHNICAL ENGINEERING REPORT
Checked By: CA	File No. 37117134	PH. (813) 221-0050 FAX. (813) 221-0051	THE LENS
Approved By: CA	Date: 2-28-13		ST. PETERSBURG, PINELLAS COUNTY, FLORIDA

EXHIBIT A-2

Soil Survey Descriptions

Co – Coastal Beaches This map unit supports little or no vegetation. Areas are either bare or covered with saltwater during daily high tides and stormy periods. This mapping unit is used for beach and water activities. The seasonal high water table is apparent from 2 feet above the surface to the surface from January through December. The parent material consists of sandy marine sediments with varying amounts of shell fragments.

Ub – Urban Land Urban land consists of high-density residential developments, commercial buildings, streets, highways, parking lots, and other types of impervious ground cover. The areas of Pinellas soil that are not covered by impervious material are too small to be delineated separately at the scale of mapping and are mostly grassy areas.

GEOTECHNICAL REPORT
(continued)

Field Exploration Description

The boring locations were laid out at the project site by Terracon personnel based on a drawing provided to us. The actual boring locations were then surveyed by George F. Young, Inc. and they are shown on the boring location plan. George F. Young also provided the boring elevations.

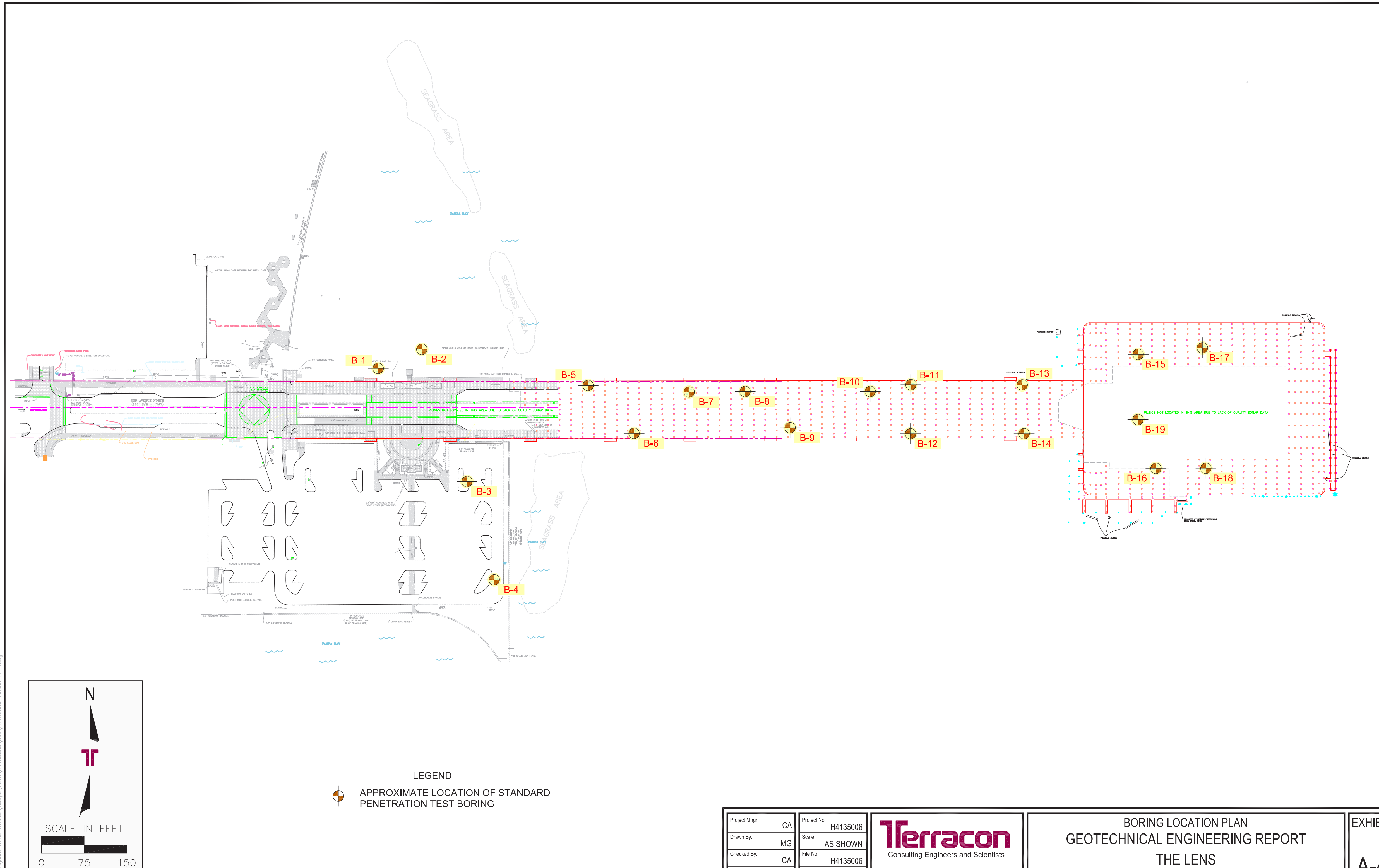
Boring B-1 through B-4 were drilled with an ATV-mounted, rotary drilling rig equipped with a rope and cathead-operated safety hammer. Borings B-5 through B-19 were drilled with a truck-mounted, rotary drilling rigs with an automatic hammer.

The boreholes were advanced with a cutting head and stabilized with the use of bentonite (drillers' mud). Soil samples were obtained by the split spoon sampling procedure in general accordance with the Standard Penetration Test (SPT) procedure. In the split spoon sampling procedure, the number of blows required to advance the sampling spoon the last 12 inches of an 18-inch penetration or the middle 12 inches of a 24-inch penetration by means of a 140-pound hammer with a free fall of 30 inches (or automatic hammer with an equivalent energy), is the standard penetration resistance value (N). This value is used to estimate the in-situ relative density of cohesionless soils and the consistency of cohesive soils. The sampling depths and penetration distance, plus the standard penetration resistance values, are shown on the boring logs.

Portions of the samples from the borings were sealed in glass jars to reduce moisture loss, and then the jars were taken to our laboratory for further observation and classification. Upon completion, the boreholes were backfilled with the site soil.

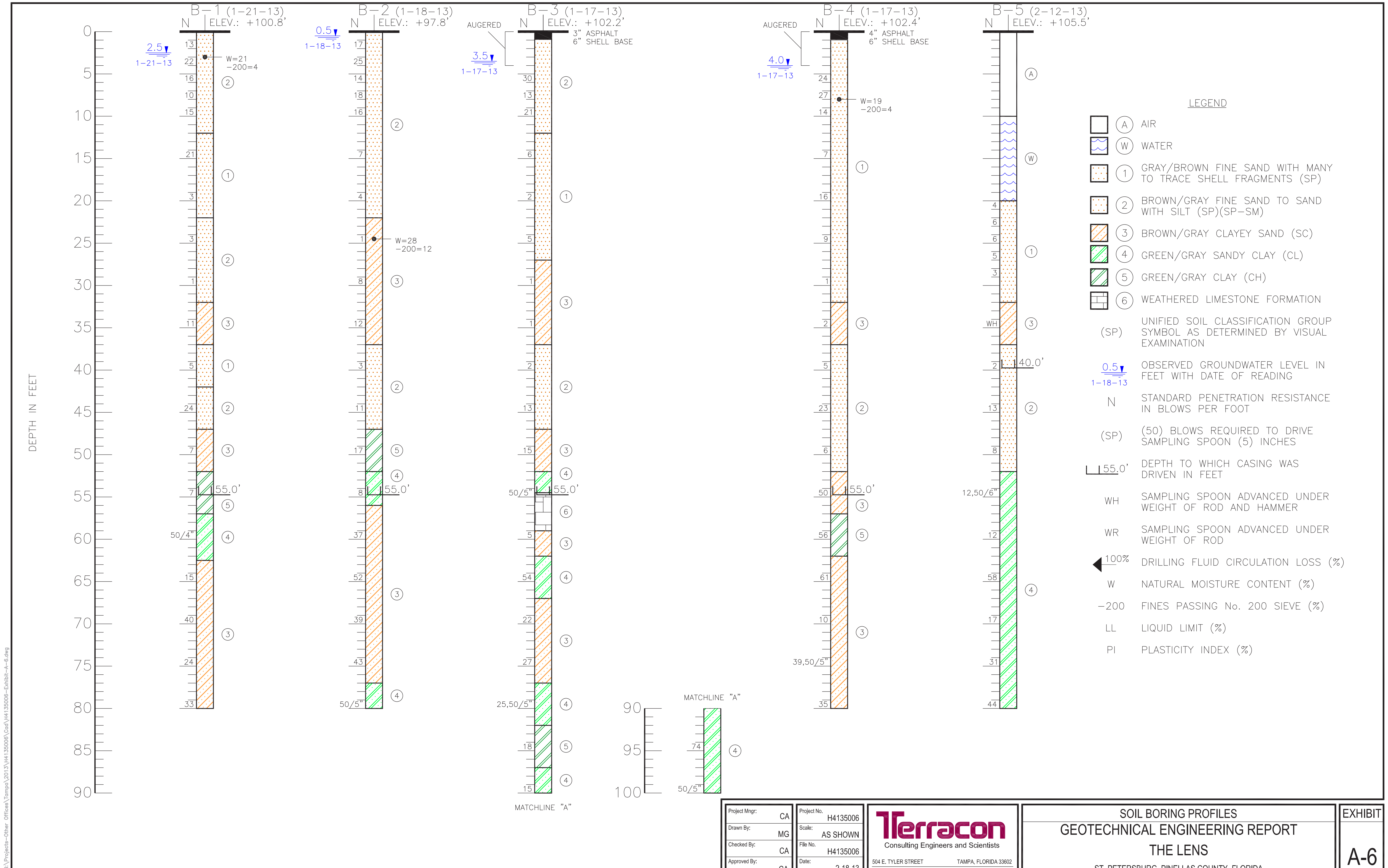
Field logs of each boring were prepared by the drill crew. These logs included visual classifications of the materials encountered during drilling as well as the driller's interpretation of the subsurface conditions between samples. The boring logs included with this report represent an interpretation of the field logs and include modifications based on laboratory observation of the samples.

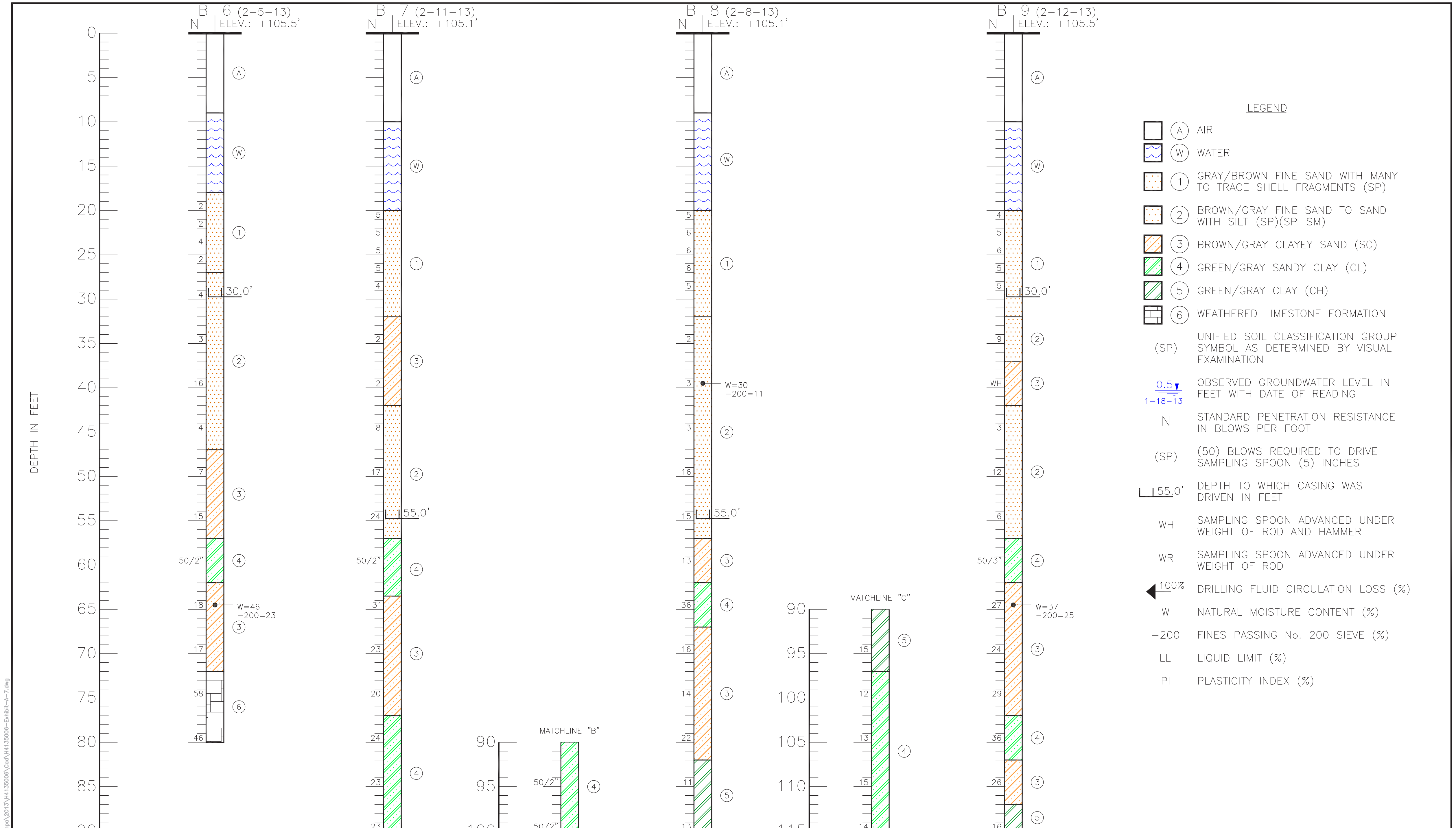
An automatic SPT hammer was used to advance the split-barrel sampler in some of the borings performed on this site. A significantly greater efficiency is achieved with the automatic hammer compared to the conventional safety hammer operated with a cathead and rope. This higher efficiency has an appreciable effect on the SPT-N value. The effect of the automatic hammer's efficiency has been considered in the interpretation and analysis of the subsurface information for this report.



Project Mngr: CA	Project No. H4135006	Terracon Consulting Engineers and Scientists	BORING LOCATION PLAN	EXHIBIT
Drawn By: MG	Scale: AS SHOWN	504 E. TYLER STREET TAMPA, FLORIDA 33602	GEOTECHNICAL ENGINEERING REPORT	A-4
Checked By: CA	File No. H4135006	PH. (813) 221-0050 FAX. (813) 221-0051	THE LENS	
Approved By: CA	Date: 2-18-13		ST. PETERSBURG, PINELLAS COUNTY, FLORIDA	

GEOTECHNICAL REPORT
(continued)

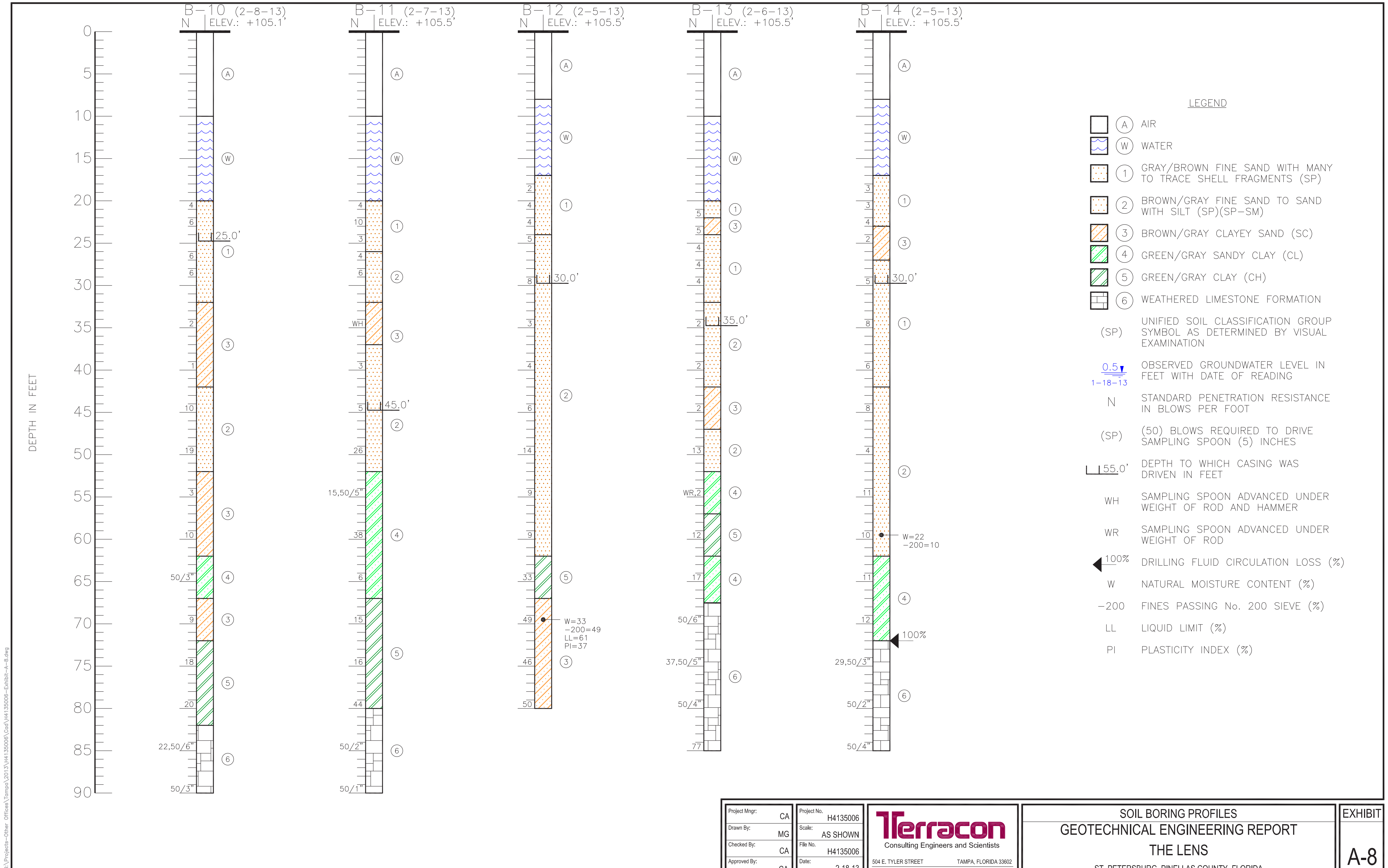


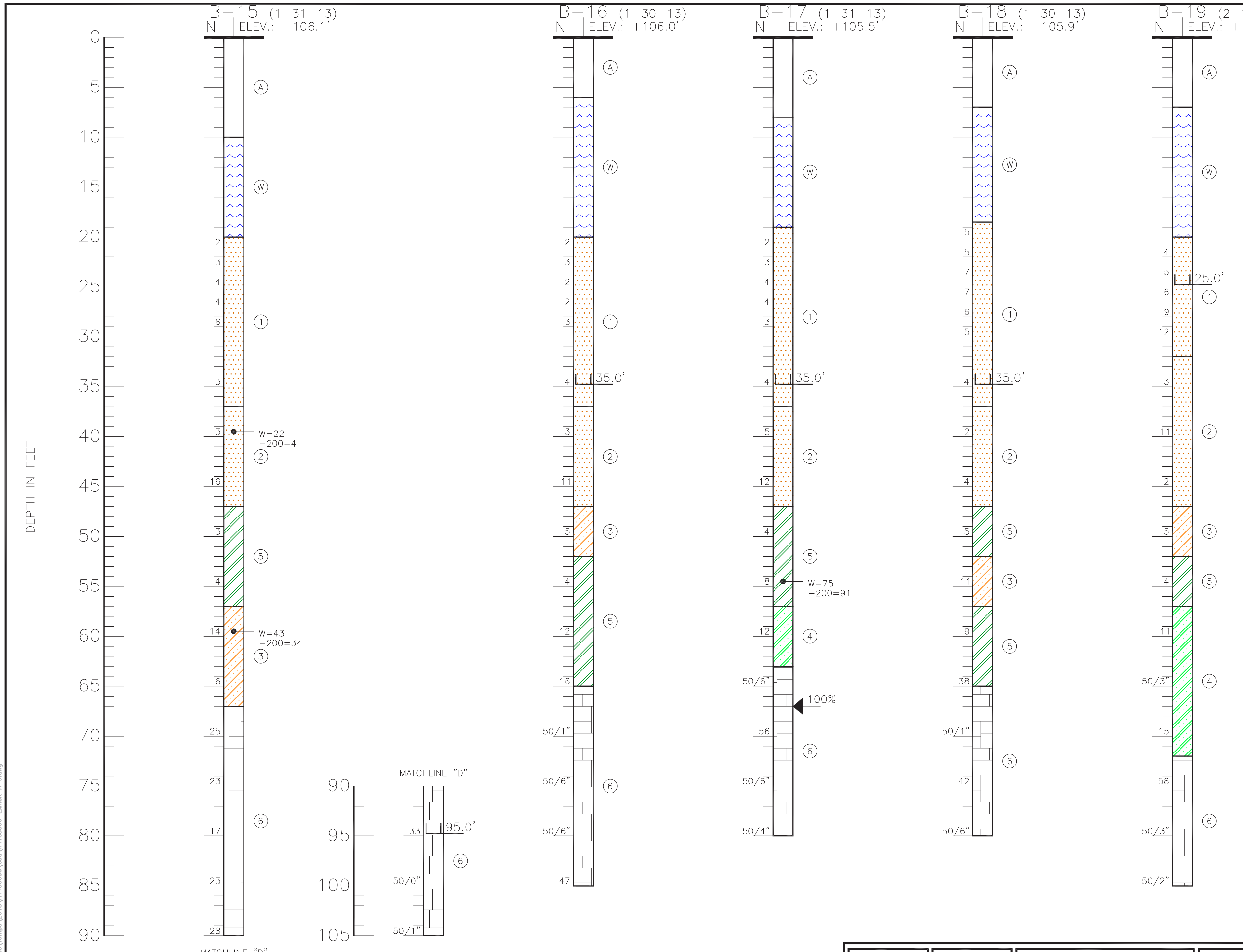


Project Mngr: CA	Project No. H4135006	Terracon	SOIL BORING PROFILES
Drawn By: MG	Scale: AS SHOWN	Consulting Engineers and Scientists	GEOTECHNICAL ENGINEERING REPORT
Checked By: CA	File No. H4135006	504 E. TYLER STREET TAMPA, FLORIDA 33602	THE LENS
Approved By: CA	Date: 2-18-13	PH. (813) 221-0050 FAX. (813) 221-0051	ST. PETERSBURG, PINELLAS COUNTY, FLORIDA

EXHIBIT A-7

GEOTECHNICAL REPORT
(continued)





LEGEND

(A)	AIR
(W)	WATER
(1)	GRAY/BROWN FINE SAND WITH MANY TO TRACE SHELL FRAGMENTS (SP)
(2)	BROWN/GRAY FINE SAND TO SAND WITH SILT (SP)(SP–SM)
(3)	BROWN/GRAY CLAYEY SAND (SC)
(4)	GREEN/GRAY SANDY CLAY (CL)
(5)	GREEN/GRAY CLAY (CH)
(6)	WEATHERED LIMESTONE FORMATION
(SP)	UNIFIED SOIL CLASSIFICATION GROUP SYMBOL AS DETERMINED BY VISUAL EXAMINATION
0.5 / 1-18-13	OBSERVED GROUNDWATER LEVEL IN FEET WITH DATE OF READING
N	STANDARD PENETRATION RESISTANCE IN BLOWS PER FOOT
(SP)	(50) BLOWS REQUIRED TO DRIVE SAMPLING SPOON (5) INCHES
55.0'	DEPTH TO WHICH CASING WAS DRIVEN IN FEET
WH	SAMPLING SPOON ADVANCED UNDER WEIGHT OF ROD AND HAMMER
WR	SAMPLING SPOON ADVANCED UNDER WEIGHT OF ROD
100%	DRILLING FLUID CIRCULATION LOSS (%)
W	NATURAL MOISTURE CONTENT (%)
-200	FINES PASSING No. 200 SIEVE (%)
LL	LIQUID LIMIT (%)
PI	PLASTICITY INDEX (%)

Project Mngr: CA	Project No. H4135006	Terracon Consulting Engineers and Scientists	SOIL BORING PROFILES
Drawn By: MG	Scale: AS SHOWN	504 E. TYLER STREET, TAMPA, FLORIDA 33602	GEOTECHNICAL ENGINEERING REPORT
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EXHIBIT A-9

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APPENDIX B – LABORATORY TESTING

GEOTECHNICAL REPORT
(continued)

Laboratory Testing

During the field exploration, a portion of each recovered sample was sealed in a glass jar and transported to our laboratory for further visual observation and laboratory testing. Selected samples retrieved from the borings were tested for moisture (water) content, fines content (soil passing a US standard #200 sieve), and Atterberg limit testing. Those results are included in this report and on the respective boring logs. The visual-manual classifications were modified as appropriate based upon the laboratory testing results.

The soil samples were classified in general accordance with the appended General Notes and the Unified Soil Classification System based on the material's texture and plasticity. The estimated group symbol for the Unified Soil Classification System is shown on the boring logs and a brief description of the Unified Soil Classification System is included in Appendix C. The results of our laboratory testing are presented in the Laboratory Test Results section of this report and on the corresponding borings logs.

SUMMARY OF LABORATORY TESTS
THE LENS
ST. PETERSBURG, FLORIDA

Boring Number	Sample Depth (ft) From To	USCS ID	Stratum Number	Percent Passing No. 200 Sieve	Natural Moisture (%)	Atterberg Limits	
						LL	PI
B-1	2-4	SP	2	4	21	--	--
B-2	23.5-25	SC	3	12	28	--	--
B-4	6-8	SP	1	4	19	--	--
B-6	63.5-65	SC	3	23	46	--	--
B-8	38.5-40	SP-SM	2	11	30	--	--
B-9	63.5-65	SC	3	25	37	--	--
B-12	68.5-70	SC	3	49	33	61	37
B-14	58.5-60	SP-SM	2	10	22	--	--
B-15	38.5-40	SP	2	4	22	--	--
B-15	58.5-60	SC	3	34	43	--	--
B-17	53.5-55	CH	5	91	75	--	--

**GEOTECHNICAL REPORT
(continued)**

APPENDIX C
SUPPORTING DOCUMENTS

GENERAL NOTES

DRILLING & SAMPLING SYMBOLS:

SS:	Split Spoon - 1-$^{3}/_{8}$" I.D., 2" O.D., unless otherwise noted	HS:	Hollow Stem Auger
ST:	Thin-Walled Tube – 2" O.D., 3" O.D., unless otherwise noted	PA:	Power Auger (Solid Stem)
RS:	Ring Sampler - 2.42" I.D., 3" O.D., unless otherwise noted	HA:	Hand Auger
DB:	Diamond Bit Coring - 4", N, B	RB:	Rock Bit
BS:	Bulk Sample or Auger Sample	WB	Wash Boring or Mud Rotary

WATER LEVEL MEASUREMENT SYMBOLS:

WL:	Water Level	WS:	While Sampling	N/E:	Not Encountered
WCI:	Wet Cave in	WD:	While Drilling	ESH:	Estimated Seasonal High Groundwater
DCI:	Dry Cave in	BCR:	Before Casing Removal	ESL:	Estimated Seasonal Low Groundwater
AB:	After Boring	ACR:	After Casing Removal		

Water levels indicated on the boring logs are the levels measured in the borings at the times indicated. Groundwater levels at other times and other locations across the site could vary. In pervious soils, the indicated levels may reflect the location of groundwater. In low permeability soils, the accurate determination of groundwater levels may not be possible with only short-term observations.

DESCRIPTIVE SOIL CLASSIFICATION: Soil classification is based on the Unified Soil Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are principally described as clays if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils on the basis of their consistency.

CONSISTENCY OF FINE-GRAINED SOILS

Unconfined Compressive Strength, Qu, psf	Standard Penetration or N-value (SS) Blows/Ft.	Consistency
< 500	0 – 1	Very Soft
500 – 1,000	2 – 3	Soft
1,000 – 2,000	4 – 6	Medium Stiff
2,000 – 4,000	7 – 12	Stiff
4,000 – 8,000	13 – 26	Very Stiff
8,000+	> 26	Hard

RELATIVE DENSITY OF COARSE-GRAINED SOILS

Standard Penetration or N-value (SS) Blows/Ft.	Relative Density
0 – 3	Very Loose
4 – 9	Loose
10 – 29	Medium Dense
30 – 50	Dense
> 50	Very Dense

RELATIVE PROPORTIONS OF SAND AND GRAVEL

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 15
With	15 – 29
Modifier	≥ 30

GRAIN SIZE TERMINOLOGY

Major Component of Sample	Particle Size
Boulders	Over 12 in. (300mm)
Cobbles	12 in. to 3 in. (300mm to 75mm)
Gravel	3 in. to #4 sieve (75mm to 4.75mm)
Sand	#4 to #200 sieve (4.75 to 0.075mm)
Silt or Clay	Passing #200 Sieve (0.075mm)

RELATIVE PROPORTIONS OF FINES

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 5
With	5 – 12
Modifier	> 12

PLASTICITY DESCRIPTION

Term	Plasticity Index
Non-plastic	0
Low	1 – 10
Medium	11 – 30
High	> 30

Rev. 4/10

C-1

GEOTECHNICAL REPORT
(continued)

UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]					Soil Classification: Group Symbol	Soil Classification: Group Name [B]
Coarse Grained Soils: More than 50% retained on No. 200 sieve	**Gravels:** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels:** Less than 5% fines [C]	$Cu \geq 4$ and $1 \leq Cc \leq 3$ [E]		GW	Well-graded gravel [F]
			$Cu < 4$ and/or $1 > Cc > 3$ [E]		GP	Poorly graded gravel [F]
		Gravels with Fines: More than 12% fines [C]	Fines classify as ML or MH		GM	Silty gravel [F,G,H]
			Fines classify as CL or CH		GC	Clayey gravel [F,G,H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:** Less than 5% fines [D]	$Cu \geq 6$ and $1 \leq Cc \leq 3$ [E]		SW	Well-graded sand [I]
			$Cu < 6$ and/or $1 > Cc > 3$ [E]		SP	Poorly graded sand [I]
		Sands with Fines: More than 12% fines [D]	Fines classify as ML or MH		SM	Silty sand [G,H,I]
			Fines classify as CL or CH		SC	Clayey sand [G,H,I]
Fine-Grained Soils: 50% or more passes the No. 200 sieve	**Silts and Clays:** Liquid limit less than 50	**Inorganic:**	$PI > 7$ and plots on or above "A" line [J]		CL	Lean clay [K,L,M]
			$PI < 4$ or plots below "A" line [J]		ML	Silt [K,L,M]
		Organic:	Liquid limit - oven dried	< 0.75	OL	Organic clay [K,L,M,N]
			Liquid limit - not dried			Organic silt [K,L,M,O]
	Silts and Clays: Liquid limit 50 or more	**Inorganic:**	PI plots on or above "A" line		CH	Fat clay [K,L,M]
			PI plots below "A" line		MH	Elastic Silt [K,L,M]
		Organic:	Liquid limit - oven dried	< 0.75	OH	Organic clay [K,L,M,P]
			Liquid limit - not dried			Organic silt [K,L,M,Q]
Highly organic soils:	Primarily organic matter, dark in color, and organic odor				PT	Peat

[A] Based on the material passing the 3-inch (75-mm) sieve

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay

[E] $Cu = D_{60}/D_{10}$ $\quad Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥ 15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.

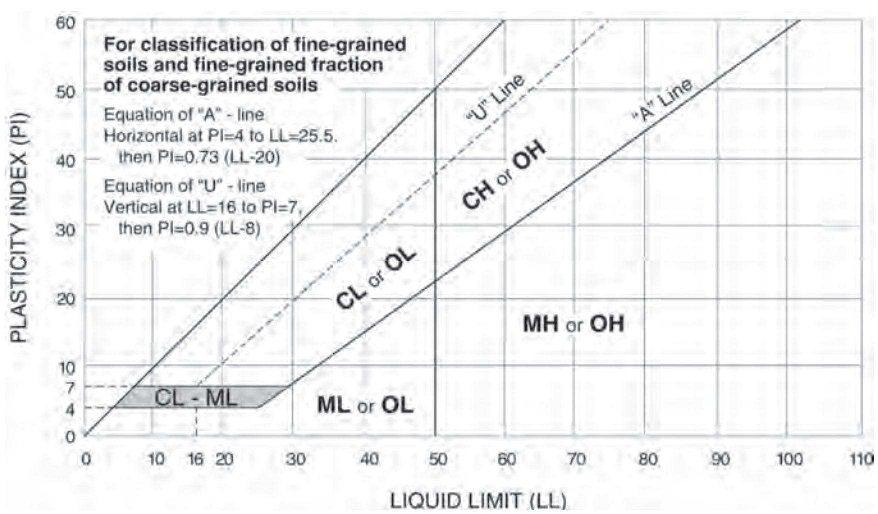
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] $PI \geq 4$ and plots on or above "A" line.

[O] $PI < 4$ or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.



Terracon

C-2

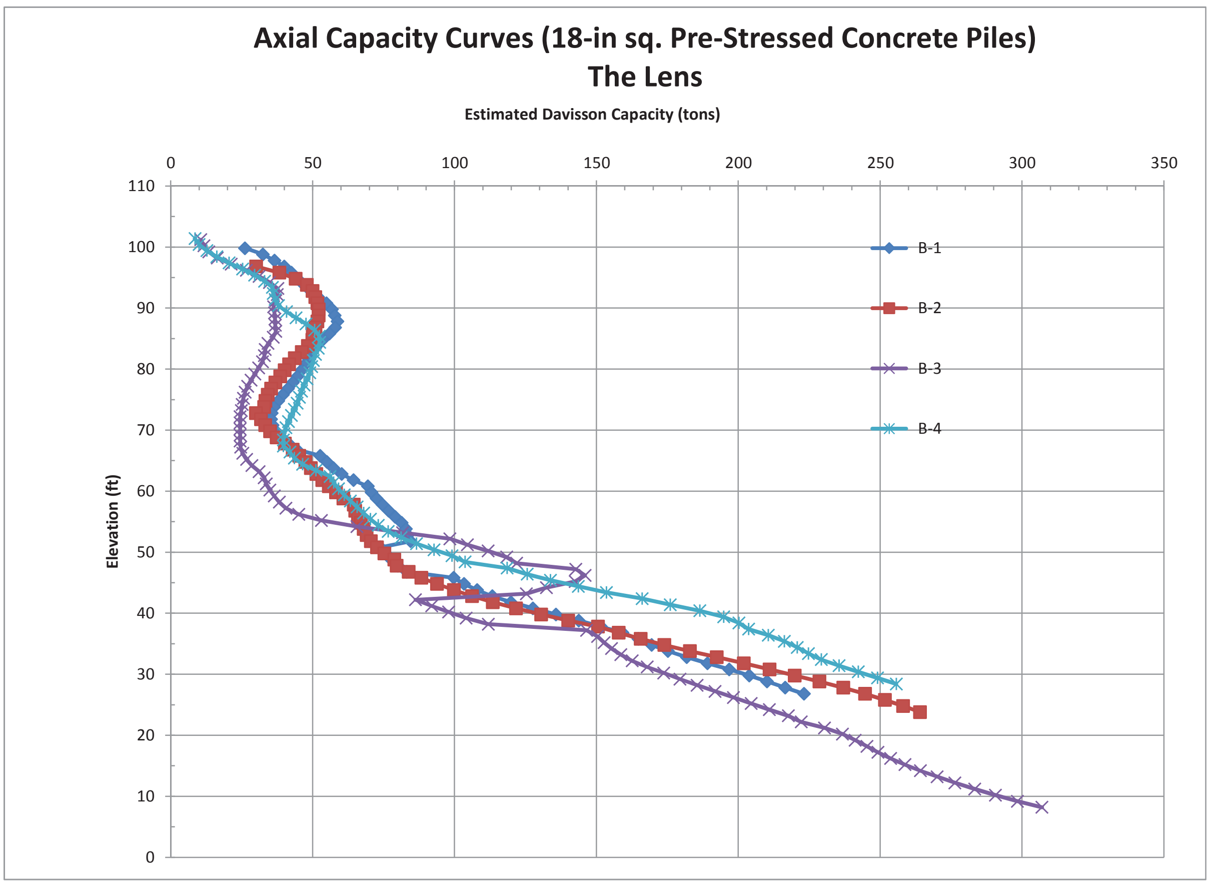

Axial Capacity Curves (18-in sq. Pre-Stressed Concrete Piles)
The Lens
Estimated Davisson Capacity (tons)
0
50
100
150
200
250
300
350
110
100
90
80
70
60
50
40
30
20
10
0
Elevation (ft)
B-1
B-2
B-3
B-4

Exhibit C-3

GEOTECHNICAL REPORT
(continued)

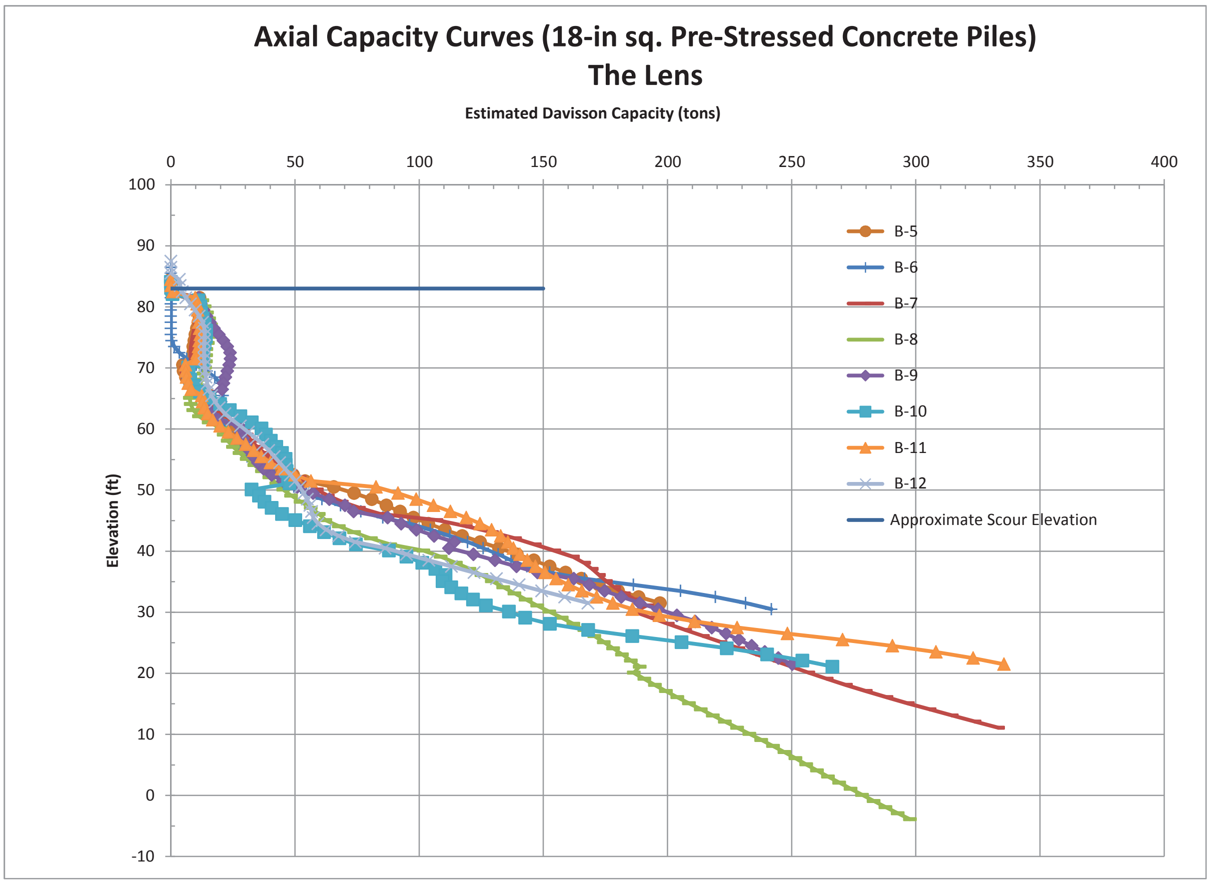


Exhibit C-4

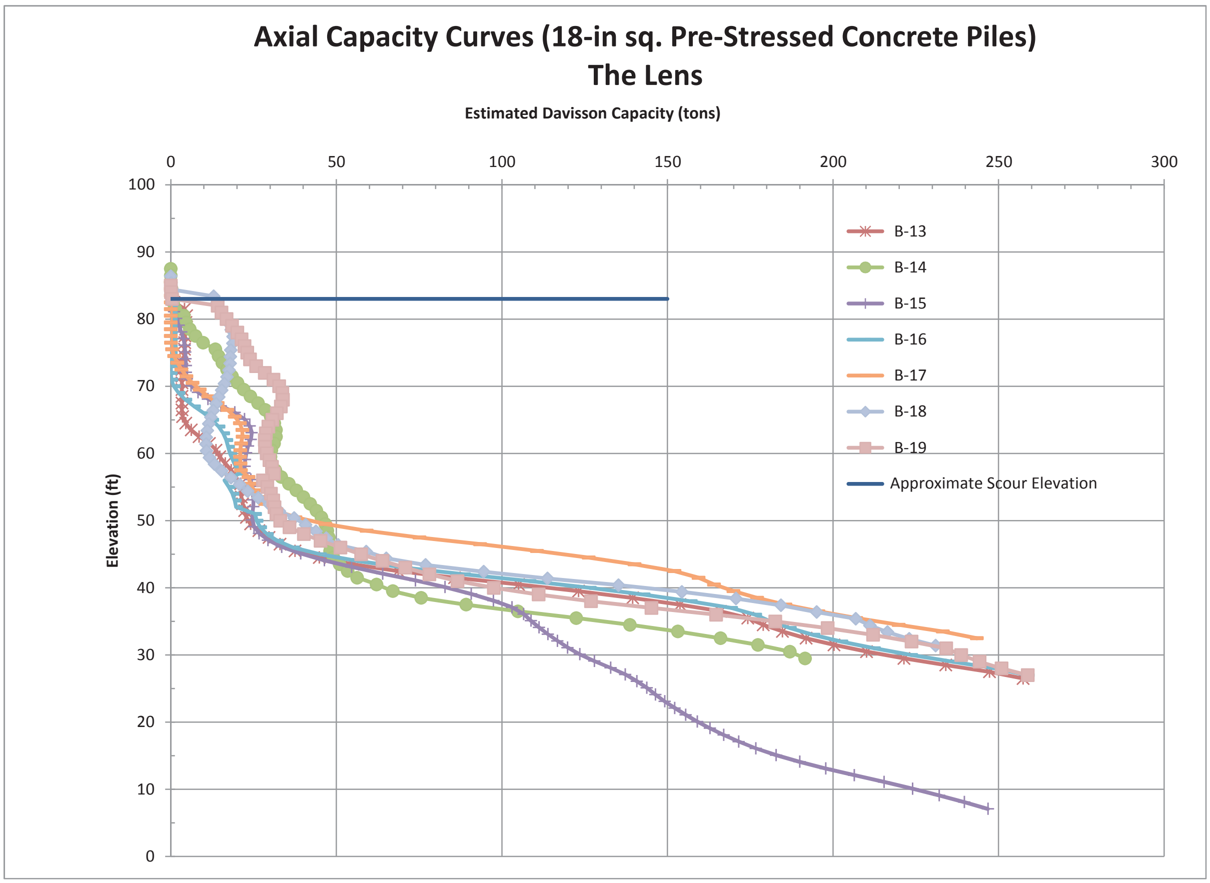

Axial Capacity Curves (18-in sq. Pre-Stressed Concrete Piles)
The Lens
Estimated Davisson Capacity (tons)
0
50
100
150
200
250
300
100
90
80
70
60
50
40
30
20
10
0
Elevation (ft)
B-13
B-14
B-15
B-16
B-17
B-18
B-19
Approximate Scour Elevation

Exhibit C-5

GEOTECHNICAL REPORT
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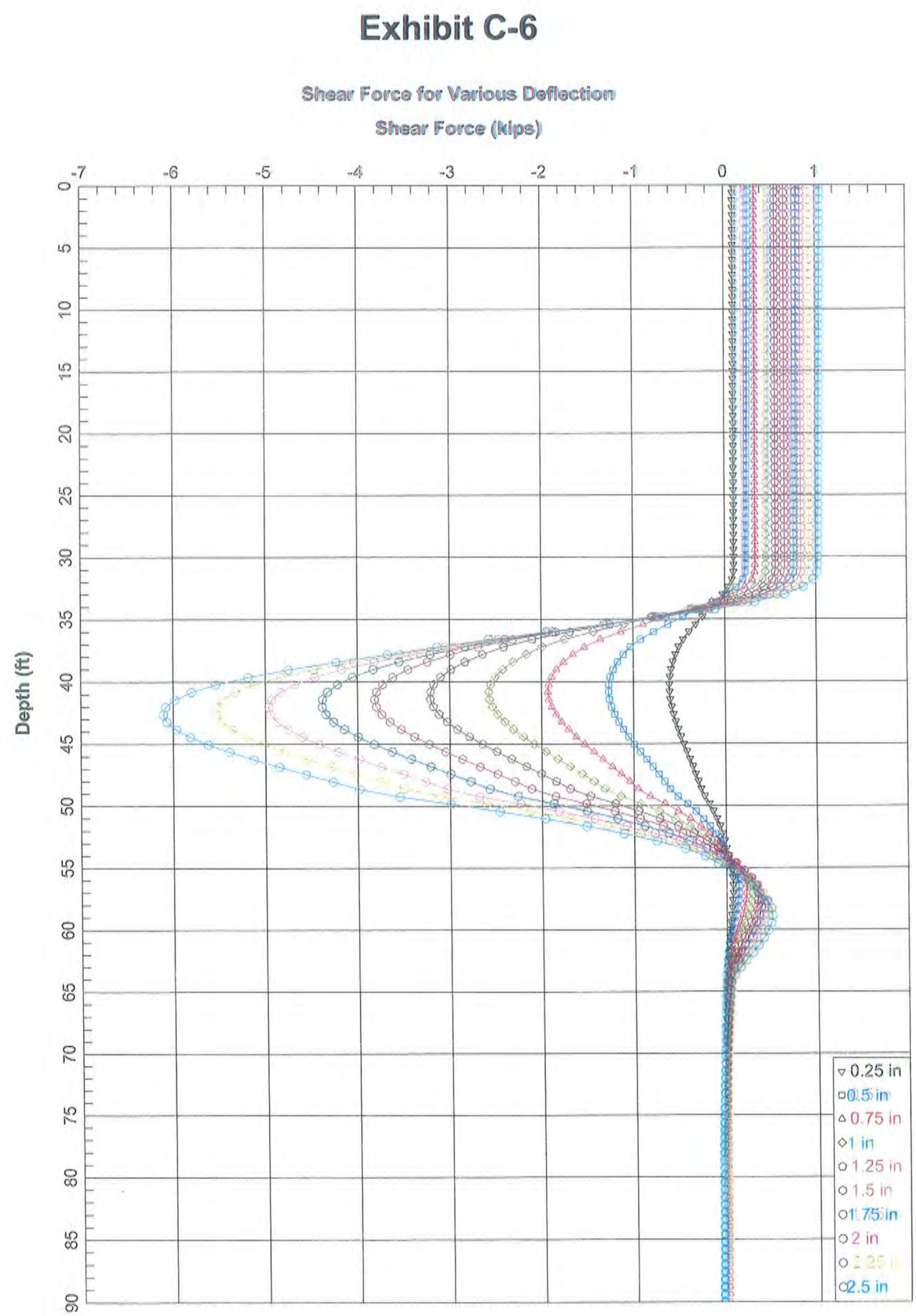
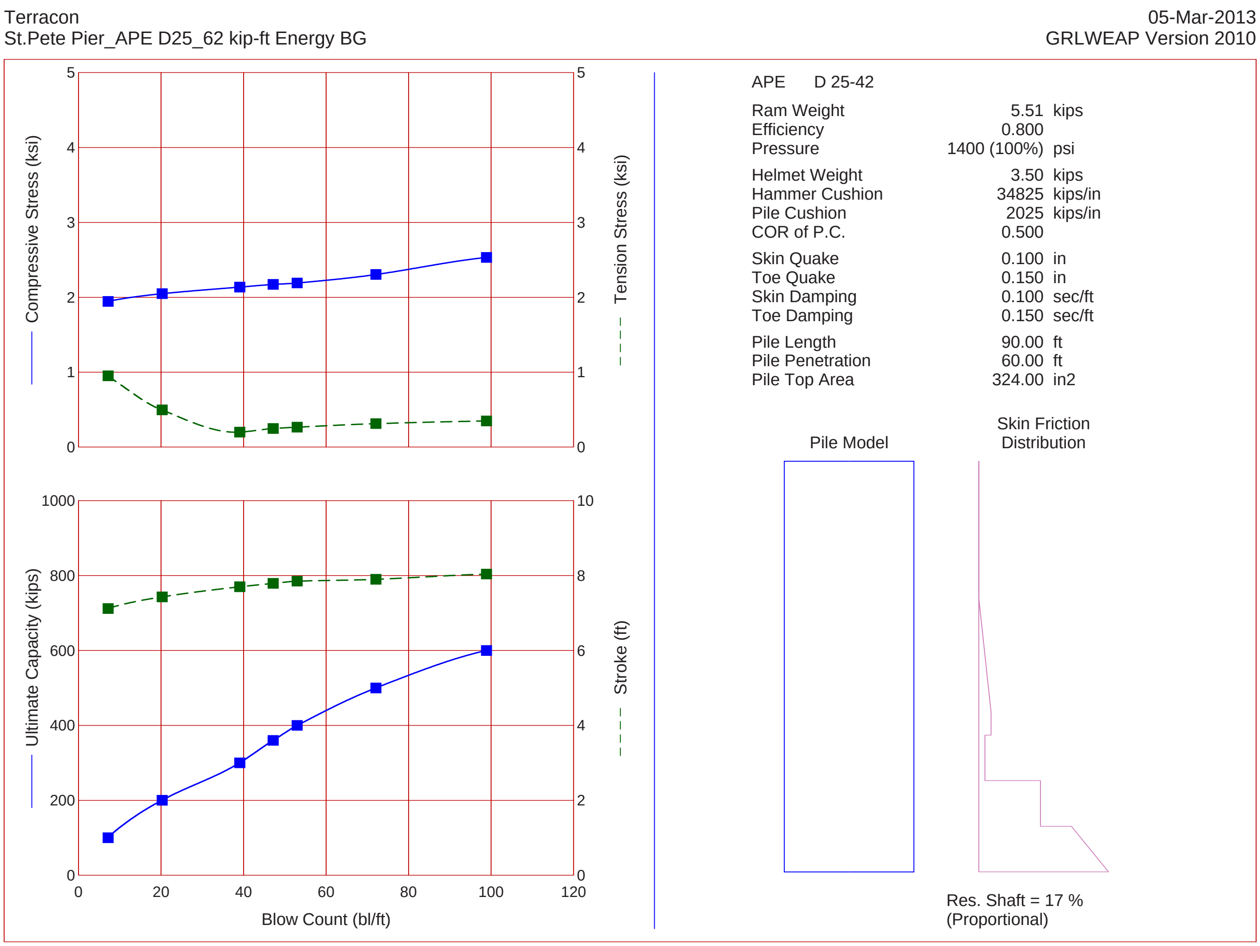


Exhibit C-7

Preliminary WEAP Analyses

- APE D25-42: Bearing Graph and Inspector's Chart
- APE D30-42: Bearing Graph and Inspector's Chart
- APE D36-42: Bearing Graph and Inspector's Chart

GEOTECHNICAL REPORT
(continued)



Terracon 05-Mar-2013
St.Pete Pier_APE D25_62 kip-ft Energy BG GRLWEAP Version 2010

Ultimate Capacity kips	Maximum Compression Stress ksi	Maximum Tension Stress ksi	Blow Count bl/ft	Stroke ft	Energy kips-ft
100.0	1.95	0.95	7.2	7.12	17.66
200.0	2.05	0.50	20.3	7.43	15.65
300.0	2.14	0.20	39.1	7.70	15.65
360.0	2.17	0.25	47.2	7.79	15.67
400.0	2.19	0.27	53.0	7.85	15.58
500.0	2.30	0.31	72.1	7.90	15.22
600.0	2.53	0.35	98.9	8.04	15.34

GEOTECHNICAL REPORT
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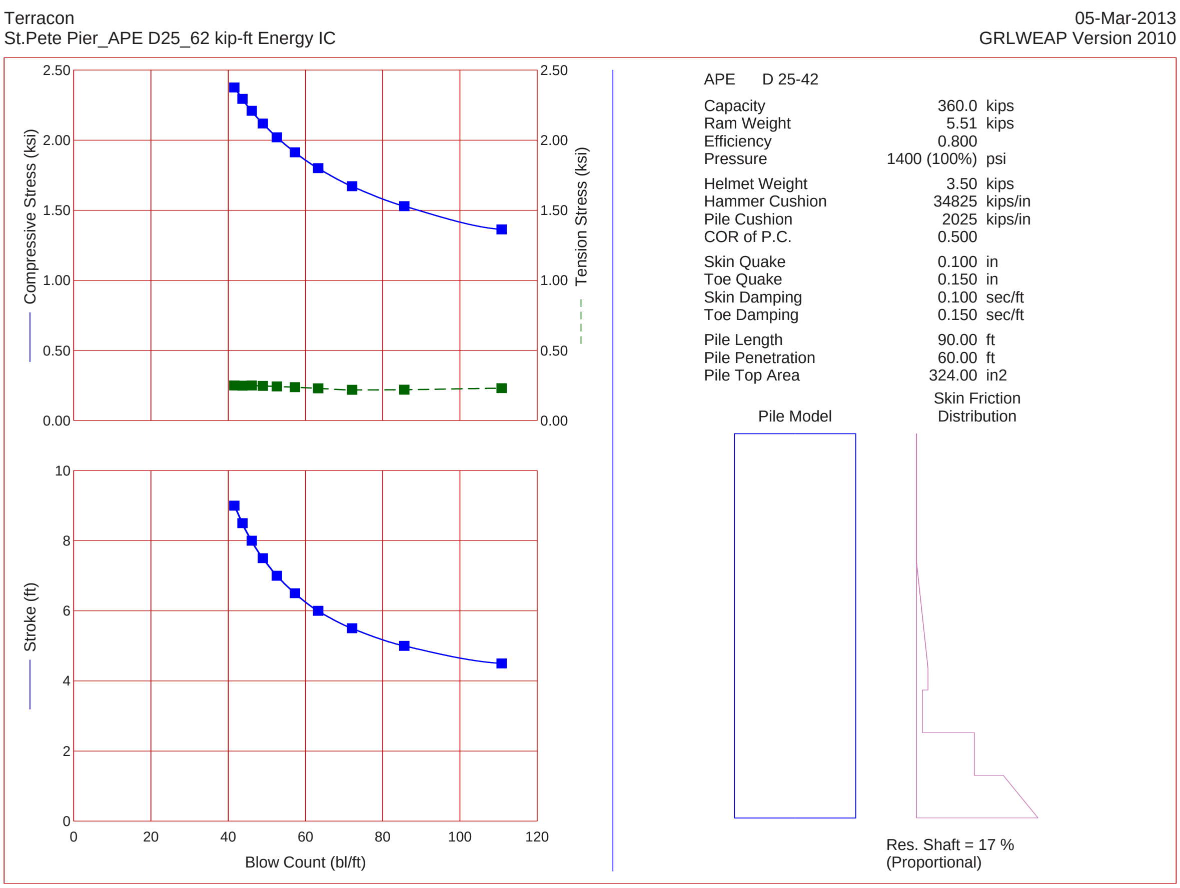
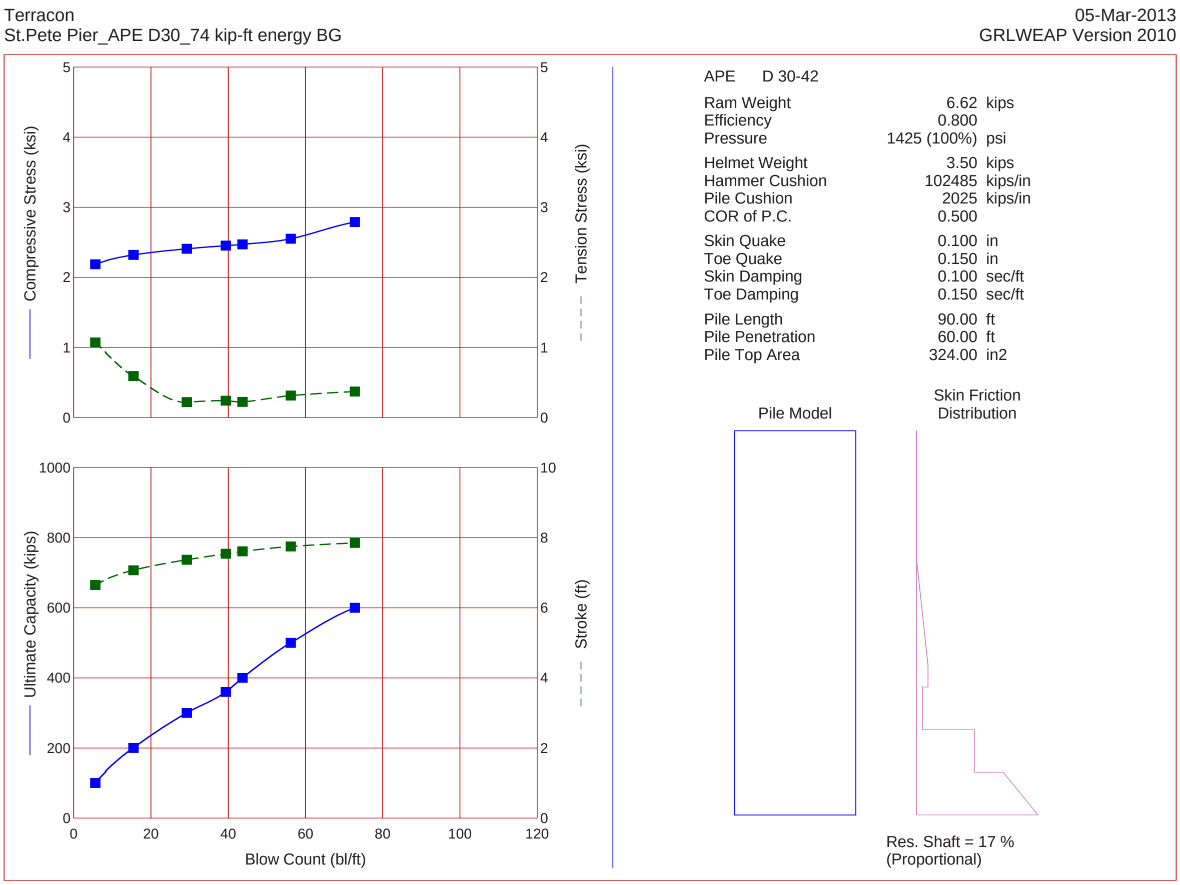


Terracon | 05-Mar-2013
St.Pete Pier_APE D25_62 kip-ft Energy IC | GRLWEAP Version 2010

Ultimate Capacity kips	Maximum Compression Stress ksi	Maximum Tension Stress ksi	Blow Count bl/ft	Stroke ft	Energy kips-ft
360.0	1.36	0.23	110.8	4.50	6.64
360.0	1.53	0.22	85.6	5.00	8.24
360.0	1.67	0.22	72.1	5.50	9.74
360.0	1.80	0.23	63.3	6.00	11.17
360.0	1.91	0.24	57.3	6.50	12.48
360.0	2.02	0.24	52.6	7.00	13.77
360.0	2.12	0.25	49.0	7.50	14.99
360.0	2.21	0.25	46.1	8.00	16.14
360.0	2.29	0.25	43.7	8.50	17.26
360.0	2.38	0.25	41.6	9.00	18.35

GEOTECHNICAL REPORT
(continued)



Terracon | 05-Mar-2013
St.Pete Pier_APE D30_74 kip-ft energy BG | GRLWEAP Version 2010

Ultimate Capacity kips	Maximum Compression Stress ksi	Maximum Tension Stress ksi	Blow Count bl/ft	Stroke ft	Energy kips-ft
100.0	2.19	1.07	5.6	6.65	23.59
200.0	2.32	0.59	15.5	7.07	20.84
300.0	2.41	0.22	29.3	7.37	20.15
360.0	2.45	0.24	39.4	7.54	20.46
400.0	2.47	0.22	43.7	7.61	20.41
500.0	2.55	0.31	56.2	7.75	20.03
600.0	2.79	0.37	72.8	7.85	20.01

GEOTECHNICAL REPORT
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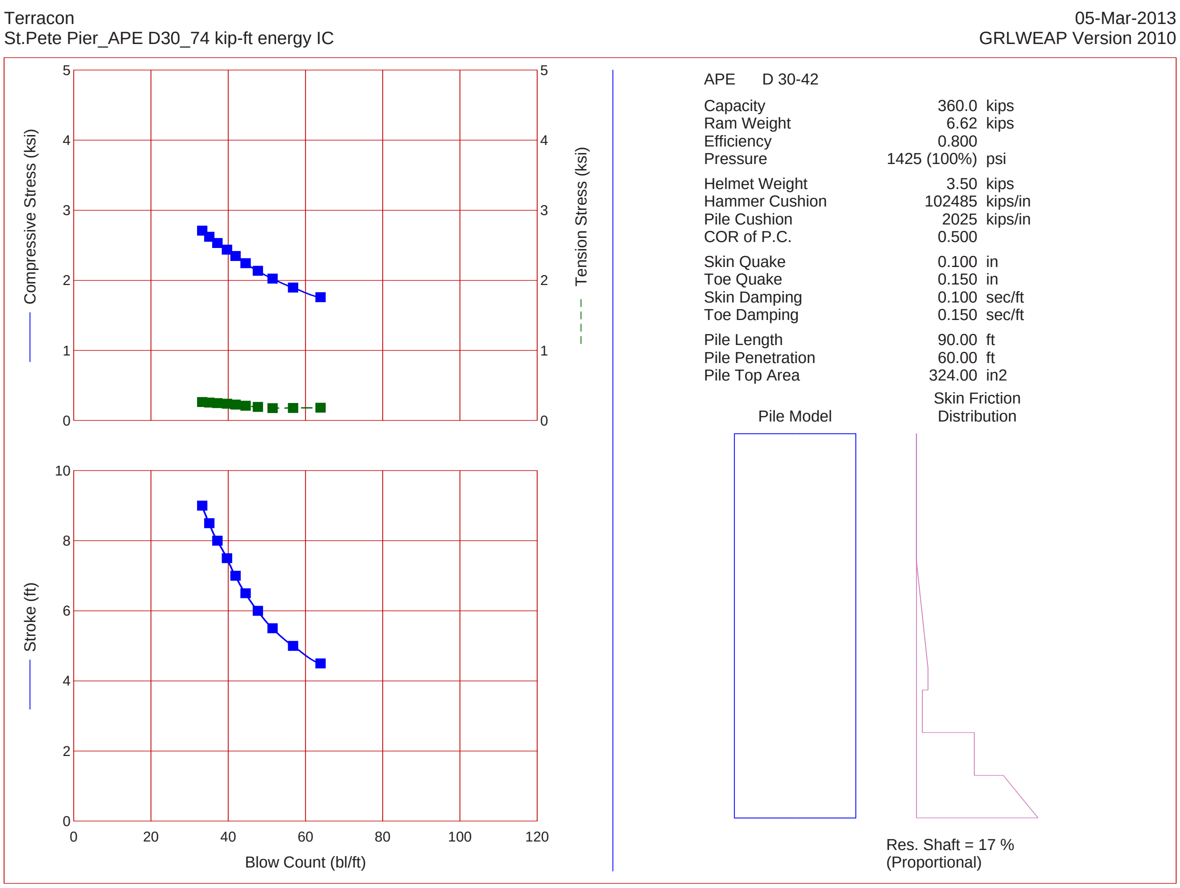
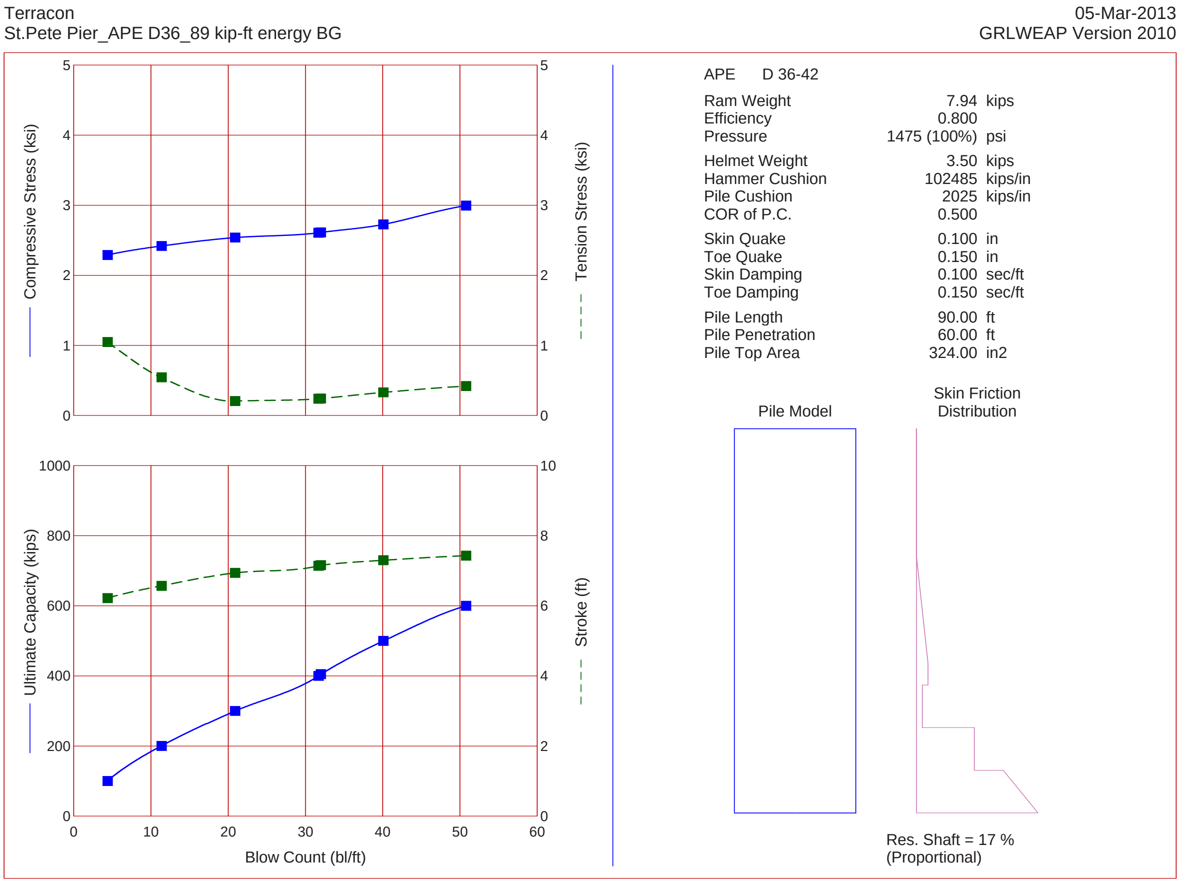


Terracon 05-Mar-2013
St.Pete Pier_APE D30_74 kip-ft energy IC GRLWEAP Version 2010

Ultimate Capacity kips	Maximum Compression Stress ksi	Maximum Tension Stress ksi	Blow Count bl/ft	Stroke ft	Energy kips-ft
360.0	1.76	0.18	63.9	4.50	11.61
360.0	1.90	0.18	56.8	5.00	13.22
360.0	2.02	0.18	51.5	5.50	14.77
360.0	2.13	0.20	47.7	6.00	16.19
360.0	2.24	0.21	44.5	6.50	17.61
360.0	2.35	0.23	41.9	7.00	19.00
360.0	2.44	0.24	39.7	7.50	20.29
360.0	2.53	0.25	37.2	8.00	21.62
360.0	2.62	0.26	35.1	8.50	22.94
360.0	2.71	0.26	33.3	9.00	24.25

GEOTECHNICAL REPORT
(continued)

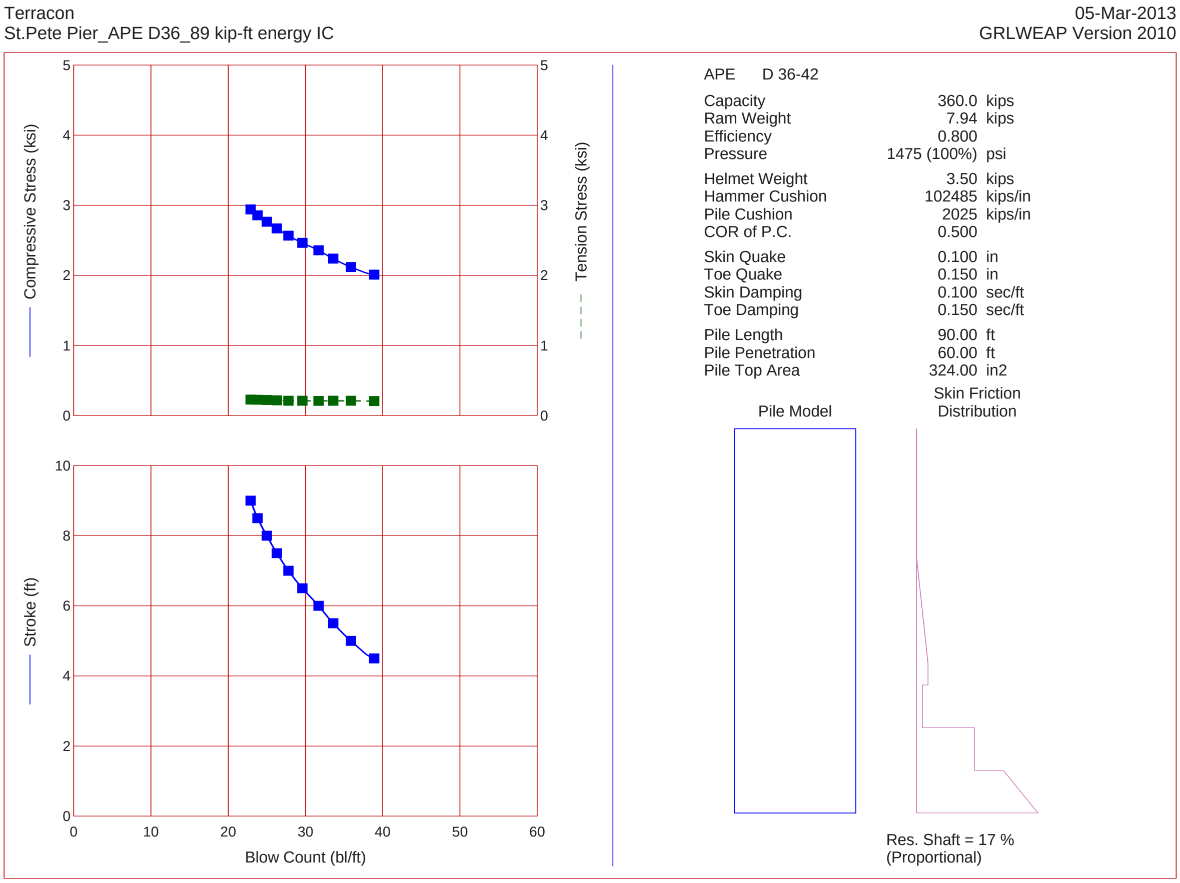


Terracon | 05-Mar-2013

St.Pete Pier_APE D36_89 kip-ft energy BG | GRLWEAP Version 2010

Ultimate Capacity kips	Maximum Compression Stress ksi	Maximum Tension Stress ksi	Blow Count bl/ft	Stroke ft	Energy kips-ft
100.0	2.29	1.05	4.4	6.22	31.50
200.0	2.42	0.55	11.4	6.57	27.89
300.0	2.54	0.21	20.9	6.94	26.71
400.0	2.61	0.24	31.7	7.14	26.73
405.0	2.61	0.24	32.0	7.16	26.74
500.0	2.73	0.33	40.1	7.30	26.27
600.0	2.99	0.42	50.8	7.43	26.28

GEOTECHNICAL REPORT
(continued)



Terracon
St.Pete Pier_APE D36_89 kip-ft energy IC

05-Mar-2013
GRLWEAP Version 2010

Ultimate Capacity kips	Maximum Compression Stress ksi	Maximum Tension Stress ksi	Blow Count bl/ft	Stroke ft	Energy kips-ft
360.0	2.01	0.21	38.9	4.50	17.12
360.0	2.12	0.21	35.9	5.00	19.18
360.0	2.24	0.21	33.6	5.50	21.09
360.0	2.36	0.21	31.7	6.00	22.98
360.0	2.46	0.21	29.6	6.50	24.72
360.0	2.57	0.21	27.8	7.00	26.45
360.0	2.67	0.22	26.3	7.50	28.19
360.0	2.76	0.22	25.0	8.00	29.85
360.0	2.86	0.23	23.8	8.50	31.48
360.0	2.94	0.23	22.9	9.00	33.03

GEOTECHNICAL REPORT
(continued)

EXHIBIT C-8

Estimated Pile Tip Elevations for Piles at The Lens
(Axial Design Pile Capacity of 150 tons or Axial Ultimate Pile Capacity of 300 tons)
St. Petersburg, Florida

Bent/Pier Group No.	Borings Considered	*Anticipated Tip Elev.	**Anticipated Tip Elev.	Bent/Pier Group No.	*Anticipated Tip Elev.	**Anticipated Tip Elev.	***Recommended Test Pile Locations
		18-in sq.	18-in sq.		24-in sq.	24-in sq.	
D1 through D10	B-1	deeper	+3	D1 through D5	23	+23	TBD
	B-2	deeper			25		
	B-3	3		D6 through D10	16	+16	
	B-5	deeper			deeper		
	B-6	deeper			28		
D11 through D15	B-8	-10	-10	D11 through D15	6	+6	TBD
	B-9	deeper			22		
P1 through P8 & P27 through P36	B-10	deeper	+10	P1 through P8 & P27 through P36	20	+20	TBD
	B-11	18			24		
	B-12	deeper			deeper		
	B-13	deeper			26		
	B-14	deeper			29		
P9 through P12	B-15	deeper	-4	P9 through P12	8	+8	TBD
P13 through P26	B-16	deeper	+15	P13 through P26	26	+25	TBD
	B-17	deeper			30		
	B-18	deeper			30		
	B-19	deeper			28		

* Estimated based on axial capacity analysis (FBdeep)
deeper = requires deeper borings to analyze axial capacity

** Estimated based on Axial capacity analysis (FBDeep), consideration of soil variation, assumption of soil conditions below the terminated boring depth, and Terracon's pile driving experience in similar soil/rock conditions

*** Dynamic pile load testing (PDA testing) is recommended to be performed on test piles (5% of production piles) to evaluate capacity, stresses and integrity. In addition, testing results and subsequent analyses (i.e. CAPWAP and WEAP Analyses) will be used to recommend driving criteria and recommend/refine production pile length.

EXHIBIT C-9

Shaft 14 - 60 in shaft 1 3 percent steel in column.lp6o

==

Pile Plus for Windows, Version 2012-06.029

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

==

This copy of LPile is licensed to:

Terracon
Terracon

Serial Number of Security Device: 162969940
Company Name Stored in Security Device: WPC, Inc. (Terracon)

Files Used for Analysis

Path to file locations: N:\H4135006 St. Petersburg Pier - Lens\The Lens Lateral Analysis\
Name of input data file: Shaft 14 - 60 in shaft 1.3 percent steel in column.lp6d
Name of output report file: Shaft 14 - 60 in shaft 1.3 percent steel in column.lp6o
Name of plot output file: Shaft 14 - 60 in shaft 1.3 percent steel in column.lp6p
Name of runtime messeage file: Shaft 14 - 60 in shaft 1.3 percent steel in column.lp6r

----
Date and Time of Analysis

Date: February 26, 2013 Time: 10:34:06

Problem Title

Project Name: The Lens - St. Petersburg Pier Replacement

Job Number: H4135006

Client: Michael Maltzan Architecture, Inc.

Engineer: TES

Description: Lateral Analysis of Drilled Shafts - B-15 (Shaft 14)

Page 1

GEOTECHNICAL REPORT
(continued)

```
                Shaft 14 - 60 in shaft 1 3 percent steel in column.lp6o


--------------------------------------------------------------------------------
                               Program Options
--------------------------------------------------------------------------------

Engineering units are US Customary Units: pounds, inches, feet

Basic Program Options:

This analysis computes pile response to lateral loading and will compute nonlinear
moment-curvature and nominal moment capacity for section types with nonlinear
properties.

Computation Options:
- Analysis does not use p-y multipliers (individual pile or shaft only)
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- No p-y curves to be computed and output for user-specified depths

Solution Control Parameters:
- Number of pile increments                          =         150
- Maximum number of iterations allowed               =        1000
- Deflection tolerance for convergence               =   1.0000E-05  in
- Maximum allowable deflection                       =     100.0000  in

Pile Response Output Options:
- Values of pile-head deflection, bending moment, shear force, and
  soil reaction are printed for full length of pile.
- Printing Increment (nodal spacing of output points)  = 1


--------------------------------------------------------------------------------
                    Pile Structural Properties and Geometry
--------------------------------------------------------------------------------

Total Number of Sections                             =         2

Total Pile Length                                    =     100.00 ft

Depth of ground surface below top of pile            =      43.00 ft

Pile dimensions used for p-y curve computations defined using 4 points.
p-y curves are computed using values of pile diameter interpolated over
the length of the pile.

Point         Depth             Pile
                X             Diameter
                ft               in
-----       ---------        -----------
  1          0.00000         48.0000000
  2        27.000000         48.0000000
  3        27.000000         60.0000000
  4       100.000000         60.0000000


Input Structural Properties:
----------------------------
                                  Page 2
```

```
Pile Section No. 1:

   Section Type                                          = Drilled Shaft (Bored Pile)
   Section Length                                        =          27.000 ft
   Section Diameter                                      =          48.000 in

Pile Section No. 2:

   Section Type                                          = Drilled Shaft (Bored Pile)
   Section Length                                        =          73.000 ft
   Section Diameter                                      =          60.000 in



--------------------------------------------------------------------------------
                      Ground Slope and Pile Batter Angles
--------------------------------------------------------------------------------

Ground Slope Angle                                       =        0.000 degrees
                                                         =        0.000 radians

Pile Batter Angle                                        =        0.000 degrees
                                                         =        0.000 radians



--------------------------------------------------------------------------------
                       Soil and Rock Layering Information
--------------------------------------------------------------------------------

The soil profile is modelled using 6 layers

Layer 1 is sand, p-y criteria by Reese et al., 1974

   Distance from top of pile to top of layer             =     43.00000 ft
   Distance from top of pile to bottom of layer          =     47.00000 ft
   Effective unit weight at top of layer                 =     37.60000 pcf
   Effective unit weight at bottom of layer              =     37.60000 pcf
   Friction angle at top of layer                        =     30.00000 deg.
   Friction angle at bottom of layer                     =     30.00000 deg.
   Subgrade k at top of layer                            =     30.00000 pci
   Subgrade k at bottom of layer                         =     30.00000 pci


Layer 2 is sand, p-y criteria by Reese et al., 1974

   Distance from top of pile to top of layer             =     47.00000 ft
   Distance from top of pile to bottom of layer          =     59.00000 ft
   Effective unit weight at top of layer                 =     27.60000 pcf
   Effective unit weight at bottom of layer              =     27.60000 pcf
   Friction angle at top of layer                        =     28.00000 deg.
   Friction angle at bottom of layer                     =     28.00000 deg.
   Subgrade k at top of layer                            =     20.00000 pci
   Subgrade k at bottom of layer                         =     20.00000 pci


Layer 3 is sand, p-y criteria by Reese et al., 1974

   Distance from top of pile to top of layer             =     59.00000 ft
```

GEOTECHNICAL REPORT
(continued)

```
              Shaft 14 - 60 in shaft 1 3 percent steel in column.lp6o
   Distance from top of pile to bottom of layer       =     64.00000 ft
   Effective unit weight at top of layer              =     52.60000 pcf
   Effective unit weight at bottom of layer           =     52.60000 pcf
   Friction angle at top of layer                     =     35.00000 deg.
   Friction angle at bottom of layer                  =     35.00000 deg.
   Subgrade k at top of layer                         =     50.00000 pci
   Subgrade k at bottom of layer                      =     50.00000 pci


Layer 4 is soft clay, p-y criteria by Matlock, 1970

   Distance from top of pile to top of layer          =     64.00000 ft
   Distance from top of pile to bottom of layer       =     74.00000 ft
   Effective unit weight at top of layer              =     27.60000 pcf
   Effective unit weight at bottom of layer           =     27.60000 pcf
   Undrained cohesion at top of layer                 =    250.00000 psf
   Undrained cohesion at bottom of layer              =    250.00000 psf
   Epsilon-50 at top of layer                         =      0.02000
   Epsilon-50 at bottom of layer                      =      0.02000


Layer 5 is stiff clay with water-induced erosion

   Distance from top of pile to top of layer          =     74.00000 ft
   Distance from top of pile to bottom of layer       =     84.00000 ft
   Effective unit weight at top of layer              =     57.60000 pcf
   Effective unit weight at bottom of layer           =     57.60000 pcf
   Undrained cohesion at top of layer                 =    750.00000 psf
   Undrained cohesion at bottom of layer              =    750.00000 psf
   Epsilon-50 at top of layer                         =      0.01000
   Epsilon-50 at bottom of layer                      =      0.01000
   Subgrade k at top of layer                         =     40.00000 pci
   Subgrade k at bottom of layer                      =     40.00000 pci


Layer 6 is stiff clay with water-induced erosion

   Distance from top of pile to top of layer          =     84.00000 ft
   Distance from top of pile to bottom of layer       =    107.00000 ft
   Effective unit weight at top of layer              =     57.60000 pcf
   Effective unit weight at bottom of layer           =     57.60000 pcf
   Undrained cohesion at top of layer                 =   1500.00000 psf
   Undrained cohesion at bottom of layer              =   1500.00000 psf
   Epsilon-50 at top of layer                         =      0.00500
   Epsilon-50 at bottom of layer                      =      0.00500
   Subgrade k at top of layer                         =     60.00000 pci
   Subgrade k at bottom of layer                      =     60.00000 pci


   (Depth of lowest soil layer extends    7.00 ft below pile tip)


--------------------------------------------------------------------------------
                           Summary of Soil Properties
--------------------------------------------------------------------------------

                      Layer                     Layer      Effective    Undrained
Angle of      Uniaxial      RQD %       Strain                                Rock
Mass                  In-situ     In-situ       Elastic
Layer               Soil Type                   Depth       Unit Wt.    Cohesion
Friction        qu            or        Factor         J          kpy       Rock
Emass      krm          Test        Test        Subgrade
                                       Page 4
```

```
 Num.         (p-y Curve Criteria)                    ft            pcf           psf
   deg.         psi           GSI      Epsilon 50     Factor         pci           psi
                    Type       Property     Mod. pci
-----   ---------------------------------  ----------   ----------   ----------
----------   ----------   ----------   ----------   ----------   ----------
----------   ----------   ----------   ----------   ----------
  1     Sand (Reese, et al.)                     43.000      37.600         --
   30.000       --           --           --           --          30.000        --
         --           --           --           --
                                                  47.000      37.600         --
   30.000       --           --           --           --          30.000        --
         --           --           --           --
  2     Sand (Reese, et al.)                     47.000      27.600         --
   28.000       --           --           --           --          20.000        --
         --           --           --           --
                                                  59.000      27.600         --
   28.000       --           --           --           --          20.000        --
         --           --           --           --
  3     Sand (Reese, et al.)                     59.000      52.600         --
   35.000       --           --           --           --          50.000        --
         --           --           --           --
                                                  64.000      52.600         --
   35.000       --           --           --           --          50.000        --
         --           --           --           --
  4     Soft Clay                                 64.000      27.600     250.000
   --           --           --        0.02000        --           --            --
         --           --           --           --
                                                  74.000      27.600     250.000
   --           --           --        0.02000        --           --            --
         --           --           --           --
  5     Stiff Clay with Free Water               74.000      57.600     750.000
   --           --           --        0.01000        --          40.000        --
         --           --           --           --
                                                  84.000      57.600     750.000
   --           --           --        0.01000        --          40.000        --
         --           --           --           --
  6     Stiff Clay with Free Water               84.000      57.600    1500.000
   --           --           --        0.00500        --          60.000        --
         --           --           --           --
                                                 107.000      57.600    1500.000
   --           --           --        0.00500        --          60.000        --
         --           --           --           --
```

Loading Type

Cyclic loading criteria were used for computation of p-y curves for all analyses.

Number of cycles of loading = 100

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 1

```
Load    Load         Condition              Condition             Axial Thrust
 No.    Type             1                      2                  Force, lbs
```

GEOTECHNICAL REPORT
(continued)

```
              Shaft 14 - 60 in shaft 1 3 percent steel in column.lp6o
-----   ----   --------------------   ----------------------   ----------------
   1     1     V =       25000. lbs   M =       0.0000 in-lbs          500000.

V = perpendicular shear force applied to pile head
M = bending moment applied to pile head
y = lateral deflection relative to pile axis
S = pile slope relative to original pile batter angle
R = rotational stiffness applie to pile head
Axial thrust is assumed to be acting axially for all pile batter angles.


--------------------------------------------------------------------------------
    Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness
--------------------------------------------------------------------------------

Axial thrust force values were determined from pile-head loading conditions

Number of Pile Sections Analyzed = 2

Pile Section No. 1:


Dimensions and Properties of Drilled Shaft:
-------------------------------------------

Length of Section                                         =     27.00000000 ft
Shaft Diameter                                            =     48.00000000 in
Concrete Cover Thickness                                  =      3.00000000 in
Number of Reinforcing Bars                                =              23 bars
Yield Stress of Reinforcing Bars                          =     60.00000000 ksi
Modulus of Elasticity of Reinforcing Bars                 =          29000. ksi
Gross Area of Shaft                                       =   1809.55736847 sq. in.
Total Area of Reinforcing Steel                           =     23.00000000 sq. in.
Area Ratio of Steel Reinforcement                         =            1.27 percent
Edge-to-Edge Bar Spacing                                  =      4.43740328 in
Rebar Offset                                              =       0.0000000 in

Axial Structural Capacities:
----------------------------

Nom. Axial Structural Capacity = 0.85 Fc Ac + Fy As    =        8972.869 kips
Tensile Load for Cracking of Concrete                     =        -904.603 kips
Nominal Axial Tensile Capacity                            =       -1380.000 kips


Reinforcing Bar Dimensions and Positions Used in Computations:
```

Bar Number	Bar Diam. inches	Bar Area sq. in.	X inches	Y inches
1	1.12800	1.00000	20.43600	0.00000
2	1.12800	1.00000	19.67818	5.51357
3	1.12800	1.00000	17.46091	10.61822
4	1.12800	1.00000	13.94866	14.93536
5	1.12800	1.00000	9.40189	18.14482
6	1.12800	1.00000	4.15783	20.00856
7	1.12800	1.00000	-1.39460	20.38836
8	1.12800	1.00000	-6.84360	19.25604
9	1.12800	1.00000	-11.78504	16.69560
10	1.12800	1.00000	-15.85244	12.89691
11	1.12800	1.00000	-18.74413	8.14172
12	1.12800	1.00000	-20.24566	2.78270
13	1.12800	1.00000	-20.24566	-2.78270

14	1.12800	1.00000	-18.74413	-8.14172
15	1.12800	1.00000	-15.85244	-12.89691
16	1.12800	1.00000	-11.78504	-16.69560
17	1.12800	1.00000	-6.84360	-19.25604
18	1.12800	1.00000	-1.39460	-20.38836
19	1.12800	1.00000	4.15783	-20.00856
20	1.12800	1.00000	9.40189	-18.14482
21	1.12800	1.00000	13.94866	-14.93536
22	1.12800	1.00000	17.46091	-10.61822
23	1.12800	1.00000	19.67818	-5.51357

Concrete Properties:

Compressive Strength of Concrete	=	5.0000000 ksi
Modulus of Elasticity of Concrete	=	4030.5086528 ksi
Modulus of Rupture of Concrete	=	-0.5303301 ksi
Compression Strain at Peak Stress	=	0.0021089
Tensile Strain at Fracture of Concrete	=	-0.0001150
Maximum Coarse Aggregate Size	=	0.7500000 in

Number of Axial Thrust Force Values Determined from Pile-head Loadings = 1

Number	Axial Thrust Force kips
1	500.000

Definitions of Run Messages and Notes:

C = concrete in section has cracked in tension.
Y = stress in reinforcing steel has reached yield stress.
T = ACI 318-08 criteria for tension-controlled section met, tensile strain in reinforcement exceeds 0.005 while simultaneously compressive strain in concrete more than than 0.003. See ACI 318-08, Section 10.3.4.
Z = depth of tensile zone in concrete section is less than 10 percent of section depth.

Bending Stiffness (EI) = Computed Bending Moment / Curvature.
Position of neutral axis is measured from edge of compression side of pile.
Compressive stresses and strains are positive in sign.
Tensile stresses and strains are negative in sign.

Axial Thrust Force = 500.000 kips

Bending Curvature rad/in.	Bending Moment in-kip	Bending Stiffness kip-in2	Depth to N Axis in	Max Comp Strain in/in	Max Tens Strain in/in	Max Concrete Stress ksi	Max Steel Stress ksi	Run Msg
0.000000625	825.2625785	1320420126.	112.6411651	0.0000704	0.0000404	0.3275649	2.0372711	
0.000001250	1650.5039086	1320403127.	68.3508275	0.0000854	0.0000254	0.3955588	2.4690175	

GEOTECHNICAL REPORT
(continued)

```
            Shaft 14 - 60 in shaft 1 3 percent steel in column.lp6o
0.000001875  2475.6908762   1320368467.    53.6008219     0.0001005     0.0000105
 0.4631681     2.9014947
0.000002500  3300.7912222   1320316489.    46.2358904     0.0001156  -0.000004410
 0.5303902     3.3347021
0.000003125  4125.2203061   1320070498.    41.8240692     0.0001307    -0.0000193
 0.5972099     3.7685563
0.000003750  4947.6421299   1319371235.    38.8868101     0.0001458    -0.0000342
 0.6635918     4.2028406
0.000004375  5767.2679904   1318232684.    36.7909550     0.0001610    -0.0000490
 0.7295114     4.6374024
0.000005000  6583.7167609   1316743352.    35.2203737     0.0001761    -0.0000639
 0.7949546     5.0721542
0.000005625  7396.7933417   1314985483.    33.9996566     0.0001912    -0.0000788
 0.8599130     5.5070440
0.000006250  8206.3918360   1313022694.    33.0236680     0.0002064    -0.0000936
 0.9243814     5.9420399
0.000006875  9012.4501487   1310901840.    32.2255590     0.0002216    -0.0001084
 0.9883565     6.3771208
0.000007500  9012.4501487   1201660020.    28.7210142     0.0002154    -0.0001446
 0.9615829     6.1946206  C
0.000008125  9012.4501487   1109224634.    27.8379343     0.0002262    -0.0001638
 1.0067369     6.5027632  C
0.000008750  9012.4501487   1029994303.    27.0569011     0.0002367    -0.0001833
 1.0507482     6.8047886  C
0.000009375  9012.4501487    961328016.    26.3586945     0.0002471    -0.0002029
 1.0936782     7.1010201  C
  0.0000100  9012.4501487    901245015.    25.7322804     0.0002573    -0.0002227
 1.1357283     7.3927613  C
  0.0000106  9012.4501487    848230602.    25.1648317     0.0002674    -0.0002426
 1.1769018     7.6799637  C
  0.0000113  9012.4501487    801106680.    24.6479008     0.0002773    -0.0002627
 1.2172734     7.9630777  C
  0.0000119  9012.4501487    758943170.    24.1754704     0.0002871    -0.0002829
 1.2569477     8.2427777  C
  0.0000125  9012.4501487    720996012.    23.7420226     0.0002968    -0.0003032
 1.2959915    -8.7065168  C
  0.0000131  9046.0104746    689219846.    23.3415552     0.0003064    -0.0003236
 1.3343883    -9.2942705  C
  0.0000138  9258.3540736    673334842.    22.9705692     0.0003158    -0.0003442
 1.3722004    -9.8847856  C
  0.0000144  9467.7064219    658623055.    22.6266626     0.0003253    -0.0003647
 1.4095174   -10.4774600  C
  0.0000150  9674.7141050    644980940.    22.3075964     0.0003346    -0.0003854
 1.4464124   -11.0717955  C
  0.0000156  9877.9196491    632186858.    22.0071723     0.0003439    -0.0004061
 1.4826891   -11.6692500  C
  0.0000163        10080.    620279750.    21.7273471     0.0003531    -0.0004269
 1.5186184   -12.2678876  C
  0.0000169        10279.    609123028.    21.4645286     0.0003622    -0.0004478
 1.5541160   -12.8683463  C
  0.0000175        10476.    598651032.    21.2171271     0.0003713    -0.0004687
 1.5892017   -13.4705080  C
  0.0000181        10672.    588820382.    20.9845288     0.0003803    -0.0004897
 1.6239483   -14.0738570  C
  0.0000188        10867.    579557279.    20.7646722     0.0003893    -0.0005107
 1.6583161   -14.6787094  C
  0.0000194        11060.    570814676.    20.5566175     0.0003983    -0.0005317
 1.6923300   -15.2849005  C
  0.0000200        11252.    562584331.    20.3607628     0.0004072    -0.0005528
 1.7261083   -15.8915575  C
  0.0000206        11442.    554745610.    20.1728365     0.0004161    -0.0005739
 1.7594029   -16.5005721  C
  0.0000213        11631.    547360330.    19.9962318     0.0004249    -0.0005951
                                   Page 8
```

```
1.7925489   -17.1094221  C
 0.0000219       11820.    540332317.    19.8273216     0.0004337    -0.0006163
1.8253264   -17.7197928  C
 0.0000225       12007.    533641919.    19.6659196     0.0004425    -0.0006375
1.8577769   -18.3313874  C
 0.0000231       12194.    527306338.    19.5134820     0.0004512    -0.0006588
1.8900814   -18.9428211  C
 0.0000238       12380.    521255323.    19.3671552     0.0004600    -0.0006800
1.9220501   -19.5555718  C
 0.0000244       12565.    515466702.    19.2264417     0.0004686    -0.0007014
1.9536830   -20.1696590  C
 0.0000256       12933.    504718646.    18.9662443     0.0004860    -0.0007440
2.0165185   -21.3973596  C
 0.0000269       13298.    494821572.    18.7239731     0.0005032    -0.0007868
2.0780877   -22.6299536  C
 0.0000281       13663.    485779961.    18.5038239     0.0005204    -0.0008296
2.1390741   -23.8620686  C
 0.0000294       14024.    477398619.    18.2975754     0.0005375    -0.0008725
2.1989132   -25.0983030  C
 0.0000306       14384.    469671558.    18.1081693     0.0005546    -0.0009154
2.2581205   -26.3345321  C
 0.0000319       14742.    462501561.    17.9321272     0.0005716    -0.0009584
2.3165303   -27.5721398  C
 0.0000331       15099.    455808861.    17.7667299     0.0005885    -0.0010015
2.3740105   -28.8122850  C
 0.0000344       15455.    449586408.    17.6139772     0.0006055    -0.0010445
2.4309403   -30.0518164  C
 0.0000356       15809.    443764313.    17.4709118     0.0006224    -0.0010876
2.4871227   -31.2924142  C
 0.0000369       16162.    438284396.    17.3351197     0.0006392    -0.0011308
2.5423865   -32.5356062  C
 0.0000381       16514.    433149252.    17.2087888     0.0006561    -0.0011739
2.5971057   -33.7781827  C
 0.0000394       16865.    428325962.    17.0910209     0.0006730    -0.0012170
2.6512781   -35.0201404  C
 0.0000406       17215.    423763197.    16.9789292     0.0006898    -0.0012602
2.7046279   -36.2639490  C
 0.0000419       17564.    419441493.    16.8723382     0.0007065    -0.0013035
2.7572064   -37.5092042  C
 0.0000431       17912.    415357615.    16.7724257     0.0007233    -0.0013467
2.8092433   -38.7538349  C
 0.0000444       18260.    411491391.    16.6786302     0.0007401    -0.0013899
2.8607365   -39.9978376  C
 0.0000456       18607.    407824861.    16.5904516     0.0007569    -0.0014331
2.9116842   -41.2412087  C
 0.0000469       18953.    404324603.    16.5055015     0.0007737    -0.0014763
2.9618086   -42.4865839  C
 0.0000481       19297.    400985326.    16.4243582     0.0007904    -0.0015196
3.0112369   -43.7328049  C
 0.0000494       19642.    397804079.    16.3477719     0.0008072    -0.0015628
3.0601238   -44.9783839  C
 0.0000506       19985.    394769091.    16.2754077     0.0008239    -0.0016061
3.1084674   -46.2233169  C
 0.0000519       20328.    391869725.    16.2069631     0.0008407    -0.0016493
3.1562655   -47.4675998  C
 0.0000531       20671.    389096344.    16.1421639     0.0008576    -0.0016924
3.2035161   -48.7112286  C
 0.0000544       21013.    386440196.    16.0807615     0.0008744    -0.0017356
3.2502170   -49.9541991  C
 0.0000556       21353.    383877770.    16.0203530     0.0008911    -0.0017789
3.2960309   -51.2000180  C
 0.0000569       21693.    381418134.    15.9629789     0.0009079    -0.0018221
3.3412961   -52.4452115  C
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GEOTECHNICAL REPORT
(continued)

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            Shaft 14 - 60 in shaft 1 3 percent steel in column.lp6o
 0.0000581       22033.    379054787.    15.9084730     0.0009247    -0.0018653
3.3860145   -53.6897301  C
 0.0000594       22371.    376781590.    15.8566567     0.0009415    -0.0019085
3.4301842   -54.9335691  C
 0.0000606       22710.    374592910.    15.8073663     0.0009583    -0.0019517
3.4738029   -56.1767240  C
 0.0000619       23047.    372483565.    15.7604513     0.0009752    -0.0019948
3.5168683   -57.4191900  C
 0.0000631       23385.    370448788.    15.7157732     0.0009921    -0.0020379
3.5593783   -58.6609624  C
 0.0000644       23721.    368484176.    15.6732043     0.0010090    -0.0020810
3.6013306   -59.9020366  C
 0.0000656       24057.    366585664.    15.6326265     0.0010259    -0.0021241
3.6427229   -60.0000000  CY
 0.0000669       24393.    364748209.    15.5936887     0.0010428    -0.0021672
3.6835135   -60.0000000  CY
 0.0000681       24727.    362963170.    15.5552962     0.0010597    -0.0022103
3.7235376   -60.0000000  CY
 0.0000694       25061.    361234237.    15.5186494     0.0010766    -0.0022534
3.7630030   -60.0000000  CY
 0.0000706       25392.    359537537.    15.4833916     0.0010935    -0.0022965
3.8018638   -60.0000000  CY
 0.0000719       25708.    357671702.    15.4468607     0.0011102    -0.0023398
3.8396941   -60.0000000  CY
 0.0000731       25990.    355414502.    15.4060272     0.0011266    -0.0023834
3.8760051   -60.0000000  CY
 0.0000744       26243.    352850916.    15.3618419     0.0011425    -0.0024275
3.9109614   -60.0000000  CY
 0.0000794       27097.    341375387.    15.1742522     0.0012045    -0.0026055
4.0411871   -60.0000000  CY
 0.0000844       27784.    329287702.    14.9791556     0.0012639    -0.0027861
4.1582482   -60.0000000  CY
 0.0000894       28358.    317292406.    14.7873939     0.0013216    -0.0029684
4.2646883   -60.0000000  CY
 0.0000944       28862.    305823575.    14.6052565     0.0013784    -0.0031516
4.3622280   -60.0000000  CY
 0.0000994       29291.    294747218.    14.4245672     0.0014334    -0.0033366
4.4501955   -60.0000000  CY
 0.0001044       29675.    284309923.    14.2555055     0.0014879    -0.0035221
4.5307767   -60.0000000  CY
 0.0001094       30011.    274386295.    14.0924237     0.0015414    -0.0037086
4.6035930   -60.0000000  CY
 0.0001144       30327.    265151576.    13.9380987     0.0015942    -0.0038958
4.6695066   -60.0000000  CY
 0.0001194       30591.    256258055.    13.7883640     0.0016460    -0.0040840
4.7283319   -60.0000000  CY
 0.0001244       30845.    248003971.    13.6498417     0.0016977    -0.0042723
4.7812949   -60.0000000  CY
 0.0001294       31084.    240265663.    13.5161441     0.0017487    -0.0044613
4.8278519   -60.0000000  CY
 0.0001344       31283.    232805275.    13.3854896     0.0017987    -0.0046513
4.8681296   -60.0000000  CY
 0.0001394       31472.    225805021.    13.2640259     0.0018487    -0.0048413
4.9030307   -60.0000000  CY
 0.0001444       31655.    219258412.    13.1496613     0.0018985    -0.0050315
4.9324730   -60.0000000  CY
 0.0001494       31828.    213071284.    13.0391155     0.0019477    -0.0052223
4.9563492   -60.0000000  CY
 0.0001544       31976.    207129523.    12.9317264     0.0019963    -0.0054137
4.9748297   -60.0000000  CY
 0.0001594       32110.    201472403.    12.8295111     0.0020447    -0.0056053
4.9881975   -60.0000000  CY
 0.0001644       32240.    196139089.    12.7346129     0.0020933    -0.0057967
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  4.9965852   -60.0000000  CY
   0.0001694        32365.   191086273.    12.6415067     0.0021412    -0.0059888
  4.9999205    60.0000000  CY
   0.0001744        32486.   186300946.    12.5541221     0.0021891    -0.0061809
  4.9976889    60.0000000  CY
   0.0001794        32597.   181723301.    12.4704747     0.0022369    -0.0063731
  4.9999985    60.0000000  CY
   0.0001844        32693.   177317621.    12.3897411     0.0022844    -0.0065656
  4.9976411    60.0000000  CY
   0.0001894        32779.   173091172.    12.3119547     0.0023316    -0.0067584
  4.9999763    60.0000000  CY
   0.0001944        32862.   169065627.    12.2394194     0.0023790    -0.0069510
  4.9964204    60.0000000  CY
   0.0001994        32940.   165216228.    12.1660837     0.0024256    -0.0071444
  4.9996255    60.0000000  CY
   0.0002044        33016.   161546674.    12.0975972     0.0024724    -0.0073376
  4.9931745    60.0000000  CY
   0.0002094        33091.   158044930.    12.0335218     0.0025195    -0.0075305
  4.9980501    60.0000000  CY
   0.0002144        33162.   154693636.    11.9727084     0.0025666    -0.0077234
  4.9999682    60.0000000  CY
   0.0002194        33231.   151481340.    11.9156277     0.0026140    -0.0079160
  4.9938314    60.0000000  CY
   0.0002244        33289.   148363508.    11.8585948     0.0026608    -0.0081092
  4.9981567    60.0000000  CY
   0.0002294        33344.   145370889.    11.8041685     0.0027076    -0.0083024
  4.9999467    60.0000000  CY
   0.0002344        33392.   142472141.    11.7503908     0.0027540    -0.0084960
  4.9916529    60.0000000  CY
   0.0002394        33436.   139680864.    11.6955838     0.0027996    -0.0086904
  4.9964575    60.0000000  CY
   0.0002444        33479.   136999349.    11.6439456     0.0028455    -0.0088845
  4.9992473    60.0000000  CY
   0.0002494        33521.   134419989.    11.5954565     0.0028916    -0.0090784
  4.9979368    60.0000000  CY
   0.0002544        33561.   131937030.    11.5498875     0.0029380    -0.0092720
  4.9915567    60.0000000  CY
   0.0002594        33602.   129548079.    11.5065361     0.0029845    -0.0094655
  4.9961976    60.0000000  CY
   0.0002644        33640.   127242008.    11.4663366     0.0030314    -0.0096586
  4.9990380    60.0000000  CYT
   0.0002694        33675.   125009752.    11.4299319     0.0030789    -0.0098511
  4.9998790    60.0000000  CYT
   0.0002744        33708.   122852398.    11.3957107     0.0031267    -0.0100433
  4.9883799    60.0000000  CYT
   0.0003044        33844.   111191195.    11.2107815     0.0034123    -0.0111977
  4.9919569    60.0000000  CYT
   0.0003344        33910.   101412526.    11.0629568     0.0036992    -0.0123508
  4.9898562    60.0000000  CYT
   0.0003644        33910.    93062953.    11.0152335     0.0040137    -0.0134763
  4.9872274    60.0000000  CYT
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   Summary of Results for Nominal (Unfactored) Moment Capacity for Section 1
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Moment values interpolated at maximum compressive strain = 0.003
or maximum developed moment if pile fails at smaller strains.

Load No.	Axial Thrust kips	Nominal Mom. Cap. in-kip	Max. Comp. Strain

GEOTECHNICAL REPORT
(continued)

Shaft 14 - 60 in shaft 1 3 percent steel in column.lp6o

1	500.000	33614.108	0.00300000

Note note that the values of moment capacity in the table above are not factored by a strength reduction factor (phi-factor).

In ACI 318-08, the value of the strength reduction factor depends on whether the transverse reinforcing steel bars are spirals or tied hoops.

The above values should be multiplied by the appropriate strength reduction factor to compute ultimate moment capacity according to ACI 318-08, Section 9.3.2.2 or the value required by the design standard being followed.

Pile Section No. 2:

Dimensions and Properties of Drilled Shaft:

Length of Section	=	73.00000000 ft
Shaft Diameter	=	60.00000000 in
Concrete Cover Thickness	=	3.00000000 in
Number of Reinforcing Bars	=	29 bars
Yield Stress of Reinforcing Bars	=	60.00000000 ksi
Modulus of Elasticity of Reinforcing Bars	=	29000. ksi
Gross Area of Shaft	=	2827.43338823 sq. in.
Total Area of Reinforcing Steel	=	36.83000000 sq. in.
Area Ratio of Steel Reinforcement	=	1.30 percent
Edge-to-Edge Bar Spacing	=	4.43111584 in
Rebar Offset	=	0.0000000 in

Axial Structural Capacities:

Nom. Axial Structural Capacity = 0.85 Fc Ac + Fy As	=	14069.865 kips
Tensile Load for Cracking of Concrete	=	-1416.005 kips
Nominal Axial Tensile Capacity	=	-2209.800 kips

Reinforcing Bar Dimensions and Positions Used in Computations:

Bar Number	Bar Diam. inches	Bar Area sq. in.	X inches	Y inches
1	1.27000	1.27000	26.36500	0.00000
2	1.27000	1.27000	25.74860	5.66770
3	1.27000	1.27000	23.92823	11.07038
4	1.27000	1.27000	20.98899	15.95542
5	1.27000	1.27000	17.06834	20.09440
6	1.27000	1.27000	12.34959	23.29380
7	1.27000	1.27000	7.05338	25.40400
8	1.27000	1.27000	1.42737	26.32633
9	1.27000	1.27000	-4.26538	26.01768
10	1.27000	1.27000	-9.75869	24.49247
11	1.27000	1.27000	-14.79570	21.82202
12	1.27000	1.27000	-19.14087	18.13120
13	1.27000	1.27000	-22.59104	13.59258
14	1.27000	1.27000	-24.98488	8.41838
15	1.27000	1.27000	-26.21045	2.85056
16	1.27000	1.27000	-26.21045	-2.85056
17	1.27000	1.27000	-24.98488	-8.41838
18	1.27000	1.27000	-22.59104	-13.59258
19	1.27000	1.27000	-19.14087	-18.13120

Shaft 14 - 60 in shaft 1 3 percent steel in column.lp6o

20	1.27000	1.27000	-14.79570	-21.82202
21	1.27000	1.27000	-9.75869	-24.49247
22	1.27000	1.27000	-4.26538	-26.01768
23	1.27000	1.27000	1.42737	-26.32633
24	1.27000	1.27000	7.05338	-25.40400
25	1.27000	1.27000	12.34959	-23.29380
26	1.27000	1.27000	17.06834	-20.09440
27	1.27000	1.27000	20.98899	-15.95542
28	1.27000	1.27000	23.92823	-11.07038
29	1.27000	1.27000	25.74860	-5.66770

Concrete Properties:

```
Compressive Strength of Concrete                    =     5.0000000 ksi
Modulus of Elasticity of Concrete                   =  4030.5086528 ksi
Modulus of Rupture of Concrete                      =    -0.5303301 ksi
Compression Strain at Peak Stress                   =     0.0021089
Tensile Strain at Fracture of Concrete              =    -0.0001150
Maximum Coarse Aggregate Size                       =     0.7500000 in
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Number of Axial Thrust Force Values Determined from Pile-head Loadings = 1

Number	Axial Thrust Force kips
1	500.000

Definitions of Run Messages and Notes:

C = concrete in section has cracked in tension.
Y = stress in reinforcing steel has reached yield stress.
T = ACI 318-08 criteria for tension-controlled section met, tensile strain in reinforcement exceeds 0.005 while simultaneously compressive strain in concrete more than than 0.003. See ACI 318-08, Section 10.3.4.
Z = depth of tensile zone in concrete section is less than 10 percent of section depth.

Bending Stiffness (EI) = Computed Bending Moment / Curvature.
Position of neutral axis is measured from edge of compression side of pile.
Compressive stresses and strains are positive in sign.
Tensile stresses and strains are negative in sign.

Axial Thrust Force =   500.000 kips

Bending Curvature rad/in.	Bending Moment in-kip	Bending Stiffness kip-in2	Depth to N Axis in	Max Comp Strain in/in	Max Tens Strain in/in	Max Concrete Stress ksi	Max Steel Stress ksi	Run Msg
0.000000417	1365.8849550	3278123892.	114.5877627	0.0000477	0.0000227	0.2232535	1.3809771	
0.000000833	2731.7655451	3278118654.	72.3250211	0.0000603	0.0000103	0.2805553	1.7406047	

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                  Shaft 14 - 60 in shaft 1 3 percent steel in column.lp6o
0.000001250  4097.5837568   3278067005.    58.2512659     0.0000728  -0.000002186
 0.3375905    2.1007334
0.000001667  5462.5544325   3277532660.    51.2235646     0.0000854    -0.0000146
 0.3943486    2.4613056
0.000002083  6824.5604545   3275789018.    47.0113403     0.0000979    -0.0000271
 0.4508005    2.8221435
0.000002500  8182.4908349   3272996334.    44.2052710     0.0001105    -0.0000395
 0.5069277    3.1831322
0.000002917  9535.9035785   3269452655.    42.2020505     0.0001231    -0.0000519
 0.5627210    3.5442151
0.000003333        10885.   3265380659.    40.7003005     0.0001357    -0.0000643
 0.6181756    3.9053624
0.000003750        12228.   3260930726.    39.5327073     0.0001482    -0.0000768
 0.6732886    4.2665569
0.000004167        13568.   3256203744.    38.5989374     0.0001608    -0.0000892
 0.7280585    4.6277883
0.000004583        14902.   3251268702.    37.8351702     0.0001734    -0.0001016
 0.7824839    4.9890497
0.000005000        16231.   3246174048.    37.1988746     0.0001860    -0.0001140
 0.8365643    5.3503368
0.000005417        16231.   2996468352.    31.3489439     0.0001698    -0.0001552
 0.7656814    4.8772716  C
0.000005833        16231.   2782434898.    30.5140613     0.0001780    -0.0001720
 0.8008092    5.1112120  C
0.000006250        16231.   2596939238.    29.7709175     0.0001861    -0.0001889
 0.8352612   -5.4246462  C
0.000006667        16231.   2434630536.    29.1037179     0.0001940    -0.0002060
 0.8690843   -5.9152812  C
0.000007083        16231.   2291416975.    28.5001399     0.0002019    -0.0002231
 0.9023173   -6.4089713  C
0.000007500        16231.   2164116032.    27.9509449     0.0002096    -0.0002404
 0.9350094   -6.9054195  C
0.000007917        16231.   2050215188.    27.4490423     0.0002173    -0.0002577
 0.9672160   -7.4042824  C
0.000008333        16231.   1947704429.    26.9890023     0.0002249    -0.0002751
 0.9990002   -7.9051578  C
0.000008750        16231.   1854956599.    26.5664304     0.0002325    -0.0002925
 1.0304240   -8.4076433  C
0.000009167        16231.   1770640390.    26.1758488     0.0002399    -0.0003101
 1.0614761   -8.9118368  C
0.000009583        16231.   1693656025.    25.8120323     0.0002474    -0.0003276
 1.0921171   -9.4180310  C
  0.0000100        16231.   1623087024.    25.4763948     0.0002548    -0.0003452
 1.1225491   -9.9248455  C
  0.0000104        16231.   1558163543.    25.1599882     0.0002621    -0.0003629
 1.1525319  -10.4339619  C
  0.0000108        16231.   1498234176.    24.8673686     0.0002694    -0.0003806
 1.1823737  -10.9432517  C
  0.0000113        16231.   1442744021.    24.5899422     0.0002766    -0.0003984
 1.2117982  -11.4546563  C
  0.0000117        16231.   1391217449.    24.3326450     0.0002839    -0.0004161
 1.2411240  -11.9659551  C
  0.0000121        16231.   1343244433.    24.0874615     0.0002911    -0.0004339
 1.2700571  -12.4792270  C
  0.0000125        16257.   1300542787.    23.8580347     0.0002982    -0.0004518
 1.2988484  -12.9927124  C
  0.0000129        16577.   1283357470.    23.6420021     0.0003054    -0.0004696
 1.3274543  -13.5067250  C
  0.0000133        16894.   1267067848.    23.4353084     0.0003125    -0.0004875
 1.3557245  -14.0223474  C
  0.0000138        17212.   1251751611.    23.2413954     0.0003196    -0.0005054
 1.3838996  -14.5378685  C
  0.0000142        17528.   1237280481.    23.0578716     0.0003267    -0.0005233
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1.4119074	-15.0538077	C			
0.0000146	17842.	1223485362.	22.8809499	0.0003337	-0.0005413
1.4395796	-15.5713899	C			
0.0000150	18157.	1210444330.	22.7140857	0.0003407	-0.0005593
1.4671584	-16.0888727	C			
0.0000154	18471.	1198096214.	22.5564640	0.0003477	-0.0005773
1.4946436	-16.6062558	C			
0.0000158	18783.	1186297688.	22.4044056	0.0003547	-0.0005953
1.5218503	-17.1248937	C			
0.0000163	19094.	1175041944.	22.2586493	0.0003617	-0.0006133
1.5488553	-17.6442365	C			
0.0000171	19717.	1154146126.	21.9890617	0.0003756	-0.0006494
1.6025893	-18.6826273	C			
0.0000179	20336.	1135021175.	21.7403258	0.0003895	-0.0006855
1.6556080	-19.7232141	C			
0.0000188	20953.	1117489287.	21.5118071	0.0004033	-0.0007217
1.7080733	-20.7648298	C			
0.0000196	21569.	1101413698.	21.3034252	0.0004172	-0.0007578
1.7601752	-21.8060547	C			
0.0000204	22182.	1086471178.	21.1064992	0.0004309	-0.0007941
1.8114321	-22.8505686	C			
0.0000213	22794.	1072666107.	20.9255461	0.0004447	-0.0008303
1.8623224	-23.8947572	C			
0.0000221	23406.	1059871899.	20.7588607	0.0004584	-0.0008666
1.9128535	-24.9385545	C			
0.0000229	24015.	1047911576.	20.6015705	0.0004721	-0.0009029
1.9627435	-25.9841646	C			
0.0000238	24622.	1036724060.	20.4539821	0.0004858	-0.0009392
2.0121108	-27.0306947	C			
0.0000246	25229.	1026267742.	20.3169520	0.0004995	-0.0009755
2.0611229	-28.0768312	C			
0.0000254	25835.	1016470582.	20.1894441	0.0005131	-0.0010119
2.1097788	-29.1225722	C			
0.0000263	26440.	1007251750.	20.0694902	0.0005268	-0.0010482
2.1579778	-30.1687255	C			
0.0000271	27043.	998524629.	19.9544011	0.0005404	-0.0010846
2.2055299	-31.2168557	C			
0.0000279	27646.	990294856.	19.8466779	0.0005541	-0.0011209
2.2527293	-32.2645853	C			
0.0000288	28247.	982519077.	19.7456823	0.0005677	-0.0011573
2.2995751	-33.3119123	C			
0.0000296	28848.	975158820.	19.6508480	0.0005813	-0.0011937
2.3460662	-34.3588349	C			
0.0000304	29449.	968179832.	19.5616710	0.0005950	-0.0012300
2.3922017	-35.4053510	C			
0.0000313	30048.	961540224.	19.4768712	0.0006087	-0.0012663
2.4378924	-36.4522104	C			
0.0000321	30646.	955195322.	19.3947507	0.0006222	-0.0013028
2.4829930	-37.5006756	C			
0.0000329	31243.	949151629.	19.3172229	0.0006359	-0.0013391
2.5277409	-38.5487259	C			
0.0000338	31839.	943386738.	19.2439497	0.0006495	-0.0013755
2.5721349	-39.5963592	C			
0.0000346	32435.	937880405.	19.1746256	0.0006631	-0.0014119
2.6161741	-40.6435733	C			
0.0000354	33030.	932614287.	19.1089742	0.0006768	-0.0014482
2.6598573	-41.6903660	C			
0.0000363	33624.	927571729.	19.0467441	0.0006904	-0.0014846
2.7031835	-42.7367352	C			
0.0000371	34218.	922737571.	18.9877067	0.0007041	-0.0015209
2.7461515	-43.7826786	C			
0.0000379	34811.	918097986.	18.9316536	0.0007178	-0.0015572
2.7887604	-44.8281941	C			

GEOTECHNICAL REPORT
(continued)

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          Shaft 14 - 60 in shaft 1 3 percent steel in column.lp6o
 0.0000387        35403.    913631856.    18.8775647    0.0007315    -0.0015935
2.8309087   -45.8742116  C
 0.0000396        35994.    909324883.    18.8249737    0.0007452    -0.0016298
2.8725559   -46.9211239  C
 0.0000404        36584.    905178871.    18.7749276    0.0007588    -0.0016662
2.9138460   -47.9675951  C
 0.0000412        37174.    901183983.    18.7272743    0.0007725    -0.0017025
2.9547778   -49.0136230  C
 0.0000421        37763.    897331160.    18.6818737    0.0007862    -0.0017388
2.9953503   -50.0592049  C
 0.0000429        38351.    893612047.    18.6385965    0.0007999    -0.0017751
3.0355623   -51.1043383  C
 0.0000437        38938.    890018924.    18.5973235    0.0008136    -0.0018114
3.0754126   -52.1490207  C
 0.0000446        39525.    886544648.    18.5579442    0.0008274    -0.0018476
3.1149001   -53.1932496  C
 0.0000454        40111.    883182597.    18.5203563    0.0008411    -0.0018839
3.1540236   -54.2370222  C
 0.0000462        40697.    879926630.    18.4844651    0.0008549    -0.0019201
3.1927820   -55.2803361  C
 0.0000471        41281.    876771037.    18.4501823    0.0008687    -0.0019563
3.2311740   -56.3231885  C
 0.0000479        41865.    873710505.    18.4174260    0.0008825    -0.0019925
3.2691985   -57.3655767  C
 0.0000487        42449.    870740084.    18.3861198    0.0008963    -0.0020287
3.3068543   -58.4074980  C
 0.0000496        43031.    867855155.    18.3561925    0.0009102    -0.0020648
3.3441401   -59.4489497  C
 0.0000529        45354.    857074834.    18.2468847    0.0009656    -0.0022094
3.4892665   -60.0000000  CY
 0.0000562        47416.    842944869.    18.1233684    0.0010194    -0.0023556
3.6239401   -60.0000000  CY
 0.0000596        48924.    821104868.    17.9537470    0.0010697    -0.0025053
3.7438556   -60.0000000  CY
 0.0000629        50166.    797339294.    17.7744383    0.0011183    -0.0026567
3.8543587   -60.0000000  CY
 0.0000662        51216.    773078745.    17.5891473    0.0011653    -0.0028097
3.9563295   -60.0000000  CY
 0.0000696        52126.    749111326.    17.4039889    0.0012110    -0.0029640
4.0510172   -60.0000000  CY
 0.0000729        52936.    725976635.    17.2260388    0.0012561    -0.0031189
4.1398096   -60.0000000  CY
 0.0000762        53650.    703601755.    17.0519310    0.0013002    -0.0032748
4.2225719   -60.0000000  CY
 0.0000796        54285.    682112697.    16.8789547    0.0013433    -0.0034317
4.2992497   -60.0000000  CY
 0.0000829        54865.    661693740.    16.7148494    0.0013859    -0.0035891
4.3712452   -60.0000000  CY
 0.0000862        55395.    642264691.    16.5585569    0.0014282    -0.0037468
4.4386717   -60.0000000  CY
 0.0000896        55867.    623627858.    16.4035688    0.0014695    -0.0039055
4.5008900   -60.0000000  CY
 0.0000929        56322.    606153859.    16.2567502    0.0015105    -0.0040645
4.5590688   -60.0000000  CY
 0.0000963        56717.    589267802.    16.1131168    0.0015509    -0.0042241
4.6127568   -60.0000000  CY
 0.0000996        57091.    573302236.    15.9778440    0.0015911    -0.0043839
4.6628069   -60.0000000  CY
 0.0001029        57454.    558258926.    15.8488867    0.0016311    -0.0045439
4.7091069   -60.0000000  CY
 0.0001063        57775.    543764173.    15.7193511    0.0016702    -0.0047048
4.7510155   -60.0000000  CY
 0.0001096        58066.    529880251.    15.5945808    0.0017089    -0.0048661
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  4.7893339   -60.0000000  CY
   0.0001129        58353.   516778141.    15.4780559     0.0017477    -0.0050273
  4.8245405   -60.0000000  CY
   0.0001163        58633.   504370165.    15.3686604     0.0017866    -0.0051884
  4.8565720   -60.0000000  CY
   0.0001196        58885.   492420132.    15.2602085     0.0018249    -0.0053501
  4.8849348   -60.0000000  CY
   0.0001229        59106.   480859359.    15.1500223     0.0018622    -0.0055128
  4.9095802   -60.0000000  CY
   0.0001263        59320.   469863753.    15.0460278     0.0018996    -0.0056754
  4.9312851   -60.0000000  CY
   0.0001296        59533.   459418890.    14.9484022     0.0019371    -0.0058379
  4.9500783   -60.0000000  CY
   0.0001329        59743.   449480244.    14.8566126     0.0019747    -0.0060003
  4.9659245   -60.0000000  CY
   0.0001363        59936.   439893604.    14.7673624     0.0020121    -0.0061629
  4.9786719   -60.0000000  CY
   0.0001396        60109.   430633825.    14.6792064     0.0020490    -0.0063260
  4.9883454   -60.0000000  CY
   0.0001429        60264.   421675065.    14.5890607     0.0020850    -0.0064900
  4.9949879   -60.0000000  CY
   0.0001462        60418.   413111397.    14.5038552     0.0021212    -0.0066538
  4.9988773    60.0000000  CY
   0.0001496        60569.   404917601.    14.4233532     0.0021575    -0.0068175
  4.9983576    60.0000000  CY
   0.0001529        60718.   397064418.    14.3473963     0.0021940    -0.0069810
  4.9968914    60.0000000  CY
   0.0001562        60862.   389516857.    14.2749069     0.0022305    -0.0071445
  4.9995905    60.0000000  CY
   0.0001596        60997.   382227501.    14.2050200     0.0022669    -0.0073081
  4.9936382    60.0000000  CY
   0.0001629        61119.   375153363.    14.1366875     0.0023031    -0.0074719
  4.9971683    60.0000000  CY
   0.0001662        61230.   368302340.    14.0680598     0.0023388    -0.0076362
  4.9995736    60.0000000  CY
   0.0001696        61332.   361665814.    13.9990731     0.0023740    -0.0078010
  4.9952459    60.0000000  CY
   0.0001729        61433.   355274211.    13.9336873     0.0024094    -0.0079656
  4.9955841    60.0000000  CY
   0.0001762        61532.   349118781.    13.8713644     0.0024448    -0.0081302
  4.9986841    60.0000000  CY
   0.0001796        61631.   343186280.    13.8119411     0.0024804    -0.0082946
  4.9999642    60.0000000  CY
   0.0001829        61727.   337458421.    13.7556875     0.0025161    -0.0084589
  4.9915600    60.0000000  CY
   0.0002029        62207.   306564222.    13.4484229     0.0027289    -0.0094461
  4.9972308    60.0000000  CY
   0.0002229        62549.   280593936.    13.1866259     0.0029395    -0.0104355
  4.9983101    60.0000000  CY
   0.0002429        62805.   258545030.    12.9962461     0.0031570    -0.0114180
  4.9977199    60.0000000  CYT
   0.0002629        62955.   239449563.    12.8367866     0.0033750    -0.0124000
  4.9937125    60.0000000  CYT
   0.0002829        63060.   222891794.    12.7038537     0.0035941    -0.0133809
  4.9817507    60.0000000  CYT
   0.0003029        63142.   208447630.    12.6017724     0.0038173    -0.0143577
  4.9996254    60.0000000  CYT
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Summary of Results for Nominal (Unfactored) Moment Capacity for Section 2

GEOTECHNICAL REPORT
(continued)

Shaft 14 - 60 in shaft 1 3 percent steel in column.lp6o

Moment values interpolated at maximum compressive strain = 0.003
or maximum developed moment if pile fails at smaller strains.

Load No.	Axial Thrust kips	Nominal Mom. Cap. in-kip	Max. Comp. Strain
1	500.000	62620.210	0.00300000

Note note that the values of moment capacity in the table above are not factored by a strength reduction factor (phi-factor).

In ACI 318-08, the value of the strength reduction factor depends on whether the transverse reinforcing steel bars are spirals or tied hoops.

The above values should be multiplied by the appropriate strength reduction factor to compute ultimate moment capacity according to ACI 318-08, Section 9.3.2.2 or the value required by the design standard being followed.

Computed Values of Pile Loading and Deflection
for Lateral Loading for Load Case Number 1

Pile-head conditions are Shear and Moment (Loading Type 1)

Shear force at pile head = 25000.000 lbs
Applied moment at pile head = 0.000 in-lbs
Axial thrust load on pile head = 500000.000 lbs

Depth X inches	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness lb-in^2	Soil Res. p lb/in	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	1.7020	5.955E-05	25000.	-0.003424	0.000	1.320E+12	0.000	0.000	0.000
8.000	1.6746	213698.	25000.	-0.003424	0.000	1.320E+12	0.000	0.000	0.000
16.000	1.6472	427390.	25000.	-0.003422	0.000	1.320E+12	0.000	0.000	0.000
24.000	1.6198	641073.	25000.	-0.003419	0.000	1.320E+12	0.000	0.000	0.000
32.000	1.5925	854739.	25000.	-0.003414	0.000	1.320E+12	0.000	0.000	0.000
40.000	1.5652	1068385.	25000.	-0.003408	0.000	1.320E+12	0.000	0.000	0.000
48.000	1.5380	1282005.	25000.	-0.003401	0.000	1.320E+12	0.000	0.000	0.000
56.000	1.5108	1495594.	25000.	-0.003393	0.000	1.320E+12	0.000	0.000	0.000
64.000	1.4837	1709147.	25000.	-0.003383	0.000	1.320E+12	0.000	0.000	0.000
72.000	1.4567	1922658.	25000.	-0.003372	0.000	1.320E+12	0.000	0.000	0.000
80.000	1.4297	2136123.	25000.	-0.003360	0.000	1.320E+12	0.000	0.000	0.000
88.000	1.4029	2349536.	25000.	-0.003346	0.000	1.320E+12			

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							0.000	0.000	0.000
96.000	1.3762	2562892.	25000.	-0.003331	0.000	1.320E+12	0.000	0.000	0.000
104.000	1.3496	2776186.	25000.	-0.003315	0.000	1.320E+12	0.000	0.000	0.000
112.000	1.3232	2989412.	25000.	-0.003298	0.000	1.320E+12	0.000	0.000	0.000
120.000	1.2969	3202567.	25000.	-0.003279	0.000	1.320E+12	0.000	0.000	0.000
128.000	1.2707	3415643.	25000.	-0.003259	0.000	1.320E+12	0.000	0.000	0.000
136.000	1.2447	3628637.	25000.	-0.003237	0.000	1.320E+12	0.000	0.000	0.000
144.000	1.2189	3841543.	25000.	-0.003215	0.000	1.320E+12	0.000	0.000	0.000
152.000	1.1933	4054355.	25000.	-0.003191	0.000	1.320E+12	0.000	0.000	0.000
160.000	1.1679	4267070.	25000.	-0.003166	0.000	1.320E+12	0.000	0.000	0.000
168.000	1.1426	4479681.	25000.	-0.003139	0.000	1.320E+12	0.000	0.000	0.000
176.000	1.1176	4692183.	25000.	-0.003111	0.000	1.320E+12	0.000	0.000	0.000
184.000	1.0928	4904572.	25000.	-0.003082	0.000	1.319E+12	0.000	0.000	0.000
192.000	1.0683	5116841.	25000.	-0.003052	0.000	1.319E+12	0.000	0.000	0.000
200.000	1.0440	5328987.	25000.	-0.003020	0.000	1.319E+12	0.000	0.000	0.000
208.000	1.0200	5541003.	25000.	-0.002987	0.000	1.319E+12	0.000	0.000	0.000
216.000	0.9962	5752885.	25000.	-0.002953	0.000	1.318E+12	0.000	0.000	0.000
224.000	0.9727	5964627.	25000.	-0.002917	0.000	1.318E+12	0.000	0.000	0.000
232.000	0.9495	6176224.	25000.	-0.002881	0.000	1.317E+12	0.000	0.000	0.000
240.000	0.9266	6387671.	25000.	-0.002842	0.000	1.317E+12	0.000	0.000	0.000
248.000	0.9041	6598963.	25000.	-0.002803	0.000	1.317E+12	0.000	0.000	0.000
256.000	0.8818	6810095.	25000.	-0.002762	0.000	1.316E+12	0.000	0.000	0.000
264.000	0.8599	7021061.	25000.	-0.002720	0.000	1.316E+12	0.000	0.000	0.000
272.000	0.8383	7231856.	25000.	-0.002677	0.000	1.315E+12	0.000	0.000	0.000
280.000	0.8170	7442475.	25000.	-0.002632	0.000	1.315E+12	0.000	0.000	0.000
288.000	0.7962	7652914.	25000.	-0.002586	0.000	1.314E+12	0.000	0.000	0.000
296.000	0.7757	7863165.	25000.	-0.002539	0.000	1.314E+12	0.000	0.000	0.000
304.000	0.7555	8073226.	25000.	-0.002491	0.000	1.313E+12	0.000	0.000	0.000
312.000	0.7358	8283089.	25000.	-0.002441	0.000	1.313E+12	0.000	0.000	0.000
320.000	0.7165	8492751.	25000.	-0.002390	0.000	1.312E+12	0.000	0.000	0.000
328.000	0.6976	8702206.	25000.	-0.002353	0.000	3.272E+12	0.000	0.000	0.000
336.000	0.6788	8911575.	25000.	-0.002331	0.000	3.271E+12	0.000	0.000	0.000

GEOTECHNICAL REPORT
(continued)

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               Shaft 14 - 60 in shaft 1 3 percent steel in column.lp6o
   344.000     0.6603   9120858.     25000.  -0.002309      0.000  3.270E+12
0.000      0.000      0.000
   352.000     0.6419   9330051.     25000.  -0.002287      0.000  3.270E+12
0.000      0.000      0.000
   360.000     0.6237   9539153.     25000.  -0.002264      0.000  3.269E+12
0.000      0.000      0.000
   368.000     0.6057   9748161.     25000.  -0.002240      0.000  3.269E+12
0.000      0.000      0.000
   376.000     0.5878   9957074.     25000.  -0.002216      0.000  3.268E+12
0.000      0.000      0.000
   384.000     0.5702  10165890.     25000.  -0.002191      0.000  3.267E+12
0.000      0.000      0.000
   392.000     0.5528  10374606.     25000.  -0.002166      0.000  3.267E+12
0.000      0.000      0.000
   400.000     0.5356  10583220.     25000.  -0.002141      0.000  3.266E+12
0.000      0.000      0.000
   408.000     0.5185  10791730.     25000.  -0.002114      0.000  3.266E+12
0.000      0.000      0.000
   416.000     0.5017  11000135.     25000.  -0.002088      0.000  3.265E+12
0.000      0.000      0.000
   424.000     0.4851  11208432.     25000.  -0.002061      0.000  3.264E+12
0.000      0.000      0.000
   432.000     0.4688  11416620.     25000.  -0.002033      0.000  3.263E+12
0.000      0.000      0.000
   440.000     0.4526  11624695.     25000.  -0.002005      0.000  3.263E+12
0.000      0.000      0.000
   448.000     0.4367  11832656.     25000.  -0.001976      0.000  3.262E+12
0.000      0.000      0.000
   456.000     0.4210  12040501.     25000.  -0.001947      0.000  3.261E+12
0.000      0.000      0.000
   464.000     0.4055  12248228.     25000.  -0.001917      0.000  3.261E+12
0.000      0.000      0.000
   472.000     0.3903  12455835.     25000.  -0.001886      0.000  3.260E+12
0.000      0.000      0.000
   480.000     0.3754  12663320.     25000.  -0.001856      0.000  3.259E+12
0.000      0.000      0.000
   488.000     0.3606  12870680.     25000.  -0.001824      0.000  3.259E+12
0.000      0.000      0.000
   496.000     0.3462  13077914.     25000.  -0.001792      0.000  3.258E+12
0.000      0.000      0.000
   504.000     0.3320  13285019.     25000.  -0.001760      0.000  3.257E+12
0.000      0.000      0.000
   512.000     0.3180  13491994.     25000.  -0.001727      0.000  3.256E+12
0.000      0.000      0.000
   520.000     0.3043  13698836.     24978.  -0.001694      0.000  3.256E+12
-5.5706   146.4417      0.000
   528.000     0.2909  13905187.     24874.  -0.001660      0.000  3.255E+12
-20.3564   559.8131      0.000
   536.000     0.2778  14110099.     24630.  -0.001625      0.000  3.254E+12
-40.6081  1169.5865      0.000
   544.000     0.2649  14312273.     24200.  -0.001590      0.000  3.253E+12
-67.0539  2025.0629      0.000
   552.000     0.2523  14510015.     23545.  -0.001555      0.000  3.253E+12
-96.5103  3060.0141      0.000
   560.000     0.2400  14701437.     22642.  -0.001519      0.000  3.252E+12
-129.4056  4313.2317      0.000
   568.000     0.2280  14884433.     21502.  -0.001483      0.000  3.251E+12
-155.3727  5451.4839      0.000
   576.000     0.2163  15057338.     20143.  -0.001446      0.000  3.251E+12
-184.4658  6822.8119      0.000
   584.000     0.2049  15218289.     18556.  -0.001409      0.000  3.250E+12
-212.3689  8292.6409      0.000
   592.000     0.1938  15365499.     16739.  -0.001371      0.000  3.249E+12
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-241.8805  9987.0294      0.000
   600.000     0.1829  15497077.     14680.  -0.001333      0.000  3.249E+12
-272.9245     11935.      0.000
   608.000     0.1724  15611035.     12372.  -0.001295      0.000  3.248E+12
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   616.000     0.1622  15705392.  9824.8265  -0.001256      0.000  3.248E+12
-332.9923     16421.      0.000
   624.000     0.1523  15778281.  7144.6307  -0.001217      0.000  3.248E+12
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   632.000     0.1427  15829444.  4441.6336  -0.001178      0.000  3.248E+12
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   640.000     0.1335  15858774.  1734.6546  -0.001139      0.000  3.248E+12
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   656.000     0.1159  15852237. -3622.0295  -0.001061      0.000  3.248E+12
-330.5460     22821.      0.000
   664.000     0.1075  15816850. -6240.1342  -0.001022      0.000  3.248E+12
-323.9801     24101.      0.000
   672.000     0.0995  15760573. -8799.0005  -0.000983      0.000  3.248E+12
-315.7364     25381.      0.000
   680.000     0.0918  15683933.    -11286.  -0.000945      0.000  3.248E+12
-305.9608     26661.      0.000
   688.000     0.0844  15587557.    -13689.  -0.000906      0.000  3.249E+12
-294.7970     27941.      0.000
   696.000     0.0773  15472160.    -15998.  -0.000868      0.000  3.249E+12
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   704.000     0.0705  15338539.    -18203.  -0.000830      0.000  3.249E+12
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   712.000     0.0640  15187558.    -21371.  -0.000792      0.000  3.250E+12
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   728.000     0.0519  14786452.    -29294.  -0.000719      0.000  3.252E+12
-466.0348     71768.      0.000
   736.000     0.0463  14539988.    -32895.  -0.000682      0.000  3.253E+12
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   744.000     0.0410  14265586.    -36236.  -0.000647      0.000  3.254E+12
-400.9015     78168.      0.000
   752.000     0.0360  13965385.    -39304.  -0.000612      0.000  3.255E+12
-366.0926     81368.      0.000
   760.000     0.0312  13641617.    -42089.  -0.000578      0.000  3.256E+12
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   768.000     0.0267  13296585.    -43759.  -0.000545      0.000  3.257E+12
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   776.000     0.0225  12945839.    -44443.  -0.000513      0.000  3.258E+12
-83.8063     29788.      0.000
   784.000     0.0185  12589602.    -45098.  -0.000482      0.000  3.260E+12
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   792.000     0.0148  12228129.    -45719.  -0.000451      0.000  3.261E+12
-75.3668     40741.      0.000
   800.000     0.0113  11861712.    -46300.  -0.000422      0.000  3.262E+12
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   808.000   0.008051  11490696.    -46835.  -0.000393      0.000  3.263E+12
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   816.000   0.005019  11115499.    -47310.  -0.000365      0.000  3.265E+12
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   824.000   0.002204  10736662.    -47700.  -0.000339      0.000  3.266E+12
-42.3387    153663.      0.000
   832.000  -0.000400  10355010.    -47774.  -0.000313      0.000  3.267E+12
23.8187    476619.      0.000
   840.000  -0.002801   9974781.    -47496.  -0.000288      0.000  3.268E+12
45.7809    130758.      0.000
```

GEOTECHNICAL REPORT
(continued)

```
              Shaft 14 - 60 in shaft 1 3 percent steel in column.lp6o
   848.000  -0.005007   9597385.    -47090.  -0.000264      0.000  3.269E+12
55.5791     88806.      0.000
   856.000  -0.007025   9223452.    -46619.  -0.000241      0.000  3.270E+12
62.2283     70868.      0.000
   864.000  -0.008862   8853410.    -46101.  -0.000219      0.000  3.271E+12
67.2437     60702.      0.000
   872.000    -0.0105   8487586.    -45547.  -0.000198      0.000  3.272E+12
71.2167     54125.      0.000
   880.000    -0.0120   8126237.    -44964.  -0.000177      0.000  3.273E+12
74.4486     49531.      0.000
   888.000    -0.0134   7769573.    -44575.  -0.000158      0.000  3.274E+12
22.8230     13663.      0.000
   896.000    -0.0146   7414294.    -44262.  -0.000139      0.000  3.274E+12
55.5566     30544.      0.000
   904.000    -0.0156   7062498.    -43802.  -0.000122      0.000  3.275E+12
59.4661     30508.      0.000
   912.000    -0.0165   6714439.    -43313.  -0.000105      0.000  3.276E+12
62.8505     30476.      0.000
   920.000    -0.0173   6370337.    -42798. -8.889E-05      0.000  3.276E+12
65.7384     30449.      0.000
   928.000    -0.0179   6030379.    -42263. -7.375E-05      0.000  3.277E+12
68.1576     30427.      0.000
   936.000    -0.0185   5694725.    -41709. -5.944E-05      0.000  3.277E+12
70.1350     30408.      0.000
   944.000    -0.0189   5363504.    -41142. -4.594E-05      0.000  3.278E+12
71.6965     30394.      0.000
   952.000    -0.0192   5036819.    -40564. -3.325E-05      0.000  3.278E+12
72.8676     30383.      0.000
   960.000    -0.0194   4714749.    -39978. -2.135E-05      0.000  3.278E+12
73.6727     30375.      0.000
   968.000    -0.0195   4397347.    -39386. -1.023E-05      0.000  3.278E+12
74.1358     30371.      0.000
   976.000    -0.0196   4084647.    -38793.  1.241E-07      0.000  3.278E+12
74.2801     30370.      0.000
   984.000    -0.0195   3776662.    -38199.  9.717E-06      0.000  3.278E+12
74.1284     30371.      0.000
   992.000    -0.0194   3473383.    -37608.  1.856E-05      0.000  3.278E+12
73.7030     30375.      0.000
  1000.000    -0.0192   3174788.    -37021.  2.668E-05      0.000  3.278E+12
73.0256     30381.      0.000
  1008.000    -0.0190   2880835.    -36156.  3.406E-05      0.000  3.278E+12
143.1938     60341.      0.000
  1016.000    -0.0187   2596019.    -34471.  4.075E-05      0.000  3.278E+12
277.9660    119018.      0.000
  1024.000    -0.0183   2328967.    -32268.  4.676E-05      0.000  3.278E+12
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  1032.000    -0.0179   2079362.    -30107.  5.214E-05      0.000  3.278E+12
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246.9997    119614.      0.000
  1064.000    -0.0160   1247662.    -21982.  6.818E-05      0.000  3.278E+12
239.3209    119761.      0.000
  1072.000    -0.0154   1079188.    -20099.  7.102E-05      0.000  3.278E+12
231.2705    119915.      0.000
  1080.000    -0.0149    925504.    -18283.  7.346E-05      0.000  3.278E+12
222.8935    120075.      0.000
  1088.000    -0.0143    786076.    -16534.  7.555E-05      0.000  3.278E+12
214.2308    120240.      0.000
  1096.000    -0.0136    660352.    -14856.  7.732E-05      0.000  3.278E+12
                                Page 22
```

```
205.3199    120409.      0.000
  1104.000    -0.0130    547761.    -13250.  7.879E-05      0.000  3.278E+12
196.1948    120582.      0.000
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186.8860    120758.      0.000
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177.4208    120937.      0.000
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167.8234    121117.      0.000
  1136.000    -0.0104    216913. -7575.6971  8.238E-05      0.000  3.278E+12
158.1150    121300.      0.000
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148.3140    121483.      0.000
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138.4359    121668.      0.000
  1160.000  -0.008436     77124. -4135.2627  8.342E-05      0.000  3.278E+12
128.4938    121853.      0.000
  1168.000  -0.007768     47819. -3147.2936  8.357E-05      0.000  3.278E+12
118.4984    122039.      0.000
  1176.000  -0.007099     26098. -2239.4675  8.366E-05      0.000  3.278E+12
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  1184.000  -0.006429     11318. -1412.1191  8.370E-05      0.000  3.278E+12
98.3790    122412.      0.000
  1192.000  -0.005760  2834.7323  -665.5412  8.372E-05      0.000  3.278E+12
88.2654    122599.      0.000
  1200.000  -0.005090     0.000      0.000  8.372E-05      0.000  3.278E+12
78.1199     61393.      0.000
```

* This analysis makes computations of pile response using nonlinear moment-curvature relationships.
  The above values of total stress are computed for combined axial and bending stress and do not
  equal the actual stresses in concrete and steel in the range of nonlinear bending.

Output Verification: Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 1:

```
Pile-head deflection             =      1.7019899 inches
Computed slope at pile head      =     -0.0034244 radians
Maximum bending moment           =      15866313. inch-lbs
Maximum shear force              =        -47774. lbs
Depth of maximum bending moment  =    648.0000000 inches below pile head
Depth of maximum shear force     =    832.0000000 inches below pile head
Number of iterations             =              9
Number of zero deflection points =              1
```

Summary of Pile Response(s)

Definitions of Pile-head Loading Conditions:

Load Type 1: Load 1 = Shear, lbs, and Load 2 = Moment, in-lbs
Load Type 2: Load 1 = Shear, lbs, and Load 2 = Slope, radians

GEOTECHNICAL REPORT
(continued)

```
               Shaft 14 - 60 in shaft 1 3 percent steel in column.lp6o
Load Type 3: Load 1 = Shear, lbs, and Load 2 = Rotational Stiffness, in-lbs/radian
Load Type 4: Load 1 = Top Deflection, inches, and Load 2 = Moment, in-lbs
Load Type 5: Load 1 = Top Deflection, inches, and Load 2 = Slope, radians


               Pile-head      Pile-head
Load  Load    Condition 1    Condition 2        Axial        Pile-head       Maximum
       Maximum       Pile-head
Case  Type    V(lbs) or     in-lb, rad.,       Loading      Deflection       Moment
        Shear        Rotation
 No.   No.    y(inches)     or in-lb/rad.        lbs          inches         in-lbs
         lbs          radians
----  ----  --------------  --------------  -------------  -------------
-------------  -------------  -------------
  1     1   V =     25000.  M =      0.000        500000.     1.70198995
15866313.        -47774.    -0.00342444

The analysis ended normally.
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ENVIRONMENTAL FORCES REPORT

The New St. Petersburg Pier

Environmental Forces Study

Prepared for:
**Buro Happold
Consulting Engineers, P.C.**

**100 Broadway, 23rd Floor
New York, NY 10005**

Project No. 111367.00
April 2013

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ENVIRONMENTAL FORCES REPORT (continued)

Executive Summary

In accordance with the contract requirements of "Phase 2, Task 1", McLaren Engineering Group (MEG) is pleased to submit this Environmental Forces Study Report. For pier design it is necessary to determine the likelihood and magnitude of extreme environmental events that will impact the pier during its lifetime. Extreme water levels, current velocities, and waves impart forces on the pier which must be sustained or avoided, otherwise the pier risks damage or even failure. This report outlines the process used to determine the recurrence levels and results for these extreme events and the conditions that should be addressed for the design of the New St. Petersburg Pier.

Water Level Analysis

An Extreme Value Analysis (EVA) of water levels at the New St. Petersburg Pier was conducted using yearly maximum water levels and storm surges from verified data obtained from NOAA Station 8726520 St. Petersburg, FL, which is located 0.5 miles southeast of the site. Water level data was normalized to 2012 by removing the Sea Level Rise (SLR) trend from the data set and the Generalized Extreme Value (GEV) distribution was then used to determine values for the 5, 10, 25, 50, 75, and 100 year events.

Similarly, storm surge was calculated by subtracting the predicted tidal water level from the observed and an EVA of storm surge values was used to determine an extreme surge event. The extreme surge event was then added to Mean High Water Spring (MHWS) to obtain an extreme storm surge elevation.

As determined by NOAA, a Sea Level Rise (SLR) rate of 2.63 mm (0.1 inches) per year was added to the 100-year water and storm surge levels to account for 100 years of SLR (Table 1). The 100-year water level and 100-year storm surge water level were determined to be 5.76 feet NAVD and 5.75 feet NAVD, respectively. For design, the 100-year water level of 5.76 feet NAVD was used.

Wind Analysis

A directional EVA of wind speeds at the site was conducted using wind data obtained from MacDill Air Force Base, approximately 9 miles northeast of the site. This data has recorded continuously from 1941-2012 and plotted at 22.5° intervals, based on occurrence (Figure 8). The wind rose indicates that a typical wind occurs from the north and northeast. However the majority of higher speed winds occurs from the south and southwest of Tampa Bay. The 100-year wind speed was calculated in 10° intervals, using the Gumbel distribution and these directional extreme values were used to calculate wave generation within Tampa Bay. From this analysis it was found that a wind speed of 64 mph, from 200° SW, generated the dominant wave condition within Tampa Bay.

Wave Analysis

Wave generation and transformation analysis was performed using the Automated Coastal Engineering System (ACES) computer software developed by the U.S. Army Corps of Engineers. Wind generated waves within Tampa Bay were calculated using a shallow water restricted fetch condition within ACES. The calculated extreme directional winds were then applied to determine the dominant wave condition and direction of propagation.

Refraction, shoaling, and breaking was analyzed using Snell's Law in ACES. As the wave transformed toward shore, it was determined that the wave would reach a non-breaking 100-year wave height, $H_{1/100}$, of 8.72 feet at the shoreward most piles. For the design wave height, H_{design}, the USACE's Coastal Engineering Manual suggests a factor equal to 1.8 times the significant wave height, H_s. This is equivalent to 1.08 times the calculated $H_{1/100}$ at the site, and results with an H_{design} of 9.42 feet, propagating normal to the structure.

Pier piles were found to have negligible effect on wave transformation due to their spacing. Water depths range from approximately 20.76 feet at the pier head to 11.76 at the concrete seawall during the 100-year storm event. Analysis found that H_{design} would break in a depth of 12.08 feet, affecting the shoreward bents of piles. The Wave Crest Elevation (WCE) is equal to 50% of H_{design} plus the 100-year water elevation. This results with a WCE of 10.47 feet NAVD 88.

Current Analysis

An analysis of current data, obtained from NOAA Acoustic Doppler Current Profiler (ADCP) t01010, located at the Sunshine Skyway Bridge (Figure 10), was performed to determine the 100-year current flow velocity at the New Pier. A peaks over threshold (POT) EVA was used to obtain speeds that were significant to design and representative of ebb and flood flows. The Gumbel distribution was used to estimate the 100-yr current velocity by using values greater than or equal to 1 knot. This resulted in an estimated 100-year current speed of 3.83 knots. Bathymetry obtained by NOAA was used to project this current speed from the Sunshine Skyway Bridge to the St. Petersburg Pier. The 100-year current speed at the Pier is estimated to be 4.00 knots.

Tabular Summary

Summary of Analysis (NAVD 88)		
100-yr WL Elevation	5.76 ft	= 4.99 ft + SLR
100-yr Surge Elevation	5.75 ft	= 4.18 ft + MHWS + SLR
Sea Level Rise	0.83 ft	= .1 in/12 x 100 yrs
Peak Directional Wind	64 mph	@ 200° true
Design Wave Height	9.42 ft	
Wave Crest Elevation	10.47 ft	=(.50 x Design Wave Height) + 100-yr WL Elevation

**ENVIRONMENTAL FORCES
REPORT (continued)**

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1. Introduction

For pier design it is necessary to determine the likelihood and magnitude of extreme environmental events that will impact the pier during its lifetime. Extreme water levels, current velocities, and waves impart forces on the pier which must be sustained or avoided, otherwise the pier risks damage or even failure. Historic environmental data has been obtained from anemometers, tidal gauges, and Acoustic Doppler Current Profilers (ADCP) operated by the National Oceanic and Atmospheric Administration (NOAA).

The collected data was evaluated, an Extreme Value Analysis was performed, and wave generation within Tampa Bay was analyzed. The results of this analysis was used to determine the design wave height, water level, storm surge elevation, and water current speed at the site. This report outlines the process used to determine the recurrence levels and results for these extreme events and the conditions that should be addressed for the design of the New St. Petersburg Pier.

2. Analysis Method and Data Source

Wind, water level, and current speed data was obtained from anemometers, tidal gauges, and an ADCP within Tampa Bay (Figure 1). Wind data was collected from records from MacDill Air Force Base, spanning from 1947-2012, and is located approximately 9.0 miles northeast of the site. The data obtained from this station was reported as average hourly wind speeds from an anemometer height of 14.1 feet above the ground surface. Water level data was obtained from NOAA Station 8726520 St. Petersburg, FL, spanning from 1946-2012, and is located 0.9 miles south of the project site. Water current speed data was obtained NOAA ADCP t01010, located at the Sunshine Skyway Bridge, located approximately 10.2 miles southwest of the site. This data represents several current meter deployments, spanning from 1999 to 2013.

To determine water levels, wind speeds, and current speeds for the 5, 10, 25, 50, 75, and 100 year events, an Extreme Value Analysis (EVA) was performed. An EVA is a statistical analysis which involves taking a set of extreme values from the gathered data and fitting it to a probability distribution. From the distribution, values associated with a particular return period can then be determined. Two different extreme value distributions were used in this analysis: The Generalized Extreme Value (GEV) distribution and the Gumbel distribution. The GEV was found to provide the best fit for water levels. Similarly, the Gumbel distribution was found to be more appropriate for wind and current speeds for long term analysis of extreme events. This also follows recommendations found in the USACE Coastal Engineering Manual regarding long term analysis.

The Automated Coastal Engineering System (ACES) computer software developed by the U.S. Army Corps of Engineers was used in the wave generation and transformation analysis. Water levels and wind speeds calculated from the EVA were used to determine design wave conditions at the site.

ENVIRONMENTAL FORCES REPORT (continued)

Figure 1. Data Station Locations

3. Water Level Analysis

The first step in determining the extreme events at the project site was to analyze the water levels. To determine the water level used for design, an EVA of water levels and storm surges at St. Petersburg was conducted. Water level and storm surge were analyzed separately is to determine which was the dominant condition. Storm surge is calculated by subtracting the predicted tidal water level from the observed (Figure 2). It is important to note that although surge is included in water level measurements, an EVA of water levels will give the extreme value for water level only (Figure 5). An EVA of storm surge values is then used to determine an extreme surge event and is added to Mean High Water Spring (MHWS) to obtain an extreme storm surge elevation.

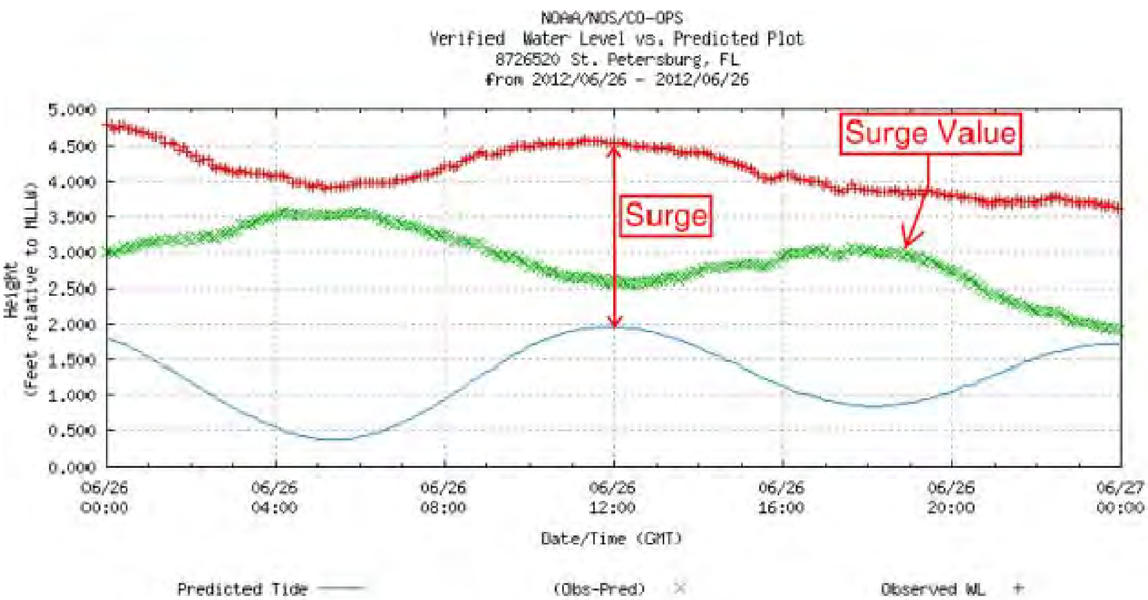

Figure 2. Storm Surge Plot, (NOAA)

When analyzing water levels, Sea Level Rise (SLR) must be removed before fitting the data to a distribution to eliminate bias in the data. This is accomplished by plotting the verified data and fitting a linear trend line to it. The slope of the trend line is then used to normalize the data to the 2012 values (Figure 3 and 4).

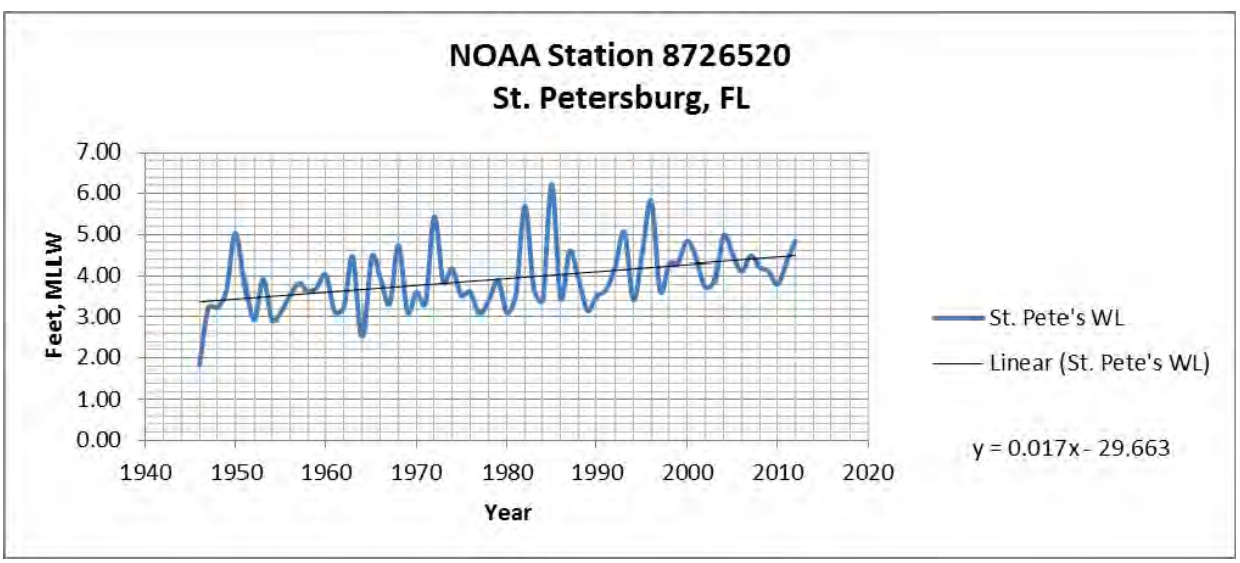

Figure 3. Annual Maximum Water Level Data

ENVIRONMENTAL FORCES REPORT (continued)

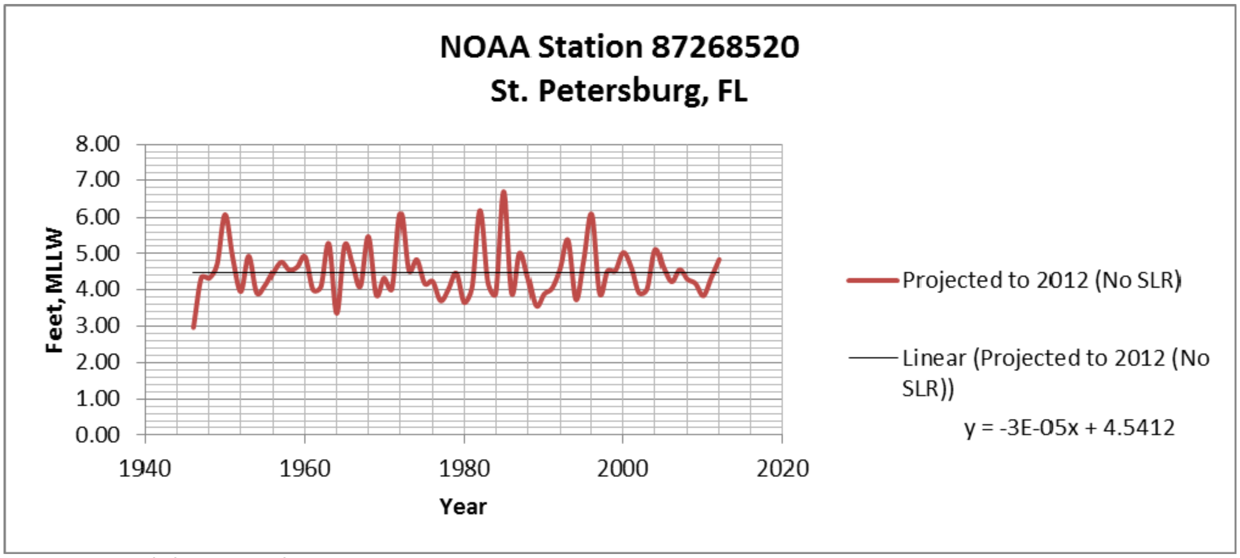

Figure 4. Detrended Water Level Data

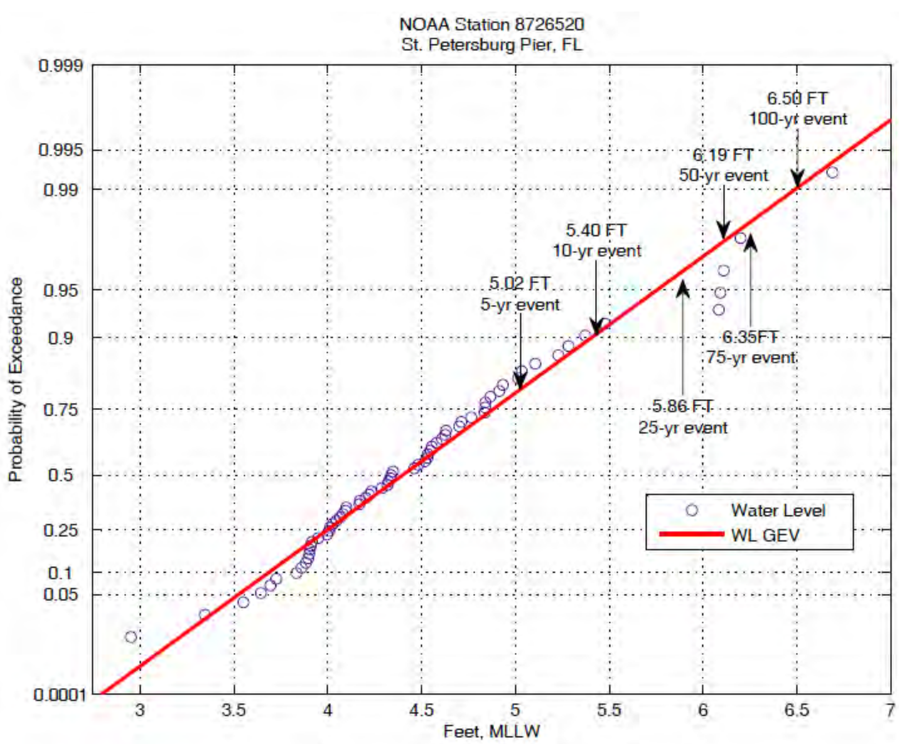

Figure 5. Water Level EVA

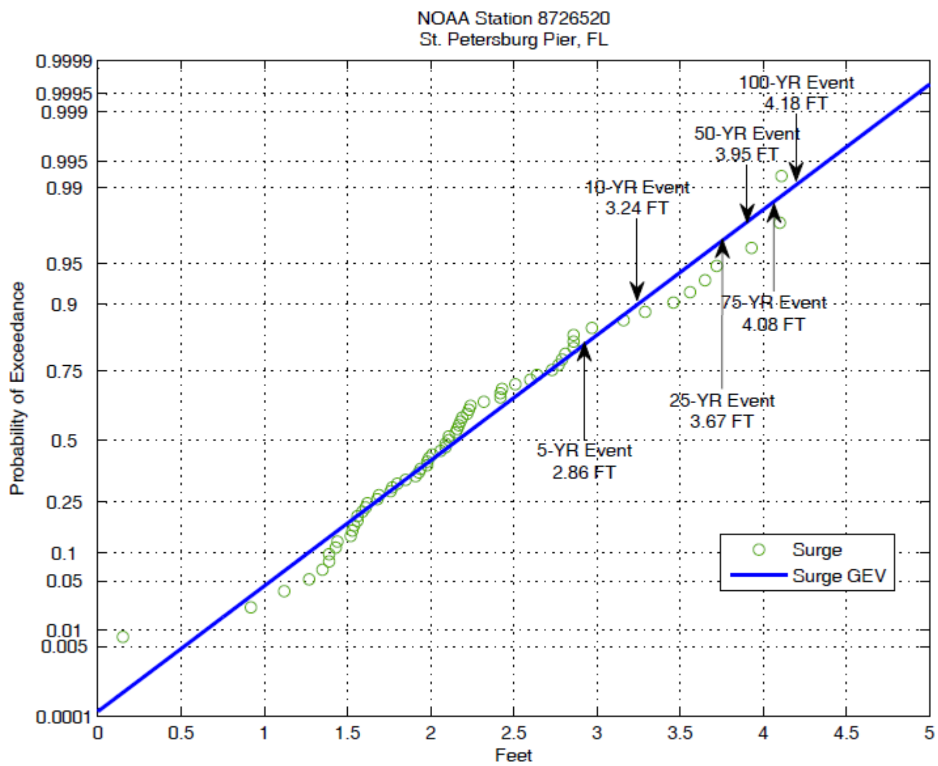

Figure 6. Surge EVA

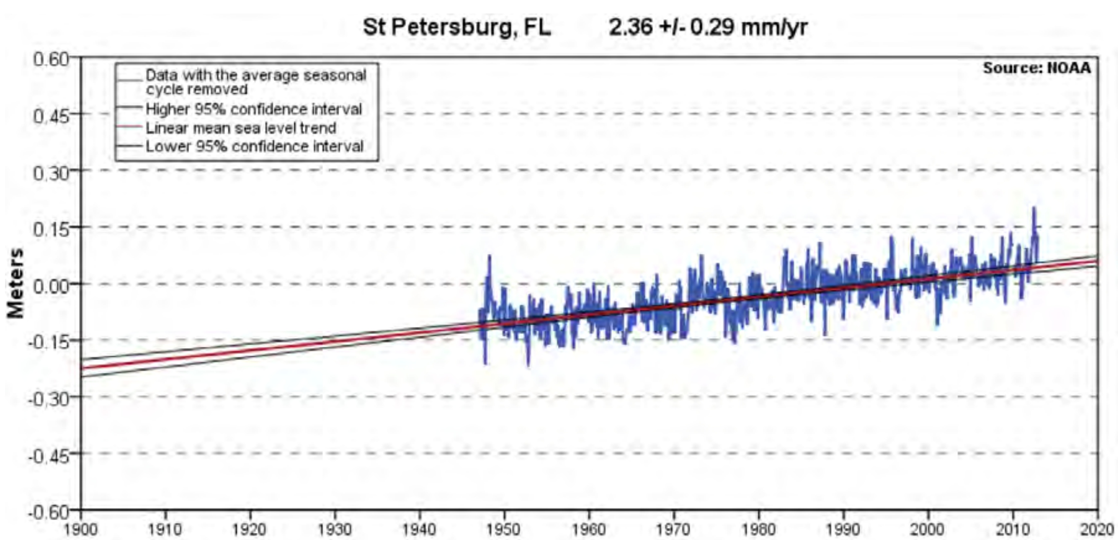

Figure 7. Sea Level Rise Trend for NOAA Station 8726520 St. Petersburg, FL

After calculating the extreme values for each event, SLR was added using a SLR rate determined by NOAA. Because the SLR value used to detrend the EVA data is based off of annual maximum water level elevations, NOAA's estimate provides a more precise value of SLR as it uses a larger sample size of data. As determined by NOAA, a SLR rate of 2.36 mm per year (Figure 7) was added to these levels account for 100 years of SLR (Table 1). The 100-year water level and 100-year

ENVIRONMENTAL FORCES REPORT (continued)

storm surge water level were determined to be 5.76 feet NAVD and 5.75 feet NAVD, respectively. For design, the 100-yr water level of 5.76 feet NAVD was used.

Tidal Datum Chart			
	MLLW	NGVD29	NAVD88
100-yr WL Elevation*	7.27	6.64	5.76
100-yr Surge Elevation*	7.26	6.63	5.75
Highest Observed Water Level (8/31/1985)	6.26	5.63	4.75
MHWS	2.31	1.68	0.80
MHHW	2.26	1.63	0.75
MHW	1.98	1.35	0.47
NAVD88	1.51	0.88	0.00
MSL	1.20	0.57	-0.31
MTL	1.18	0.55	-0.33
NGVD29	0.63	0.00	-0.88
MLW	0.39	-0.24	-1.12
MLLW	0.00	-0.63	-1.51
Lowest Observed Water Level (1/16/1972)	-2.47	-3.10	-3.98

*Includes Sea Level Rise of 2.36 mm/year

Table 1. NOAA Station 8726520 St. Petersburg, FL Tidal Datum Chart

4. Wind Analysis

A directional EVA of wind speeds at the New St. Petersburg Pier was conducted using wind data obtained from MacDill Air Force Base. This station was selected due to its proximity to the project site and large record of data. Results from this analysis are used in conjunction with the results obtained from the water level EVA for wave prediction. Although wind speeds can be obtained from ASCE 7-10, using these values can result in unrealistic wave height predictions for the design event and therefore were not used. Analyzing site specific data will result in more precise values that will better describe conditions within Tampa Bay.

A wind rose of recorded data from MacDill Air Force Base (Figure 8) was created to show speed, direction, and percent occurrence of the recorded data. As seen in the wind rose, the majority of observations occur from the north and northeast and the majority of higher speed winds occur in the south and southwest of Tampa Bay. This data has been continuously recorded from 1941-2012, and was reported as average hourly wind speeds in miles per hour. To determine the dominant wind speed and direction for wave generation, the data was binned into 10° intervals and then fitted to the Gumbel distribution.

From this analysis, the 100-year wind speeds for each interval was determined (Table 2) and used with the design water level to predict wave generation within Tampa Bay. It should be noted that these values represent average hourly speeds observed from an anemometer height of 14.1 feet above the ground surface. The wind speed values reported in ASCE 7-10 are given in 3-second gust durations at a height of 33 feet for exposure Category C and correspond to a recurrence interval of 700 years.

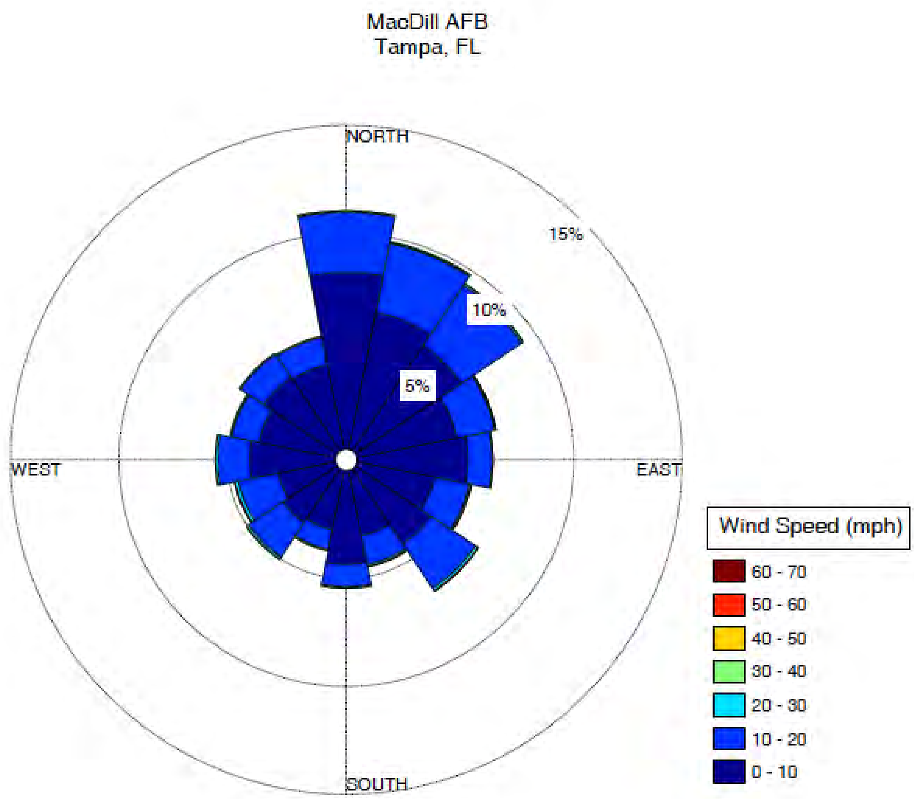

Figure 8. MacDill AFB Wind Rose.

Directional EVA of Wind at MacGill AFB, FL					
Direction	Speed (mph)	Direction	Speed (mph)	Direction	Speed (mph)
10	36.70	130	46.13	250	56.11
20	56.58	140	46.13	260	43.93
30	43.39	150	48.80	270	53.15
40	49.78	160	50.52	280	46.66
50	54.02	170	51.12	290	61.43
60	51.36	180	54.02	300	49.96
70	48.49	190	60.05	310	47.25
80	49.19	200	64.22	320	58.85
90	45.30	210	58.09	330	46.62
100	47.47	220	55.82	340	57.71
110	45.96	230	59.60	350	41.44
120	46.72	240	49.27	360	49.40

*Anemometer height is 14.1 ft; 1 hr avg. wind speed.

Table 2. Directional EVA of Wind at MacDill AFB.

ENVIRONMENTAL FORCES REPORT (continued)

5. Wave Analysis

Wave generation and transformation analysis was performed using the Automated Coastal Engineering System (ACES) computer software developed by the U.S. Army Corps of Engineers. Waves are generated by wind blowing over an area of open water called a fetch (Figure 9). Wind generated waves within Tampa Bay were calculated using a shallow water restricted fetch condition within ACES. This method applies the concept of wave development in an off wind direction and by doing so, the shape of the bay and the effects of wind funneling are taken into consideration.

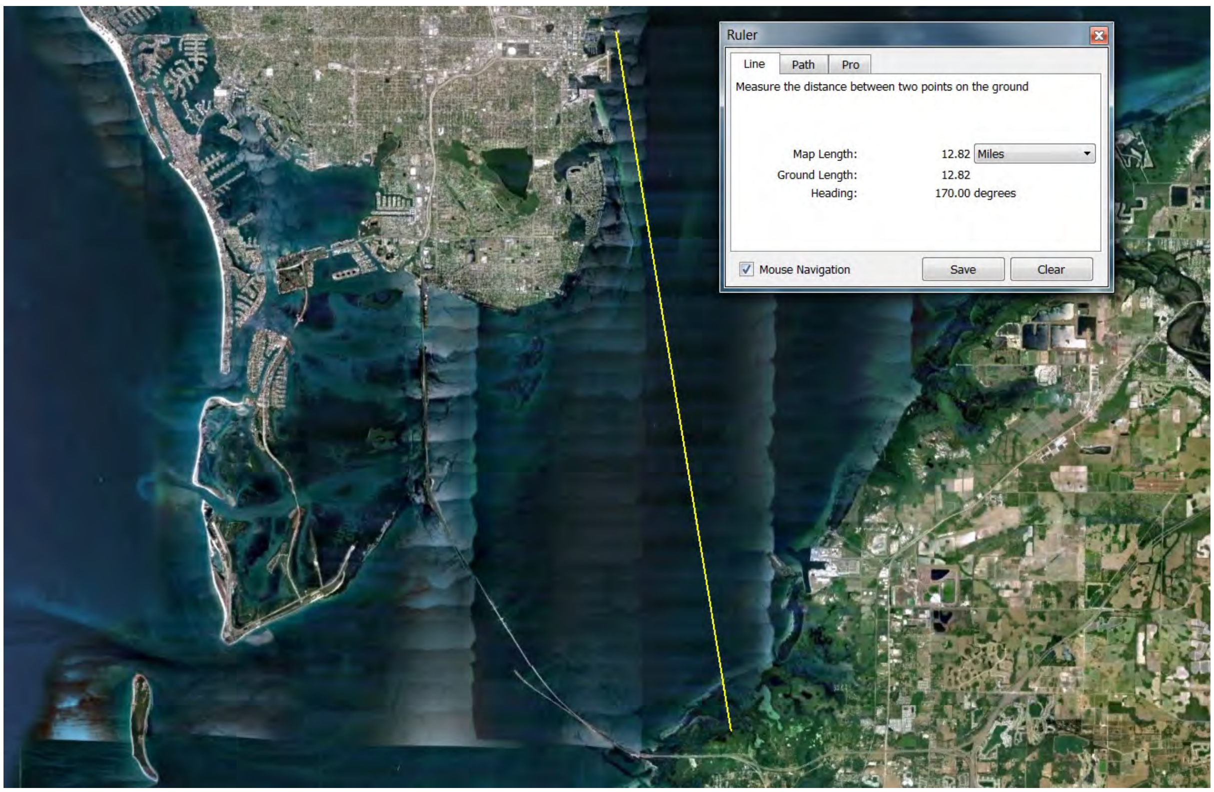

Figure 9. Fetch Radial

To describe the shape and extents of the Tampa Bay, fetch distances were taken from the location of the New Pier to the shoreline of the bay at 10° increments. The calculated extreme directional winds were then applied to determine the dominant wave condition and direction of propagation. From this analysis, a 100-year wave height ($H_{1/100}$) of 8.07 feet at a direction of 175° SE was estimated to occur within Tampa Bay.

As waves propagate from deep to shallower depths, the bottom bathymetry will affect the direction, speed, length, and height of the waves. Refraction is the bending of waves in response to varying bathymetry across the crest of the wave. This bending occurs when the wave crosses bathymetry contours at an angle, resulting in varying wave speeds, relative to depth, across the wave crest. The part of the wave that travels across depths that are deeper will do so at a higher speed than the part of the wave that is passing over shallower depths. This results with the wave crest bending and becoming more parallel with the contours of the bottom.

Wave shoaling is the effect by which waves increase in height as they enter shallower depths. As wave speed slows upon entering shallower depths, its height will increase and the wave will steepen until it becomes unstable. This instability is due to the crest of the wave moving faster than the trough, resulting with the wave breaking. Because the bottom gently slopes across the length of the New Pier, the breaking wave height was found to be equal to 0.78 times the water depth ($H_b = 0.78h_b$).

Refraction, shoaling, and breaking were analyzed using Snell's Law in ACES. The incident angle of the dominant waves was found to be 175° SE. Because of the refraction limitations of Snell's law within ACES, this angle was changed to 105° SE to allow for computation and to remain conservative. Refraction and shoaling to the head of the New Pier resulted in a wave height of 8.31 feet at a depth of 19.76 feet with an angle of 107° SE. At this location within Tampa Bay, the bathymetry becomes very complex with elongated contours stretching toward the head of the existing pier. This pattern is likely caused by diffraction of waves around the existing pier head. Based on the bathymetry at the pier head, the incident wave angle was again changed so that wave propagation was pier-normal and the bathymetry contours were assumed to be straight and parallel to the existing concrete seawall.

As the wave transformed toward shore, it was determined that the wave would reach a 100-year wave height, $H_{1/100}$, of 8.72 feet at the shoreward piles. For the design wave height, H_{design}, the USACE's Coastal Engineering Manual suggests a factor equal to 1.8 times the significant wave height, H_s. This is equal to 1.08 times the calculated $H_{1/100}$ at the site, and results with an H_{design} of 9.42 feet.

Pier piles were found to have negligible effect on wave transformation due to their spacing. Water depths range from approximately 20.76 feet at the pier head to 11.76 at the concrete seawall during the 100-year storm event. Analysis found that H_{design} would break in a depth of 12.08 feet, affecting only the most shoreward bents of piles. The Wave Crest Elevation (WCE) is equal to 50% of H_{design} plus the 100-year water elevation. This results with a WCE of 10.47 feet NAVD 88.

6. Current Analysis

An analysis of current data, obtained from NOAA Acoustic Doppler Current Profiler (ADCP) t01010, located at the Sunshine Skyway Bridge (Figure 10), was performed to determine the 100-year current flow velocity at the New Pier. A peaks over threshold (POT) EVA was used to obtain speeds that were significant to design and representative of ebb and flood flows. The Gumbel distribution was used to estimate the 100-yr current by using values greater than or equal to 1 knot. This resulted in an estimated 100-year current speed of 3.83 knots. Bathymetry obtained by NOAA was used to project this current speed from the Sunshine Skyway Bridge to the St. Petersburg Pier. The 100-year current speed at the Pier is estimated to be 4.00 knots.

ENVIRONMENTAL FORCES REPORT (continued)

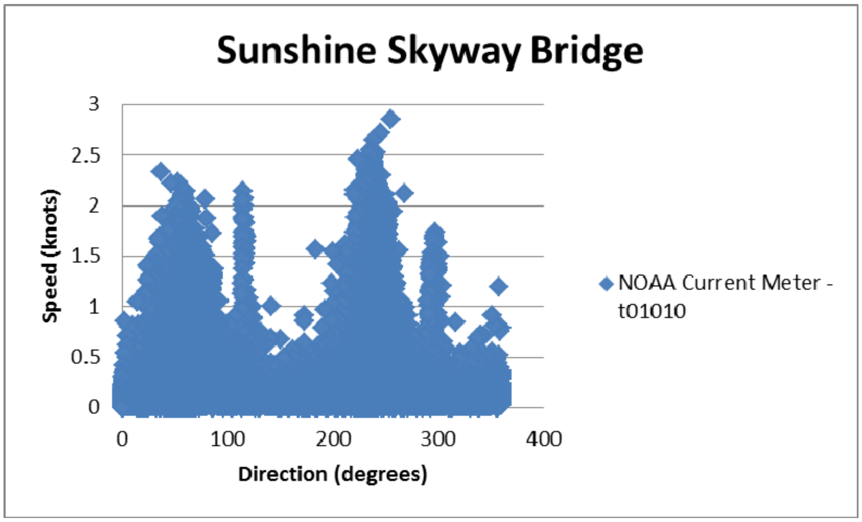

Figure 10. Sunshine Skyway Bridge Current Meter Data, 1999-2013

7. Conclusions

An EVA of environmental forces was used to calculate the 100-year water level, current velocity, and design wave height at the New St. Petersburg Pier. The 100-year water level was estimated to be 5.76 feet NAVD by applying the GEV distribution to yearly maximum water levels. Similarly, a directional EVA of wind speeds from MacDill AFB, using the Gumbel distribution, was found to generate waves that resulted in an H_{design} of 9.42 feet for the New Pier. A POT EVA of current velocity data, obtained from the NOAA current meter at the Sunshine Skyway Bridge, was also conducted using the Gumbel distribution, resulting with an estimated 100-year current of 4.00 knots at the New St. Petersburg Pier.

Analysis of the loadings on the pier from these extreme forces is needed for design. Special attention should be made to current induced scour around the New Pier's concrete caissons, as riprap scour protection may be required. Designing the New Pier for these conditions will enable the pier to withstand the 100-year event.

Summary of Analysis (NAVD 88)		
100-yr WL Elevation	5.76 ft	= 4.99 ft + SLR
100-yr Surge Elevation	5.75 ft	= 4.18 ft + MHWS + SLR
Sea Level Rise	0.83 ft	= .1 in/12 x 100 yrs
Peak Directional Wind	64 mph	@ 200° true
Design Wave Height	9.42 ft	
Wave Crest Elevation	10.47 ft	=(.50 x Design Wave Height) + 100-yr WL Elevation

Table 3. Analysis Summary

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STRUCTURE WIND ASSESSMENT STUDY

CONSULTING ENGINEERS & SCIENTISTS

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February 27, 2013

Jean-Pierre Chakar, P.E.
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T 310.945-4800

Email: jp.chakar@burohappold.com

Re: Desk-top Assessment on Structural Wind Loads
St. Petersburg Pier Lens, St. Petersburg, Florida
RWDI Reference #1300997

Dear JP,

We have completed the desk-top assessment to provide estimated overall structural wind loads acting on the lens structure of the St. Petersburg Pier in St. Petersburg, Florida. Our review was based on the planned lens shape, the surroundings, wind load information from building codes and other technical literature, and previous wind tunnel model studies of similar structures. Consideration has also been given to the strength and directionality of the local wind climate.

The building geometry was based on the 3D AutoCad drawing provided on January 30, 2013:

1201_130127_Digital Model_R4_KB01

The estimated loads allow for some dynamic amplification of the loading for inertial effects based on our experience. Several wind load distributions are provided that represent the primary load patterns based on our experience. However, these loading patterns may not reflect all of the important loading scenarios for this structure. A more accurate prediction of the wind loads in the structurally important loading patterns will be obtained through the wind tunnel tests.

The estimated preliminary wind loads provided in this report are based on an ultimate state 3-second gust design wind speed of 145 mph a height of 33 ft in open terrain. **This value is consistent with that identified for St. Petersburg in the ASCE/SEI 7-10 Standard and the 2010 Florida Building Code for use with Load and Resistance Factor Design (LRFD)**. The provided wind loads are based on a Category II Structure. If needed, this report can be updated to reflect wind loading consistent with ASCE/SEI 7-05 and standard 50 year return period wind loading.

Estimated Overall Structural Wind Loads

For the preliminary overall structural design of the lens, estimated overall structural design wind load distributions are presented in Figures 1 to 4. The pressures indicated are net instantaneous loads across windward and leeward surfaces. Note that "negative pressure", or uplift, is defined to act outward, normal to the top surface of the lens, and "positive pressure", or downforce, act towards the top surface of the lens. It is understood at this point in time that the lens structure will be segmented through expansion joints but that the precise scheme has yet to be determined. The presented loads in Figure 1 to 4 take this into consideration on the assumption that four structurally independent quadrants will be created.

Overall Drag Wind Loading Cases

Simultaneous loading patterns affecting the entire structure are provided in Figures 5 through 9. These figures follow the same convention as Figures 1 to 4 in that the wind pressure acts across the Lens structure as a net wind load. The wind pressures are normal to the surface of the Lens structure and are presented on the top surface of the Lens. A negative pressure acts normal to the surface and away from the top surface. A positive pressure acts normal to the surface and towards the top surface of the Lens.

Figures 5 through 9 are drag wind loading acting simultaneously over the entire Lens. A wind direction is shown in each figure. There are 5 load cases, however at this preliminary stage 3 of these load cases can be mirrored about central east-west axes to provide additional cases. Consider this for the following load cases:

Figure 6: Mirror Loads from Southeast Wind about east-west axis (Column line 27 extended length of structure) to act as Loads from a Northeast Wind.

Figure 7: Mirror Loads from South Wind about east-west axis (Column line 27 extended length of structure) to act as Loads from a North Wind.

Figure 8: Mirror Loads from Southwest Wind about east-west axis (Column line 27 extended length of structure) to act as Loads from a Northwest Wind.

Please note that the wind loads provided here are estimates based on a preliminary review only. This information does not reflect the results of a wind tunnel study of this structure. The provided wind loads are approximate in nature and are not recommended to be used for final design purposes. Local wind pressures for design of secondary structural members (such as roof purlins) likely will be higher than provided in these estimates. A more accurate prediction of the wind loads will be obtained through the wind tunnel tests. Should you have any questions or comments, we would be pleased to discuss them with you.

Yours very truly,

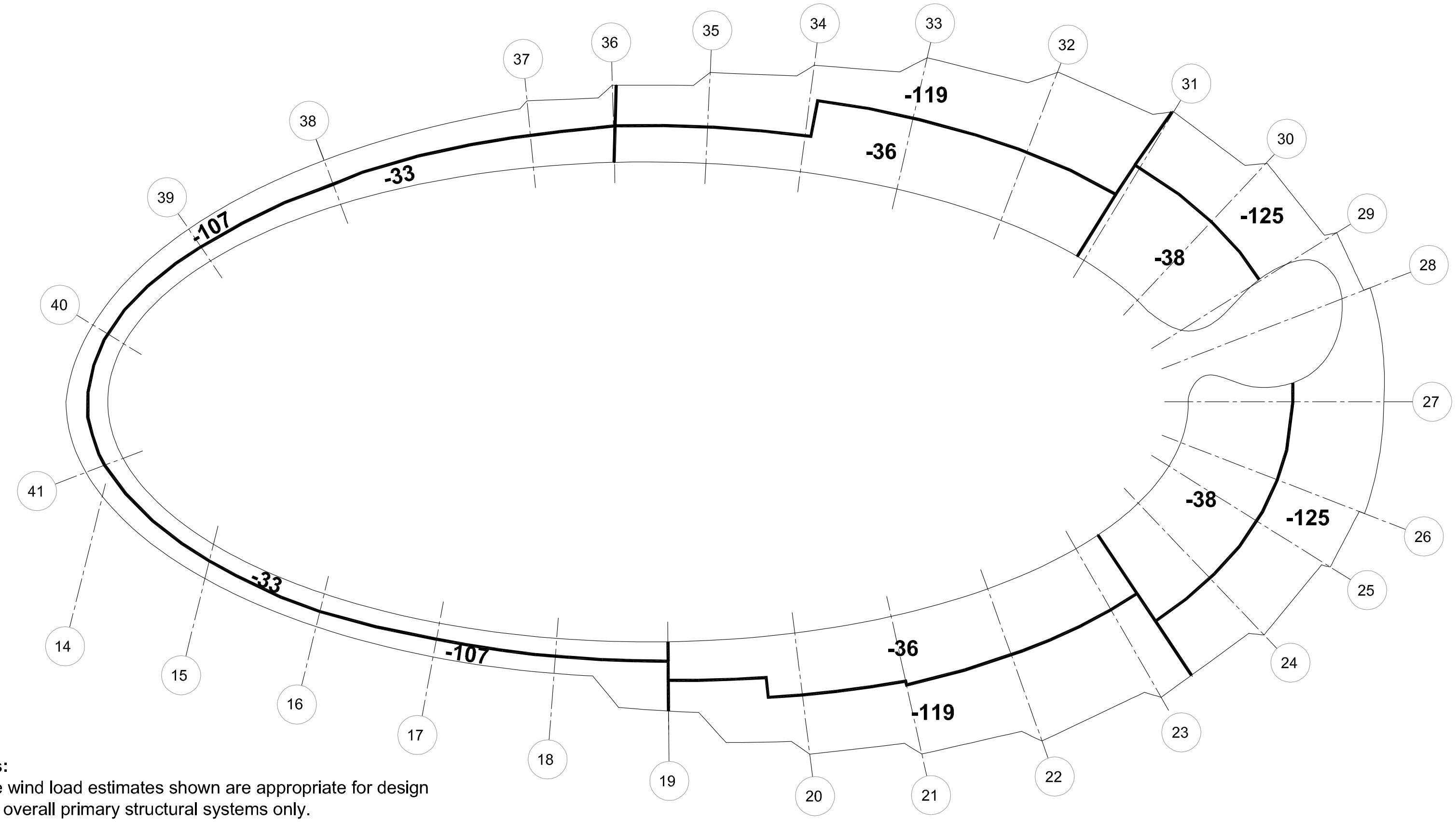
ROWAN WILLIAMS DAVIES & IRWIN

Jonathan B. Lankin, P.Eng.
Project Manager/Senior Specialist

Scott L. Gamble, P.Eng.
Principal

STRUCTURE WIND ASSESSMENT STUDY (continued)

FIGURES



Notes:
1. The wind load estimates shown are appropriate for design of the overall primary structural systems only.
2. The structural wind loads DO NOT contain load or safety factors and are to be applied to the building's structural system in the same manner as would wind loads calculated by code analytical methods.
3. The wind pressures provided are to be applied to all surfaces simultaneously.
4. The wind pressures are to be applied normal to each surface. Positive pressures are defined to act inwards towards the surface, and negative pressures act outwards.

TOP VIEW

0 40 80ft

Estimated Structural Wind Loads (Psf)
Load Case 1a - Uplift Top Weighted
Basic Wind Speed = 145 mph, Category II ASCE/SEI 7-10
Ultimate State Wind Loads for Load and Resistance Factor Design
St. Petersburg Pier (The Lens) - St. Petersburg, Florida

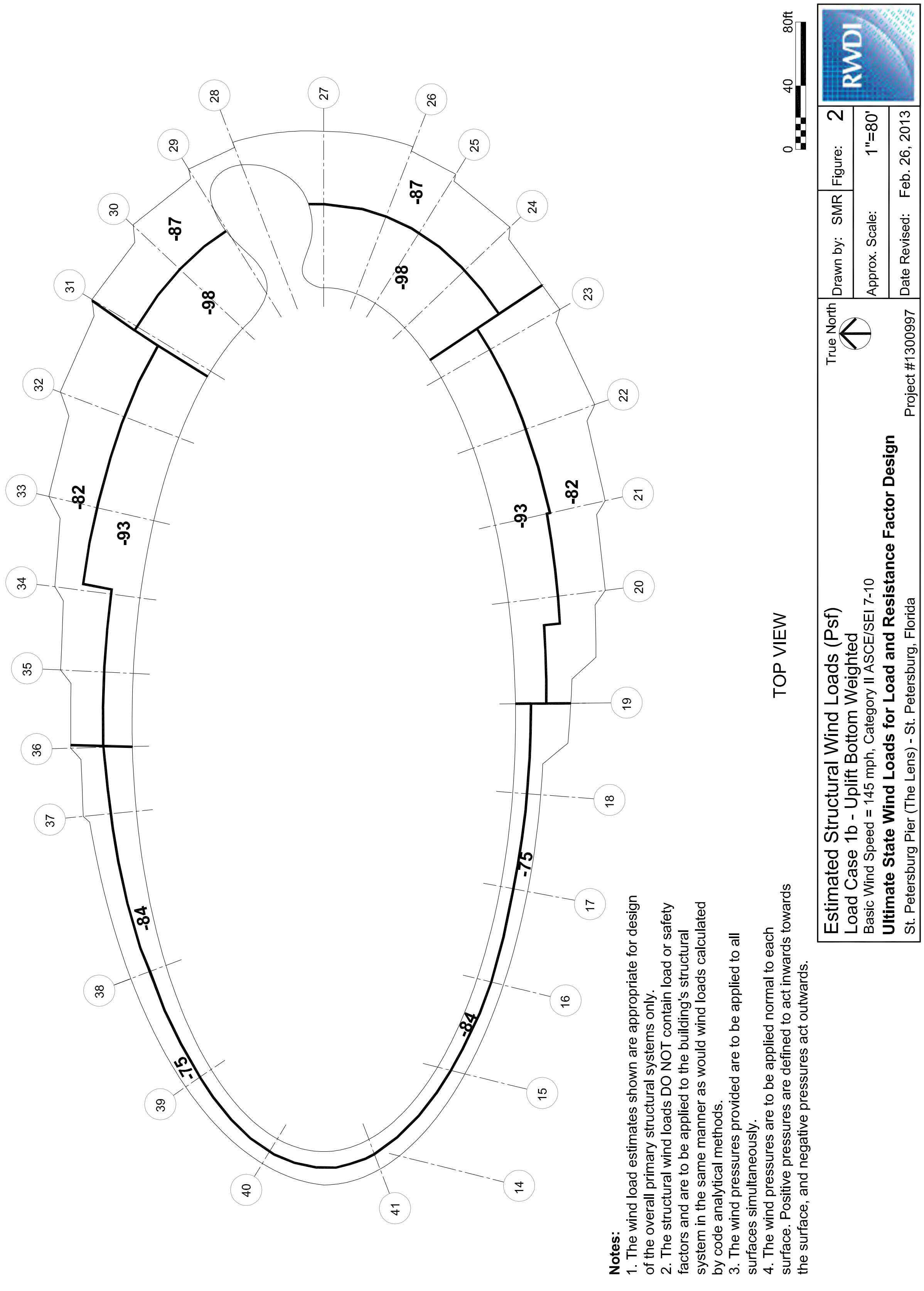
True North

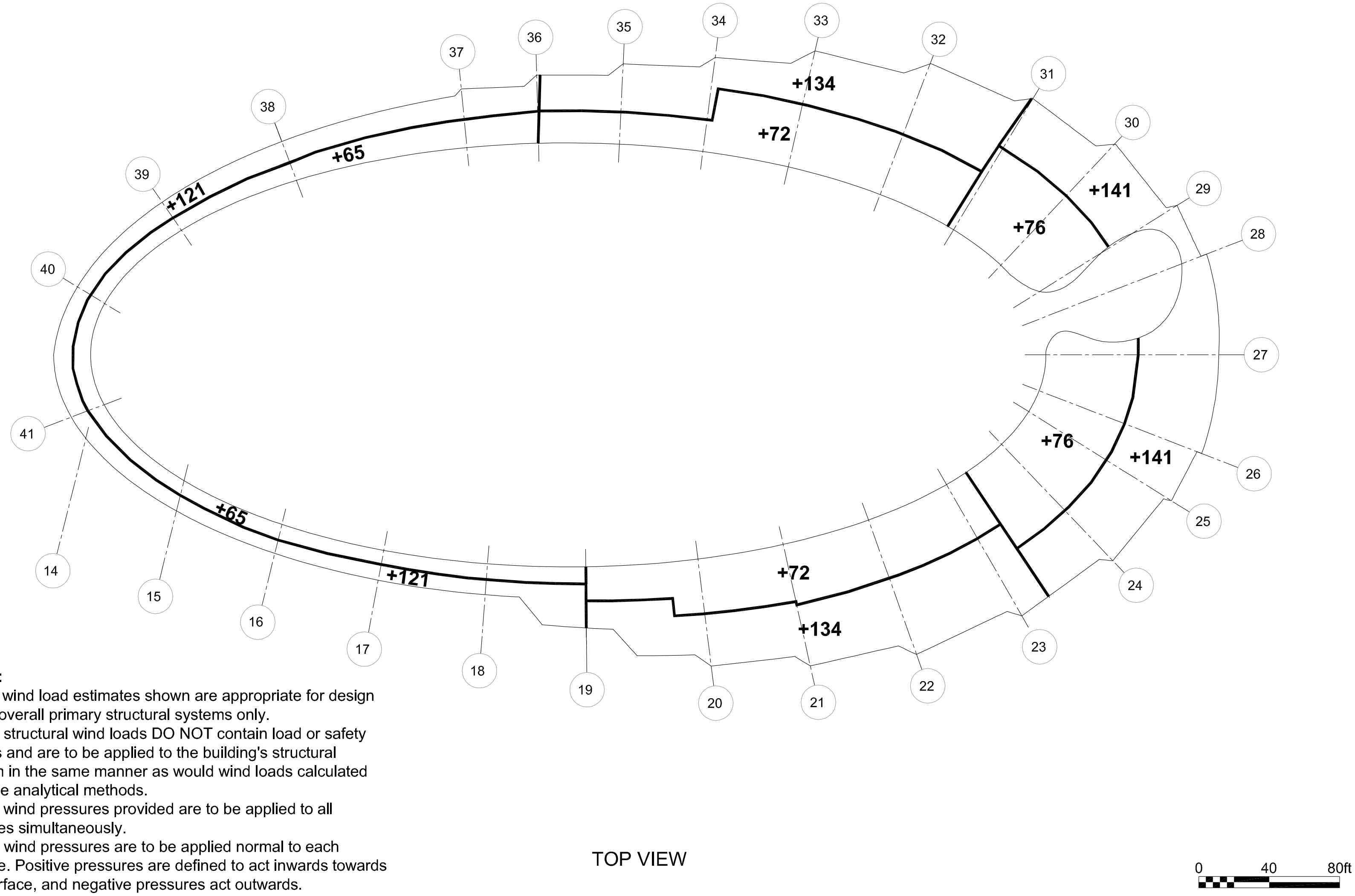
Project #1300997

Drawn by: SMR | Figure: 1
Approx. Scale: 1"=80'
Date Revised: Feb. 26, 2013

RWDI

STRUCTURE WIND ASSESSMENT STUDY (continued)

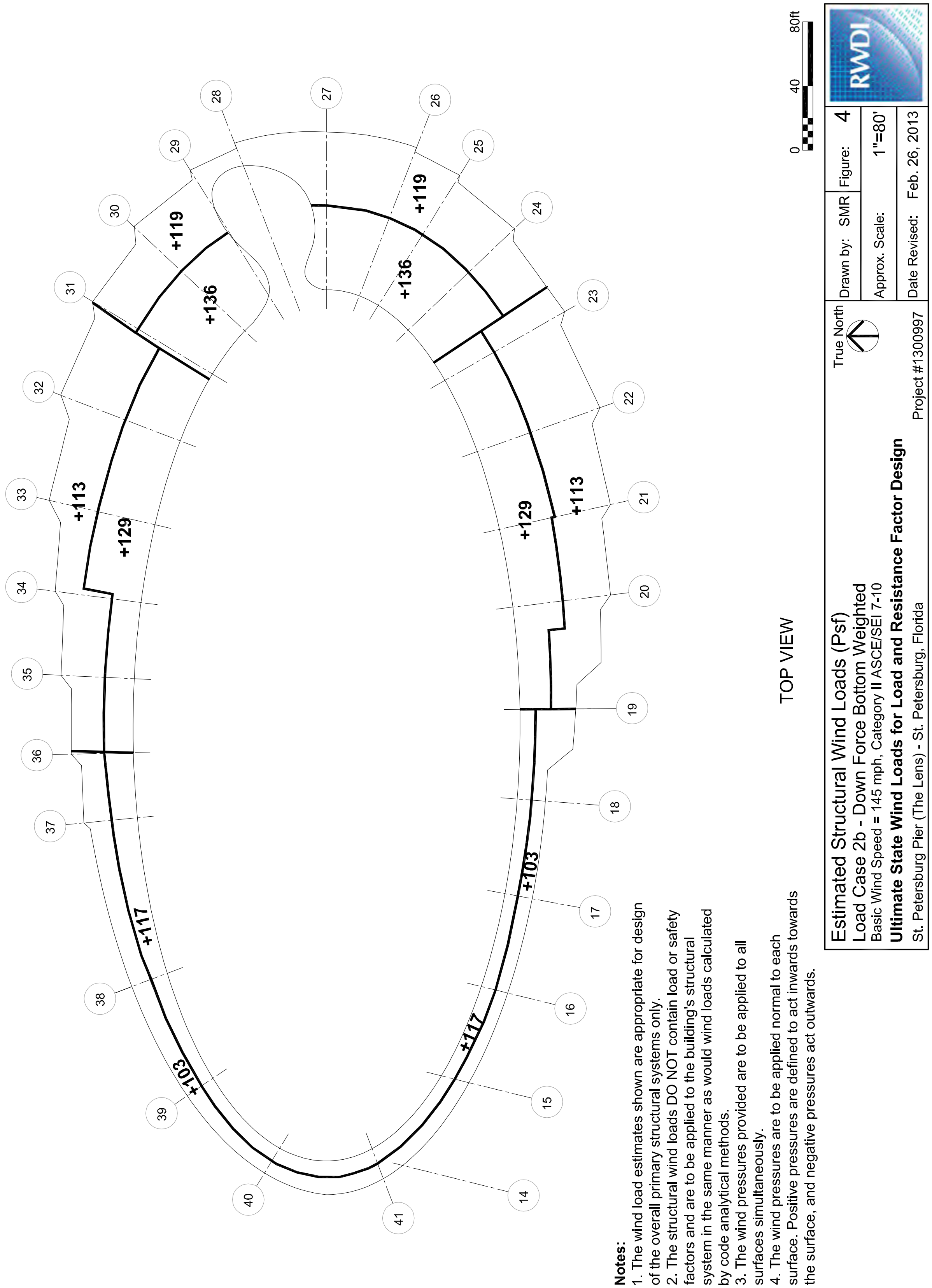


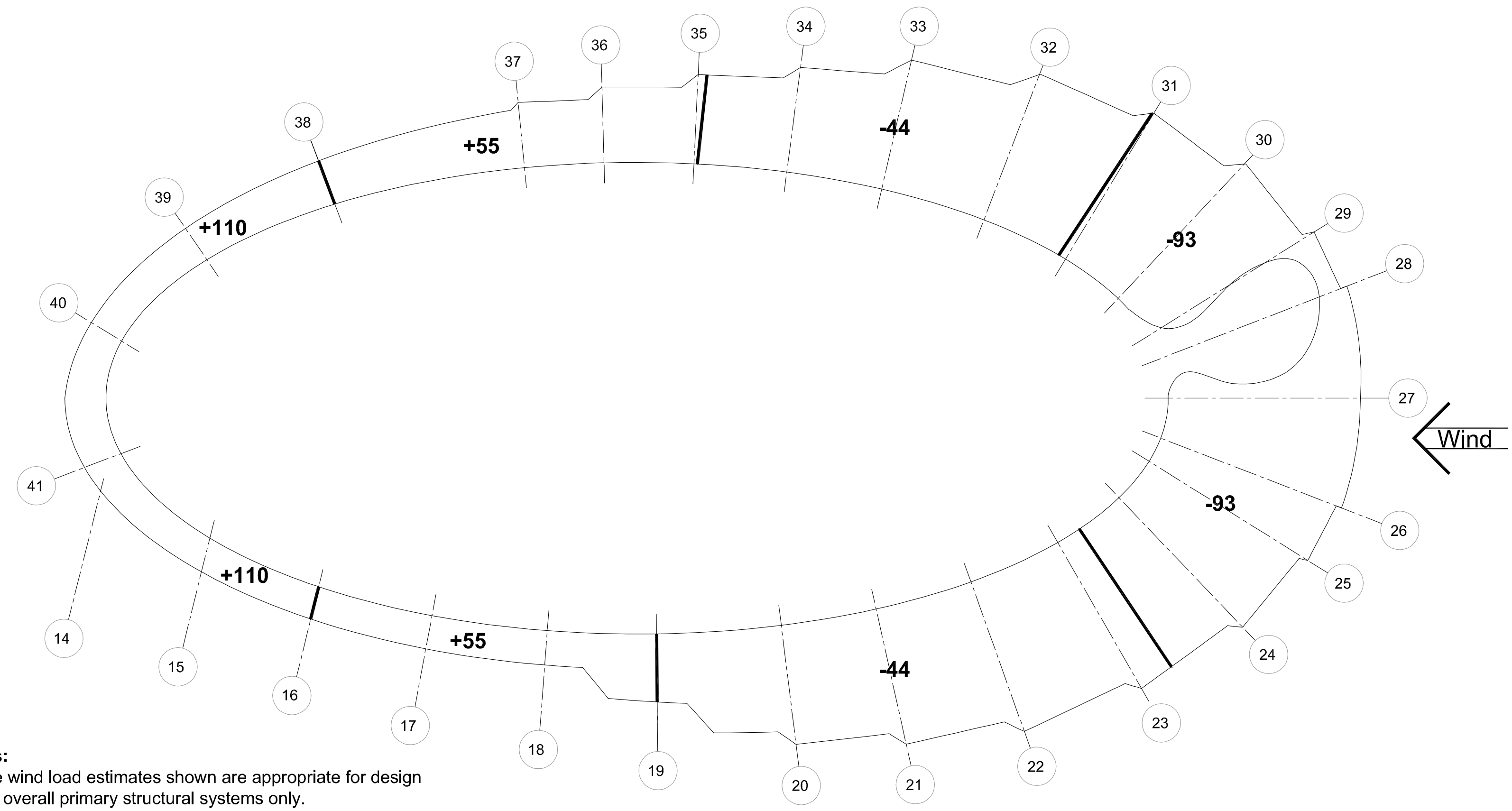


Notes:
1. The wind load estimates shown are appropriate for design of the overall primary structural systems only.
2. The structural wind loads DO NOT contain load or safety factors and are to be applied to the building's structural system in the same manner as would wind loads calculated by code analytical methods.
3. The wind pressures provided are to be applied to all surfaces simultaneously.
4. The wind pressures are to be applied normal to each surface. Positive pressures are defined to act inwards towards the surface, and negative pressures act outwards.

Estimated Structural Wind Loads (Psf) Load Case 2a - Down Force Top Weighted Basic Wind Speed = 145 mph, Category II ASCE/SEI 7-10 **Ultimate State Wind Loads for Load and Resistance Factor Design** St. Petersburg Pier (The Lens) - St. Petersburg, Florida	True North Project #1300997	Drawn by: SMR Figure: 3 Approx. Scale: 1"=80' Date Revised: Feb. 26, 2013

STRUCTURE WIND ASSESSMENT STUDY (continued)





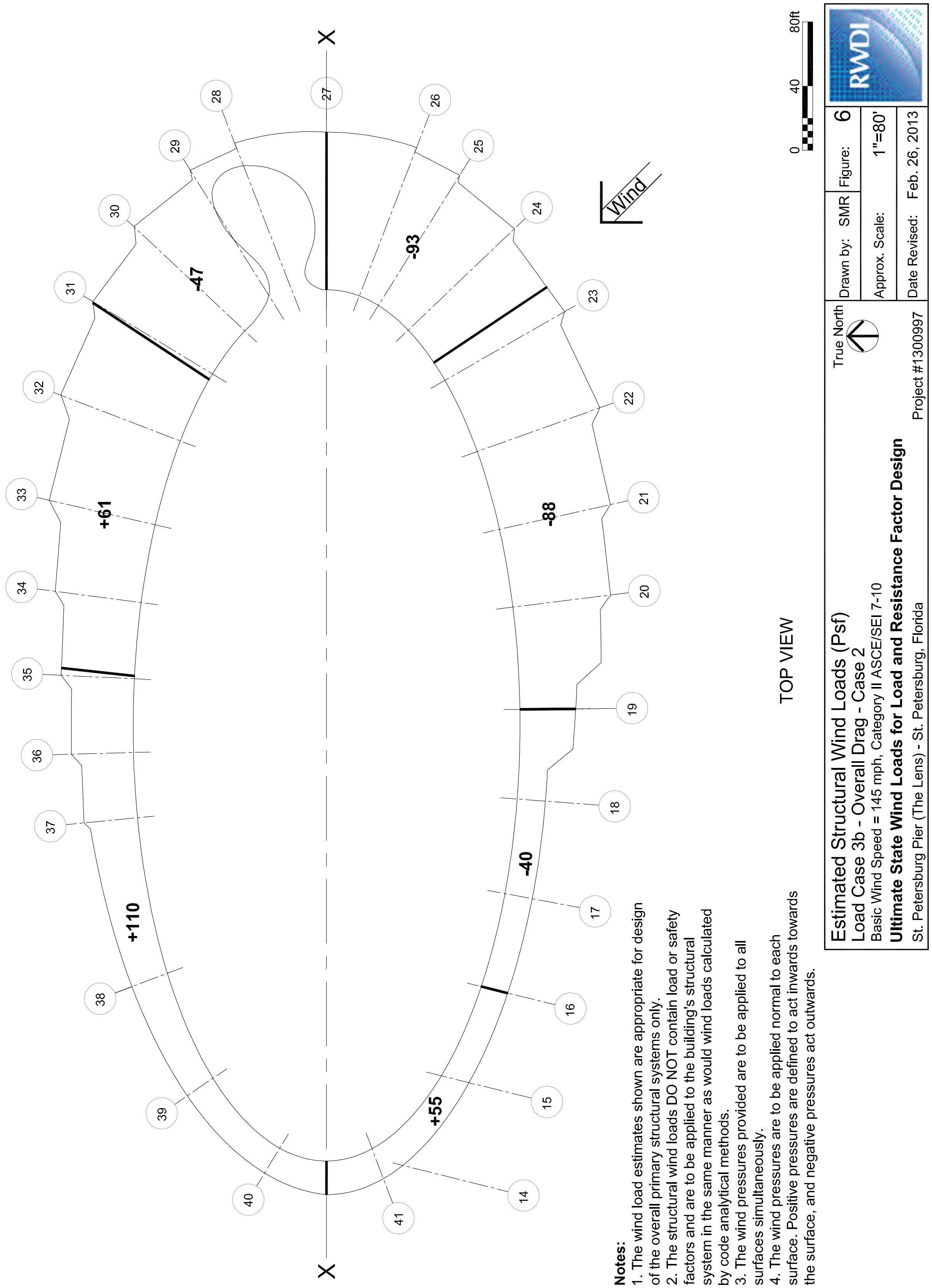
Notes:
1. The wind load estimates shown are appropriate for design of the overall primary structural systems only.
2. The structural wind loads DO NOT contain load or safety factors and are to be applied to the building's structural system in the same manner as would wind loads calculated by code analytical methods.
3. The wind pressures provided are to be applied to all surfaces simultaneously.
4. The wind pressures are to be applied normal to each surface. Positive pressures are defined to act inwards towards the surface, and negative pressures act outwards.

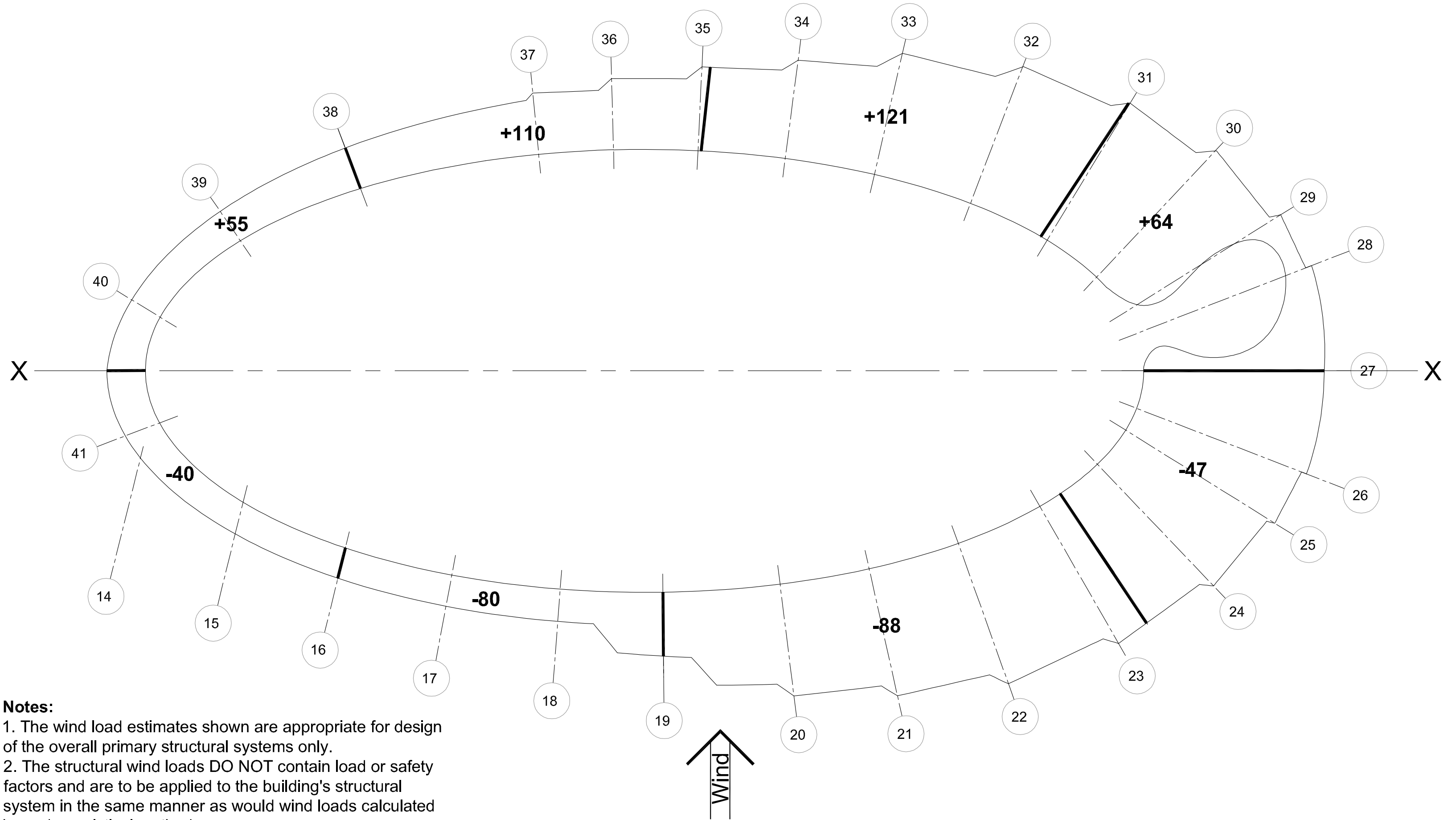
Estimated Structural Wind Loads (Psf)
Load Case 3a - Overall Drag - Case 1
Basic Wind Speed = 145 mph, Category II ASCE/SEI 7-10
Ultimate State Wind Loads for Load and Resistance Factor Design
St. Petersburg Pier (The Lens) - St. Petersburg, Florida
Project #1300997
True North

Drawn by: SMR	Figure: 5
Approx. Scale: 1"=80'	
Date Revised: Feb. 26, 2013	

RWDI

STRUCTURE WIND ASSESSMENT STUDY (continued)





TOP VIEW

Notes:
1. The wind load estimates shown are appropriate for design of the overall primary structural systems only.
2. The structural wind loads DO NOT contain load or safety factors and are to be applied to the building's structural system in the same manner as would wind loads calculated by code analytical methods.
3. The wind pressures provided are to be applied to all surfaces simultaneously.
4. The wind pressures are to be applied normal to each surface. Positive pressures are defined to act inwards towards the surface, and negative pressures act outwards.

0 40 80ft

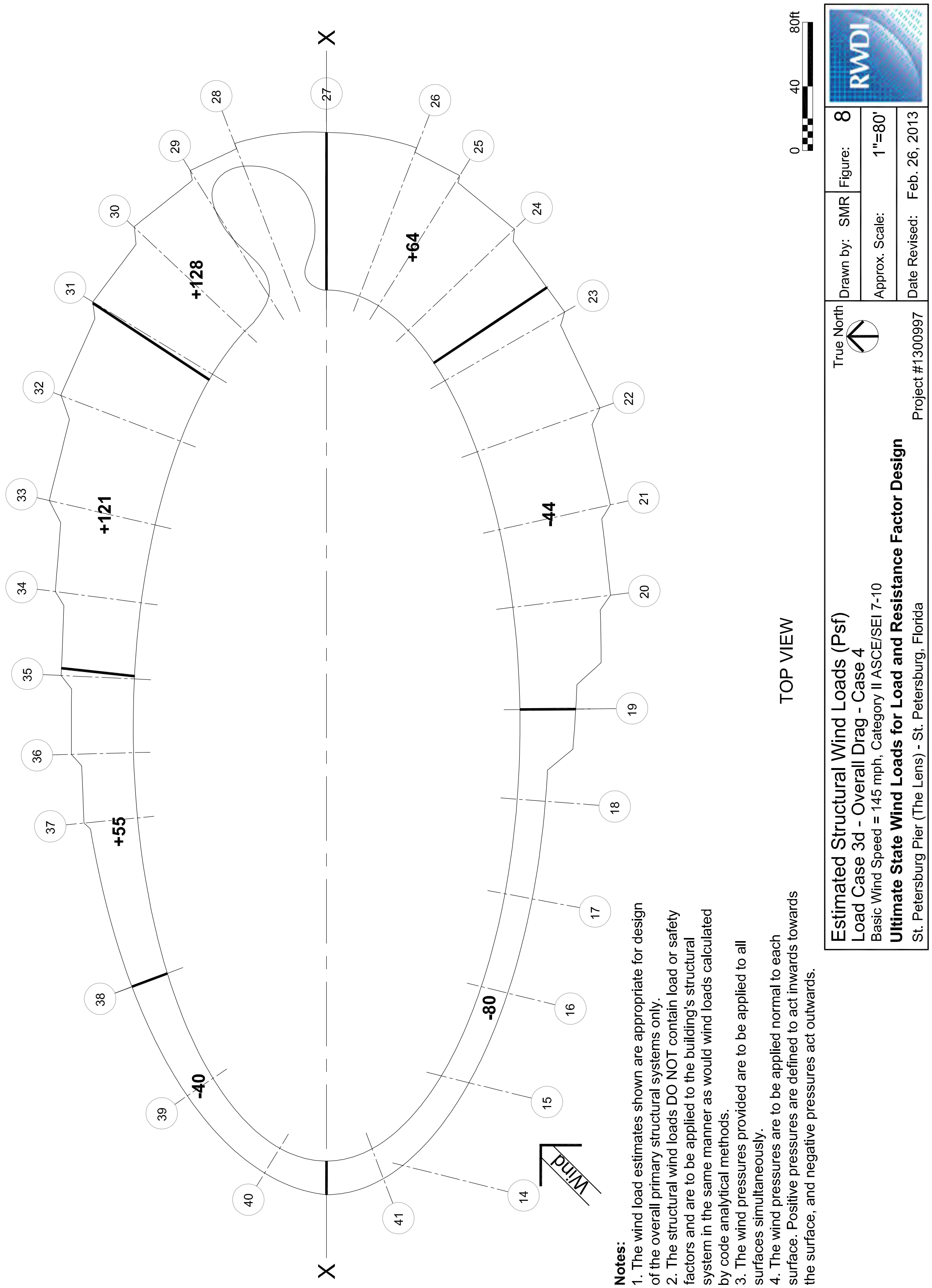
Estimated Structural Wind Loads (Psf)
Load Case 3c - Overall Drag - Case 3
Basic Wind Speed = 145 mph, Category II ASCE/SEI 7-10
Ultimate State Wind Loads for Load and Resistance Factor Design
St. Petersburg Pier (The Lens) - St. Petersburg, Florida
Project #1300997

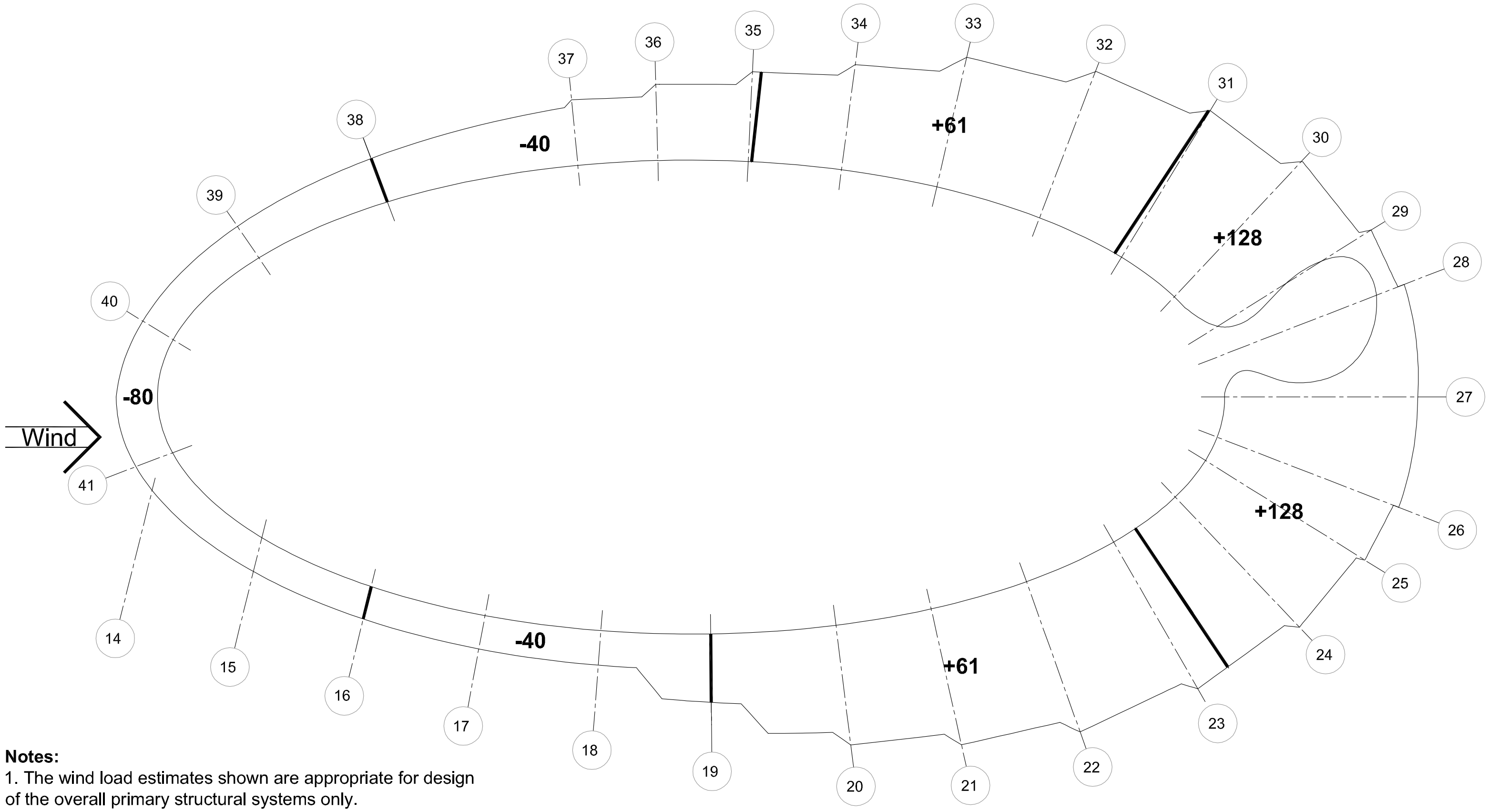
True North

Drawn by: SMR	Figure: 7
Approx. Scale: 1"=80'	
Date Revised: Feb. 26, 2013	

RWDI

STRUCTURE WIND ASSESSMENT STUDY (continued)





Notes:
1. The wind load estimates shown are appropriate for design of the overall primary structural systems only.
2. The structural wind loads DO NOT contain load or safety factors and are to be applied to the building's structural system in the same manner as would wind loads calculated by code analytical methods.
3. The wind pressures provided are to be applied to all surfaces simultaneously.
4. The wind pressures are to be applied normal to each surface. Positive pressures are defined to act inwards towards the surface, and negative pressures act outwards.

TOP VIEW

0 40 80ft

Estimated Structural Wind Loads (Psf)
Load Case 3e - Overall Drag - Case 5
Basic Wind Speed = 145 mph, Category II ASCE/SEI 7-10
Ultimate State Wind Loads for Load and Resistance Factor Design
St. Petersburg Pier (The Lens) - St. Petersburg, Florida

True North

Project #1300997

Drawn by:	SMR	Figure:	9
Approx. Scale:	1"=80'		
Date Revised:	Feb. 26, 2013		

RWDI

CLAD WIND ASSESSMENT STUDY

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February 27, 2013

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Email: jp.chakar@burohappold.com

Re: Desk-top Assessment on Cladding Wind Loads
St. Petersburg Pier Lens, St. Petersburg, Florida
RWDI Reference #1300997

Dear JP,

We have completed the desk-top assessment to provide estimated cladding wind loads acting on the lens surfaces of the St. Petersburg Pier in St. Petersburg, Florida. Our review was based on the planned lens shape, the surroundings, wind load information from building codes and other technical literature, and previous wind tunnel model studies of similar structures. Consideration has also been given to the strength and directionality of the local wind climate.

The building geometry was based on the 3D AutoCad drawing provided on January 30, 2013:

1201_130127_Digital Model_R4_KB01

Wind load distributions are provided that represent the peak suction loading on the cladding system which is expected to dominate and govern the design. These loading patterns are estimates and may not reflect all of the important patterns, which will be revealed through the wind tunnel tests and incorporated in final recommendations.

The estimated preliminary wind loads are based on an ultimate state 3-second gust design wind speed of 145mph a height of 33 ft in open terrain. **This value is consistent with that identified for St. Petersburg in the ASCE/SEI 7-10 Standard and the 2010 Florida Building Code. The ultimate state cladding loads have then been factored down by multiplying the wind loading by 0.6 to represent loads suitable for Allowable Stress Design** of cladding elements and are presented in the recommendations. The provided wind loads are based on a Category II Structure.

For Load and Resistance Factor design, such as for use in the design of secondary structural elements that carry the cladding loads from individual surfaces to the primary structure, the cladding loads presented herein should be divided by 0.6 and then adjusted to account for the effective wind area using the area reduction factors included in ASCE 7-10. The resultant loads can then be used for ultimate strength design of the secondary structural members.

Estimated Cladding Wind Load Recommendations

For the preliminary cladding design of the lens, design wind load distributions are presented in Figures 1 and 2. Note that "negative pressure", is defined to act outward, normal to the surface of the lens. In other words negative pressures on the top surface act to lift the cladding up and away from the lens and on the bottom surface (shown as reflected ceiling plan) act to pull the cladding down and away from the lens.

These cladding wind loading estimates are not considered as wind pressures across the top and bottom surfaces of the Lens. Our estimates assume that there is an internal air space between the cladding panels on the top surface of the Lens and the cladding panels on the bottom surface of the lens. We have also assumed that there are no dominant openings into this internal air space. As such, we have assumed the internal pressure to have a magnitude consistent with background pressure leakage into the internal air space. The cladding pressures provided are net pressures across the top surface cladding panels independent of the net pressure across the bottom surface cladding panels.

Please note that the wind loads provided here are estimates based on a preliminary review only. This information does not reflect the results of a wind tunnel study of this structure. The provided wind loads are approximate in nature and are not recommended to be used for final design purposes. More comprehensive recommendations for the cladding wind loads will be provided based on the wind tunnel tests.

Should you have any questions or comments, we would be pleased to discuss them with you.

Yours very truly,

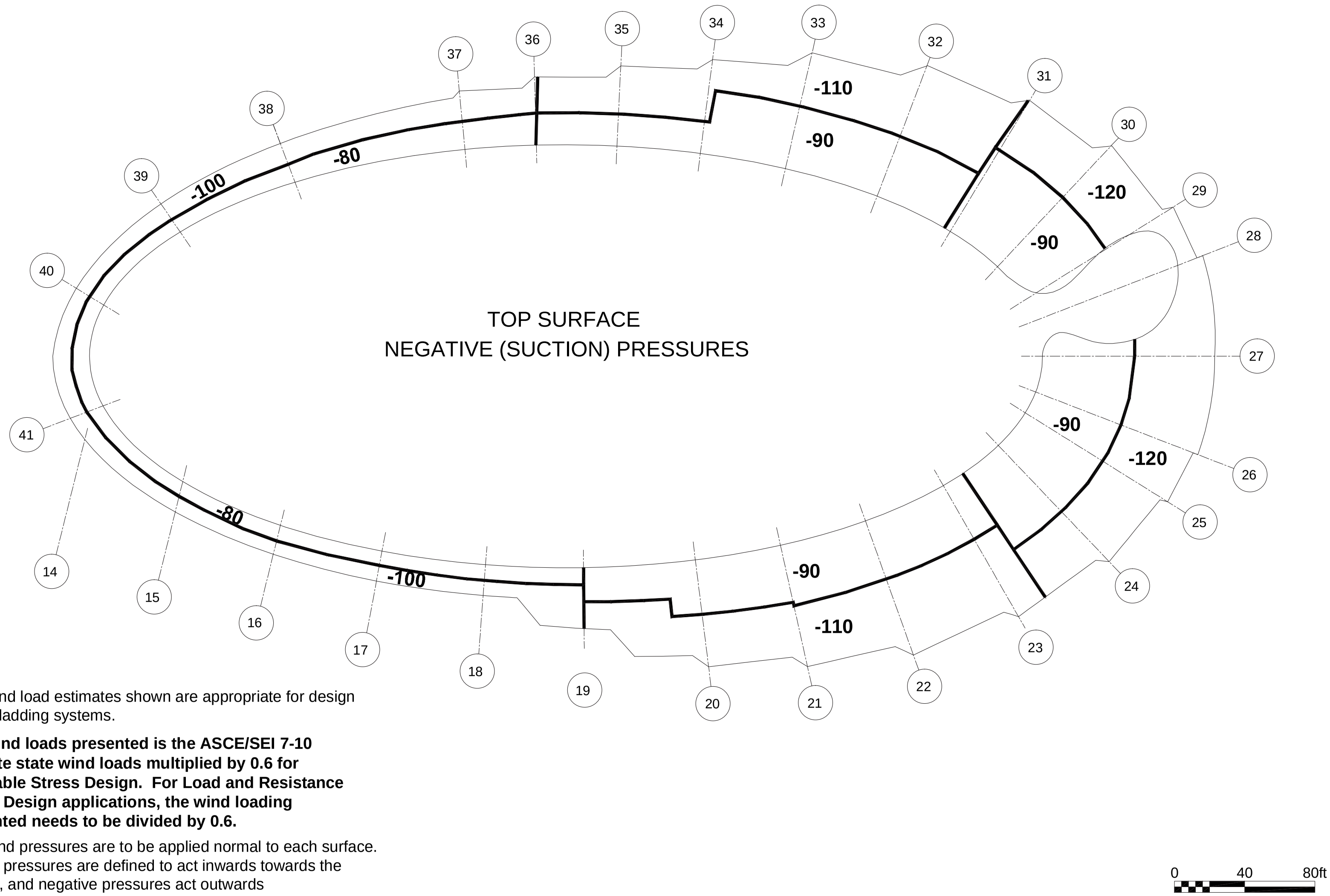
ROWAN WILLIAMS DAVIES & IRWIN

Jonathan B. Lankin, P.Eng.
Project Manager/Senior Specialist

Scott L. Gamble, P.Eng.
Principal

CLAD WIND ASSESSMENT STUDY
(continued)

FIGURES

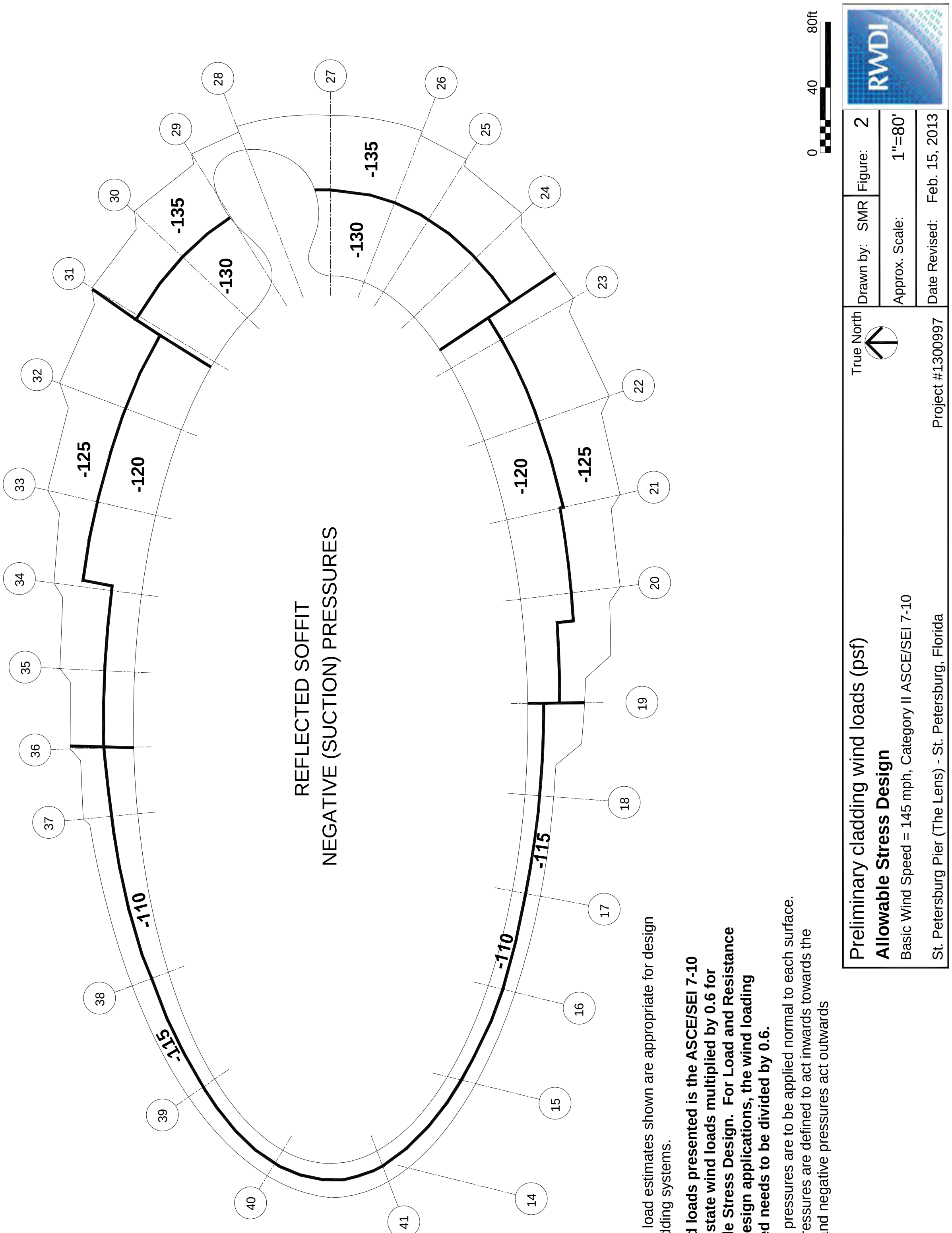


Notes:

1. The wind load estimates shown are appropriate for design of the cladding systems.
2. **The wind loads presented is the ASCE/SEI 7-10 ultimate state wind loads multiplied by 0.6 for Allowable Stress Design. For Load and Resistance Factor Design applications, the wind loading presented needs to be divided by 0.6.**
3. The wind pressures are to be applied normal to each surface. Postive pressures are defined to act inwards towards the surface, and negative pressures act outwards

Preliminary cladding wind loads (psf) **Allowable Stress Design** Basic Wind Speed = 145 mph, Category II ASCE/SEI 7-10 St. Petersburg Pier (The Lens) - St. Petersburg, Florida	True North Project #1300997	Drawn by: SMR	Figure: 1
		Approx. Scale: 1"=80'	
		Date Revised: Feb. 15, 2013	

CLAD WIND ASSESSMENT STUDY
(continued)



Notes:

1. The wind load estimates shown are appropriate for design of the cladding systems.
2. **The wind loads presented is the ASCE/SEI 7-10 ultimate state wind loads multiplied by 0.6 for Allowable Stress Design. For Load and Resistance Factor Design applications, the wind loading presented needs to be divided by 0.6.**
3. The wind pressures are to be applied normal to each surface. Postive pressures are defined to act inwards towards the surface, and negative pressures act outwards

bridge, highway & rail engineering
entertainment engineering
subaqueous investigation
civil & site engineering
structural design
marine facilities
geotechnics
surveying

February 22, 2013

Michael Maltzan Architecture, Inc.
2801 Hyperion Avenue, Studio 107
Los Angeles, California 90027

Attn: Tim Williams E-Mail: twilliams@mmaltzan.com

Re: St. Petersburg Pier Existing Caisson Inspection
MEG File No. 111367.01

Dear Mr. Williams:

As requested by Michael Maltzan Architecture, Inc. (MMA), McLaren Engineering Group (MEG) has completed an inspection of the five existing caissons supporting the inverted pyramid building and elevator located at the St. Petersburg Pier at 800 2nd Ave NE, St Petersburg, FL. MEG performed a dive inspection on February 12, 2013. The purpose of the inspection was to ascertain the general condition of the caissons and to report on their condition. The dive inspection was composed of visual and tactile observations. Ultrasonic thickness measurements were taken on the steel sheet pile surrounding the caissons. No destructive testing of the caissons was conducted. Provided in this report is a summary of the typical existing conditions of the caissons. This report is intended to support the forthcoming decision on whether to reuse the existing caissons as part of the design for The New St. Petersburg Pier.

Description of Existing Caissons:

The current St. Petersburg Pier is oriented east-west with an inverted pyramid building and elevator shaft located on the pier head at the east end of the pier. The inverted pyramid building and elevator shaft are supported by five concrete caissons ranging from 13′-6″ to 15′-6″ in exposed height measured from the mudline to the bottom of the pier deck. Four caissons are oriented in a square pattern and are centered under and support the existing inverted pyramid building. The plan dimensions of the southwest building caisson is approximately 20′ by 15′, the northwest and southeast building caissons are approximately 20′ by 20′, and the northeast building caisson is approximately 20′ by 18′. The fifth caisson is located under the existing elevator to the west of the group of four caissons. The plan dimensions of the elevator caisson are approximately 15′ by 18′. Refer to figure 6 in Appendix B of this report for a plan view of the current St. Petersburg Pier showing the approximate locations of the caissons.

Per previous plans and reports, the group of four caissons and the inverted pyramid building were built circa 1970. Per previous plans, the elevator shaft and elevator caisson were built circa 1986. Plans and reports indicate that groups of steel HP14x73 piles were driven to rock, a steel sheet pile

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CAISSON INSPECTION REPORT (continued)

cofferdam was constructed around each group of piles, and a concrete cap was placed around each group of piles within the cofferdam via a tremie. The sheet pile cofferdam around each group of piles served as a stay-in-place form for concrete placement. Rip rap was placed around the base of each caisson to prevent scour.

Observations at Existing Caissons:

The exterior of all five caissons is in fair to poor condition. Heavy marine growth is present on the face of all caissons from the mudline up to the tidal zone (See Photo 1). In areas where marine growth was removed to view the condition of the sheet pile stay-in-place forms, heavy corrosion was encountered. Heavy corrosion was also observed in the tidal zone above the extent of the marine growth (See Photos 2 and 3). An underwater ultrasonic thickness gauge was used to measure the thickness of the remaining sheet pile in various areas. Remaining thickness measurements ranged from 0.315″ to 0.045″. Holes were evident in some locations where there is no section remaining.

Multiple scattered holes through the sheet piling extending into the concrete face of the caisson are present at the northwest and northeast building caissons (See Photos 4 and 5). The holes range from 2″ diameter to 9″ diameter and extend as deep as 10″ into the caisson. The holes are a result of the sheet piling rusting away in these locations exposing the concrete behind the sheet pile. The exposed concrete has spalled leaving voids. While the sheet piling is a stay-in-place form and is not necessary for the structural capacity of the caissons, it helps to preserve the integrity of the caisson by slowing chloride penetration into the concrete cap surrounding the steel H-piles. Areas with holes in the sheet piling and voids in the concrete cap provide less concrete cover for encapsulated H-piles and will experience more chloride penetration.

Presence, number, and condition of steel H-piles within caissons was not able to be verified during the inspection since the H-piles are encapsulated in the caissons. No scour was observed at the bottoms of the five caissons. Rip rap was not observed at the bottoms of three of the caissons. Rip rap was observed in isolated areas at the bottoms of the southeast and northeast building caissons. Comparing the observed height of the caissons to the design height of the caissons from details in previous reports, the rip rap has likely been covered with sediment deposited at the base of the caissons over time.

Refer to figures 1 through 5 in Appendix B of this report for observation locations at each of the five caissons.

Conclusion and Recommendations:

The decision on whether to reuse the existing caissons as part of the design for The New St. Petersburg Pier is forthcoming. Reuse of the caissons will be contingent on their purported use in the new pier's design. Caisson reuse for The New St. Petersburg Pier could be appropriate if the caissons are repurposed to support much less load than currently supported. Given the existing condition of the caissons and the required 75 year design life of The New St. Petersburg Pier, caisson reuse for the new design is only viable with both an increase of factor of safety on loading via a reduction of load and mitigation of deterioration of the exterior of the caissons.

For caisson reuse, surface deterioration would need to be addressed prior to construction of The New St. Petersburg Pier, but the urgency of these repairs is currently of low to moderate priority. The exterior of all five caissons is in fair to poor condition. The American Society of Civil Engineers (ASCE) Underwater Investigations Standard Practice Manual defines fair and poor condition ratings as follows:

> **Fair:** All primary structural elements are sound, but minor to moderate defects or deterioration are observed. Localized areas of moderate to advanced deterioration may be present but do not significantly reduce the load-bearing capacity of the structure. Repairs are recommended, but the priority of the recommended repairs is low.
>
> **Poor:** Advanced deterioration or overstressing is observed on widespread portions of the structure but does not significantly reduce the load-bearing capacity of the structure. Repairs may be carried out with moderate urgency.

If the caissons are reused, it is recommended to address the condition of the exterior of the caissons to prevent further deterioration. One solution for preserving the caissons is to clear the marine growth from the caissons, use underwater concrete to patch existing holes and voids, and coat the face of the caissons with underwater epoxy paint appropriate for marine conditions. The City of St. Petersburg will have ongoing maintenance associated with this solution to maintain coatings. Frequency of maintenance would be established by the lifespan of the selected coating. This solution will not address chlorides that have already penetrated the concrete cap.

A second solution for preserving the caissons is to leave the exterior of the caissons as is with corrosion and voids, but to slow further deterioration with an impressed current cathodic protection system. Cathodic protection would slow both the deterioration on exposed surfaces of the caissons as well as any H-pile deterioration from existing chloride penetration. An impressed current cathodic protection system could be designed to achieve a 15 to 30 year life span reducing ongoing maintenance for the City of St. Petersburg.

Should you have any questions or comments, or if you require additional information, please feel free to contact our office at any time.

Regards,

The Office of
McLaren Engineering Group
M. G. McLAREN, P.C.

Andrew Habel, P.E.

Attachments: Appendix A – Photographs
Appendix B – Figures: Caisson Elevation Sketches and Existing Pier Plan View Locating Caissons

cc: SDF, MGM, TPM, Internal File 111367.01

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McLaren Engineering Group

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CAISSON INSPECTION REPORT (continued)

Appendix A
Photographs

Photo 1: Typical Heavy Marine Growth on Sheet Piling from the Mudline up to the Tidal Zone.

Photo 2: Typical Heavy Corrosion on Sheet Piling in the Tidal Zone.

CAISSON INSPECTION REPORT (continued)

Photo 3: Typical Heavy Corrosion on Sheet Piling in the Tidal Zone.

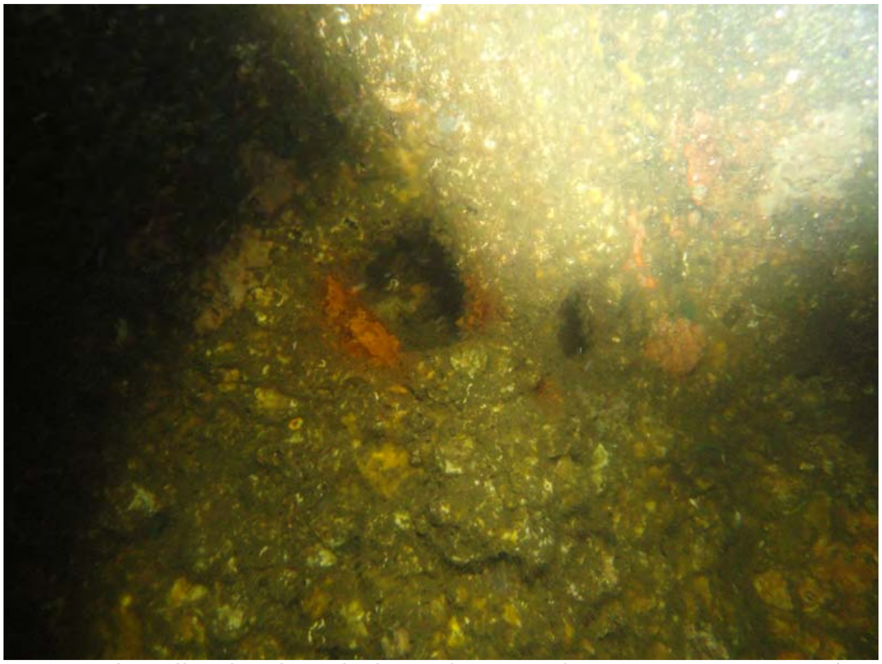


Photo 4: Typical Small Holes Through Sheet Piling Extending into Concrete Face of Caisson.

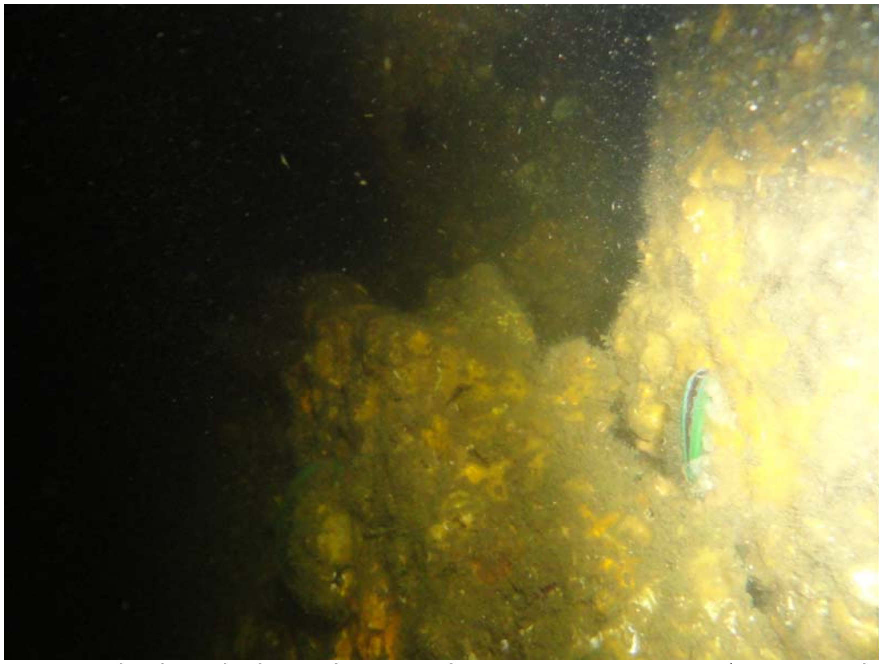
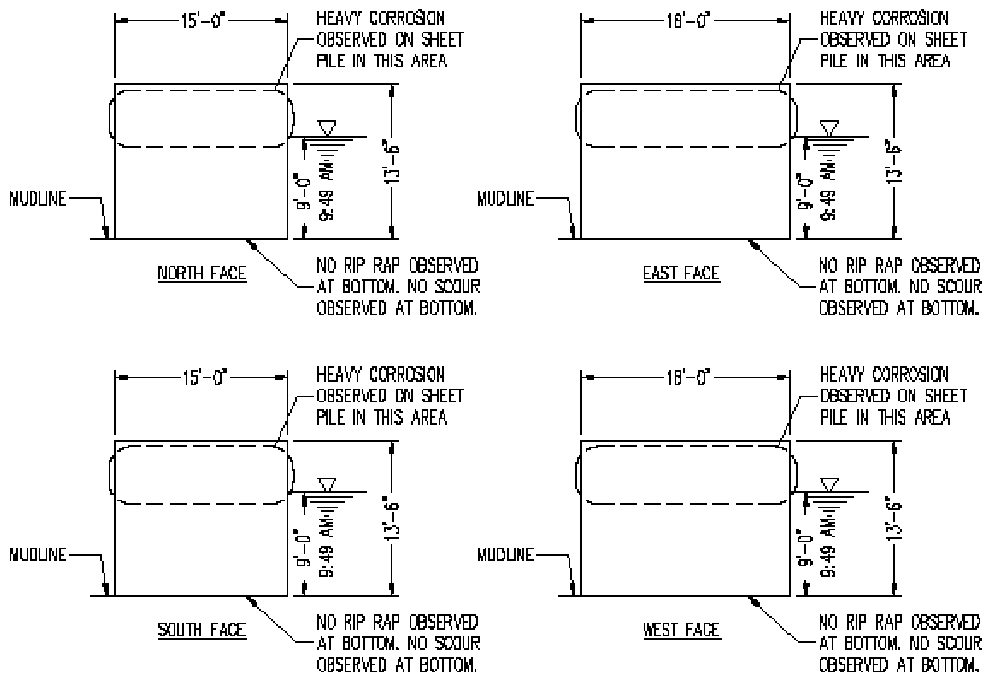


Photo 5: Larger Hole Through Sheet Piling Extending into Concrete Face of Caisson. This hole is located near the west corner of the South face of the Northwest Building Caisson.

**CAISSON INSPECTION
REPORT (continued)**

Appendix B

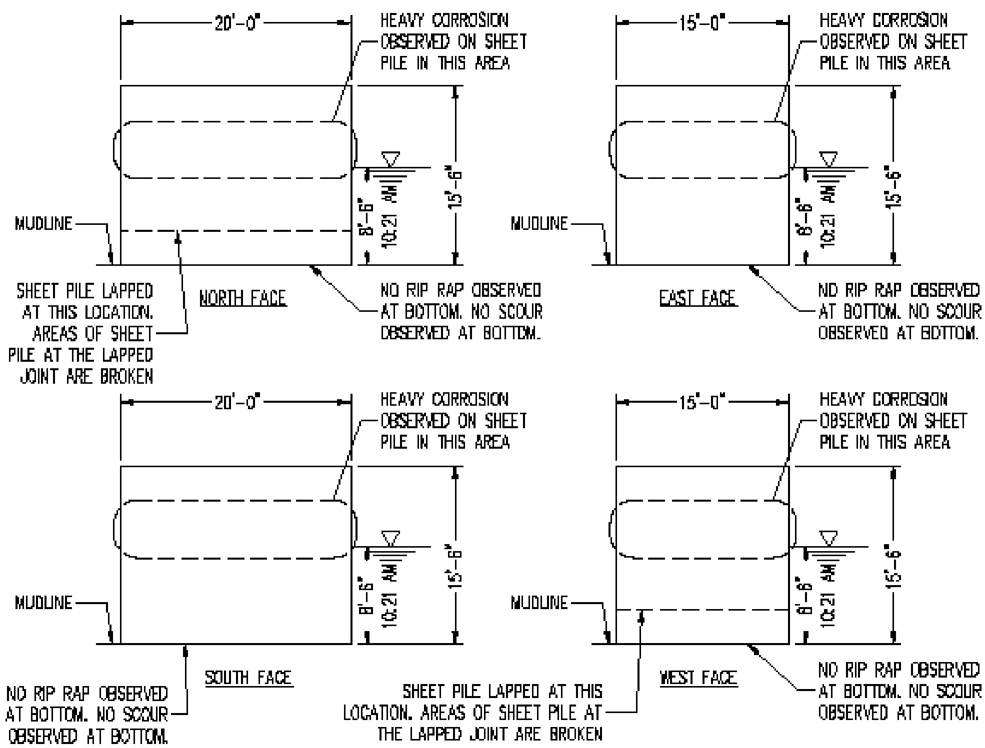
Figures: Caisson Elevation Sketches and
Existing Pier Plan View Locating Caissons



NOTE: HEAVY MARINE GROWTH WAS PRESENT ON SHEET PILING ON ALL FACES FROM THE MUDLINE UP TO THE TIDAL ZONE.

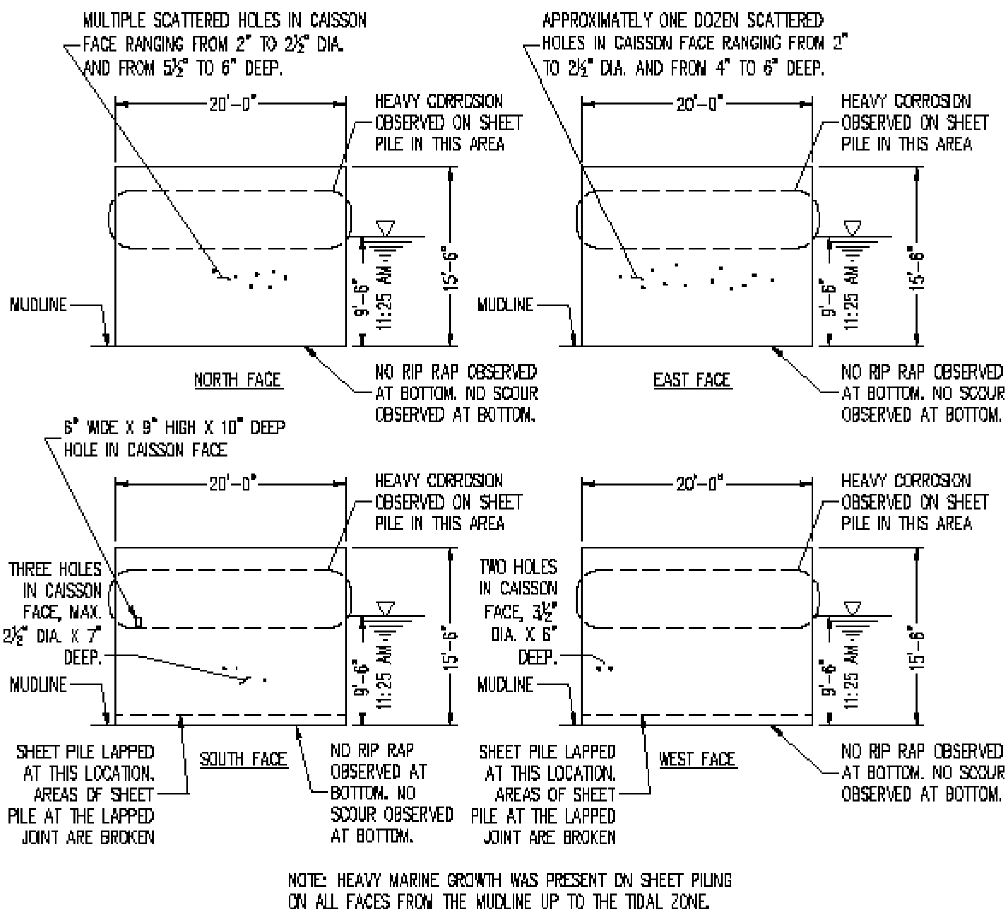
1 FIG. 1 **ELEVATOR CAISSON**
NOT TO SCALE

CAISSON INSPECTION REPORT (continued)



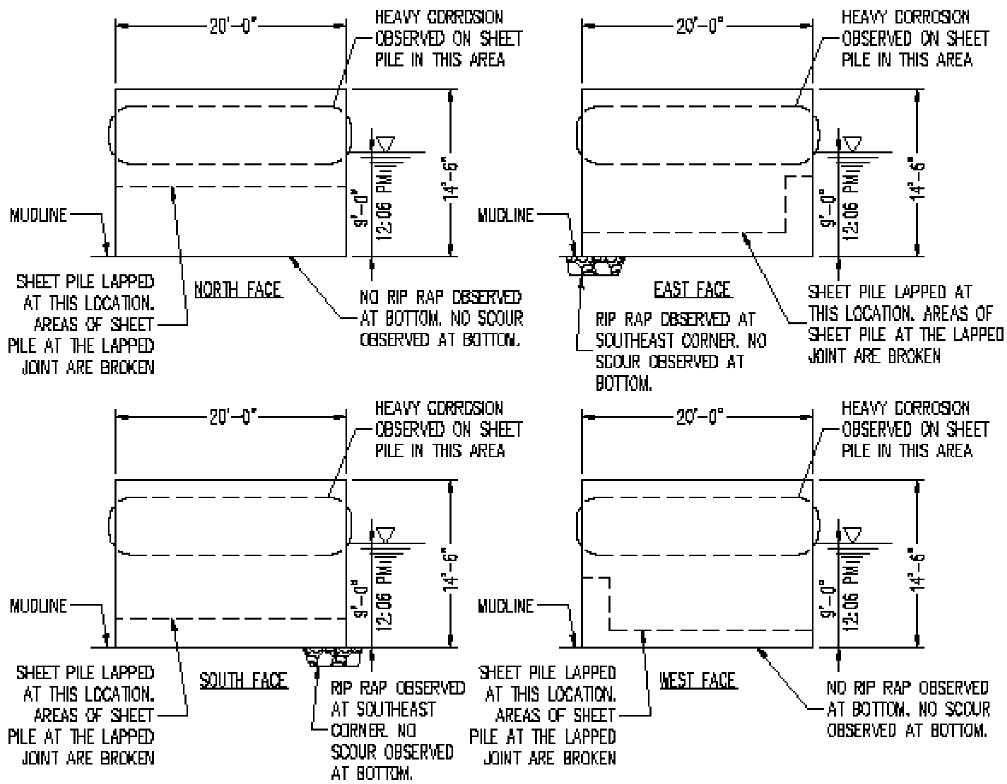
NOTE: HEAVY MARINE GROWTH WAS PRESENT ON SHEET PILING ON ALL FACES FROM THE MUDLINE UP TO THE TIDAL ZONE.

1 SOUTHWEST BUILDING CAISSON
FIG. 2 NOT TO SCALE



1 FIG. 3 **NORTHWEST BUILDING CAISSON**
NOT TO SCALE

CAISSON INSPECTION REPORT (continued)



NOTE: HEAVY MARINE GROWTH WAS PRESENT ON SHEET PILING ON ALL FACES FROM THE MUDLINE UP TO THE TIDAL ZONE.

1 SOUTHEAST BUILDING CAISSON
FIG. 4 NOT TO SCALE

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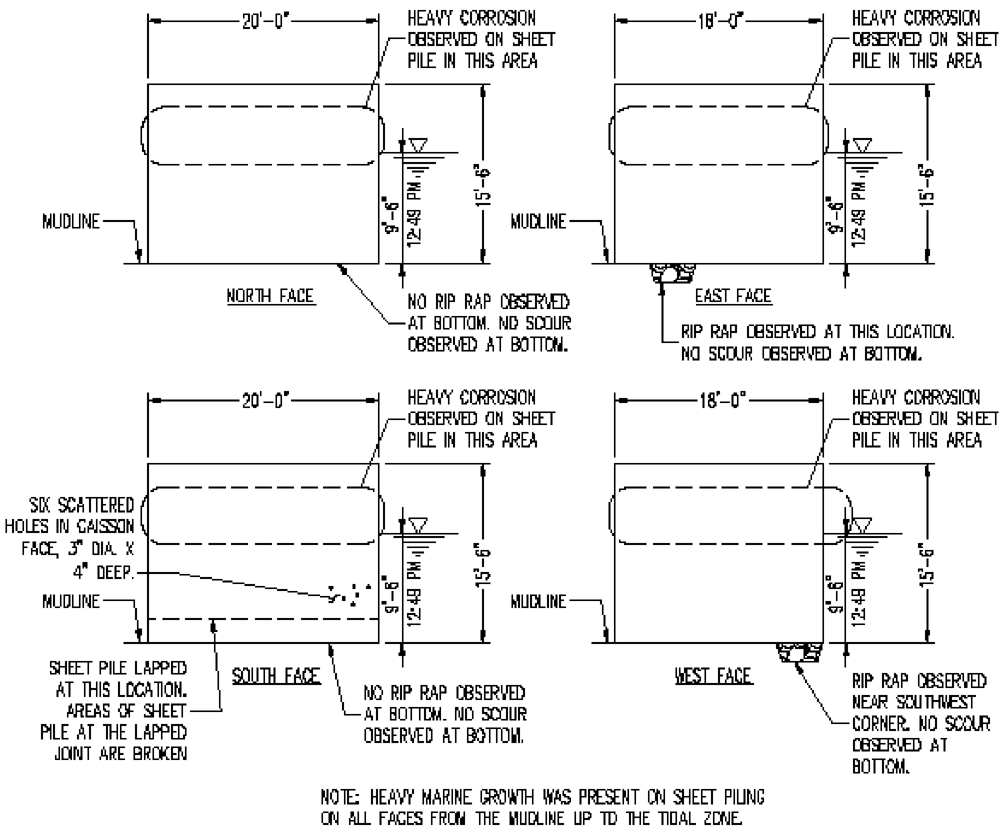

1 NORTHEAST BUILDING CAISSON
FIG. 5 NOT TO SCALE

CAISSON INSPECTION REPORT (continued)

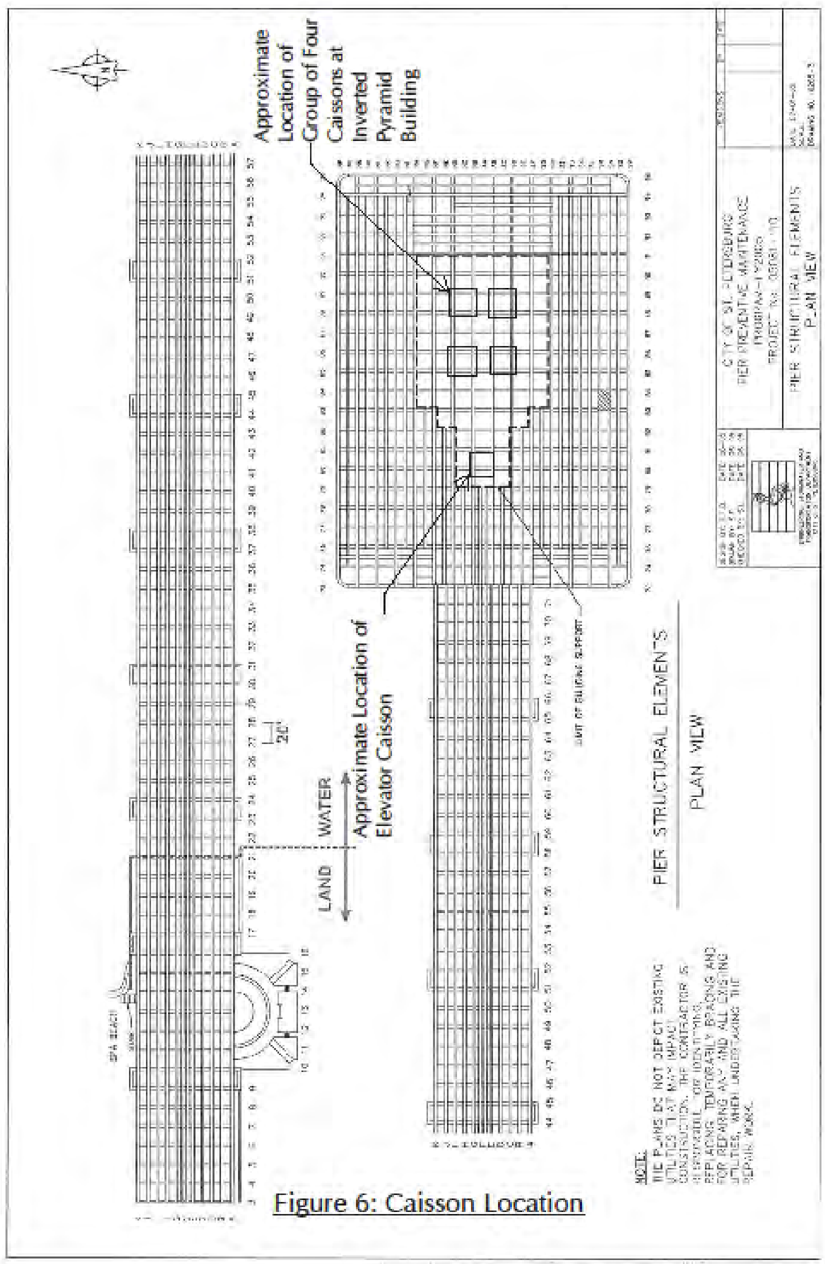

Figure 6: Caisson Location

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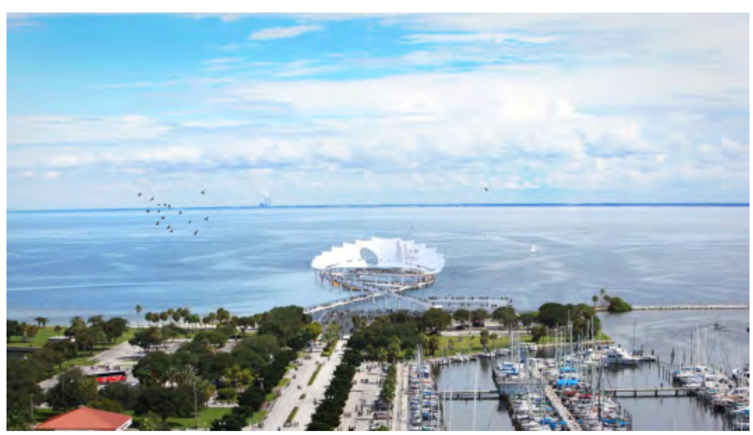
The New St. Petersburg Pier

100% SD Life Safety Report

030734

22 April 2013

Revision 01



LIFE SAFETY REPORT
(continued)

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Revision	Description	Issued by	Date	Checked
00	100% Scheme Design Report	ISM	April 17, 2013	CK
01	100% Scheme Design Report	ISM	April 22, 2013	CK

author	**Iain Macfarlane**
signature	
date	**April 22, 2013**
approved	**Carl Keogh**
signature	
date	**April 22, 2013**

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Contents

LIFE SAFETY REPORT
(continued)

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1 Executive Summary

The following report provides an overview of the fire & life safety design of the New St Petersburg Pier, Florida, including the project's performance based egress design.

Based upon a maximum occupant load of 5,954 people, the following pier egress scenarios were analyzed;

Scenario 1 – Full Pier Evacuation

This scenario represents a condition where a full evacuation of the pier is required. This scenario provides a 'base case' for all other egress simulations.

Scenario 2 – Vehicle Fire

This scenario represents an incident where a full evacuation of the pier is required for a fire incident occurring at the most remote area of the pier. This scenario will assess the conditions affecting occupants in the immediate vicinity of the fire.

Scenario 3 – Emergency Vehicle Attendance

This scenario represents an incident where a full evacuation of the pier is required at the same time as emergency personnel/vehicle being in attendance at the pier creating an obstruction in the flow of evacuees. This scenario has been produced in order to assess the effect that an emergency vehicle on the pier will have on the evacuating occupants, in terms of the evacuation from a fire incident locally at the end of the pier (as per Scenario 2), and the global evacuation time for the entire pier (as per Scenario 1).

The results of the egress scenarios outlined above are given in the table below;

	Scenario 1	Scenario 2	Scenario 3
'Safe Area' Egress Time	N/A	2m 25s	2m 25s
Total Egress Time	13m 14s	13m 14s	18m 26s

From the results of the analysis it can be summarized that;

- The time taken to *clear* the pier of its 5,954 occupants is just over 13 minutes. This is the case for both an emergency and non-emergency case and is largely a function of the piers length and egress capacity available (the exit capacity of 30ft to cater for 5,954 people being in full compliance with the requirements of the Florida Building Code).
- The time taken to evacuate the immediate vicinity of a vehicle fire occurring at the end of the Promontory is in the region of 2.5 minutes. This is considered acceptable based upon any vehicle fire occurring in this location would be very early within its growth phase after 2.5 minutes and would be creating a level of heat output significantly less than the maximum heat output modeled.
- The presence of a Fire Dept. vehicle within the flow of evacuees on Overwater Drive does not affect the evacuation time in the immediate vicinity of the fire at the end of the Promontory as there is sufficient space on the remainder of the pier for occupants to collect which is remote from the fire. The vehicle obstruction does however increase the overall pier evacuation time by 5 minutes – to in the region of 18.5 minutes. Given that in this condition all occupants are remote from the fire location, and hence considered *safe*, this is not seen as reducing the level of occupant safety on the pier.

LIFE SAFETY REPORT
(continued)

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2 Introduction

2.1 General

The following report provides an overview of the fire & life safety design for the New St Petersburg Pier, Florida.

A series of presentations of this fire strategy have been given to the Building & Fire Departments in St. Petersburg and copies of the minutes from these meetings are provided in Appendix A for reference.

2.2 Applicable Design Codes

The fire safety strategy for the Pier will be developed in accordance with the applicable codes and regulations for St. Petersburg – namely the:

- Florida Building Code 2010
- Florida Fire Prevention Code 2010 [based upon NFPA 1 *Fire Code* 2009 & NFPA 101 *Life Safety Code* 2009]

In addition to these base codes, additional guidance has been sought from the following reference documents:

- International Fire Code, 2009 Edition [Chapter 45 – Marinas]
- NFPA 302 - *Fire Protection Standard for Pleasure and Commercial Motor Craft*
- NFPA 303 - *Fire Protection Standard for Marinas and Boatyards*
- NFPA 307 - *Standard for the Construction and Fire Protection of Marine Terminals, Piers, and Wharves*
- NFPA 1405 - *Guide for Land-Based Fire Fighters Who Respond to Marine Vessel Fires*
- NFPA 1925 - *Standard on Marine Fire-Fighting Vessels*
- NFPA 13 – *Standard for the Installation of Sprinkler Systems*
- NFPA 14 – *Standard for the Installation of Standpipe and Hose Systems*
- NFPA 24 - *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*
- NFPA 72 - *National Fire Alarm and Signaling Code*

2.3 Building Code Review

Project Name:	St. Petersburg Pier – Proposed MMA Design	
Project Number:	1206	
Review by:	Sean Williams	
Date:	April 16, 2013	
Applicable Codes:	(A) 2010 Florida Building Code, Building (B) 2010 Florida Building Code, Accessibility (C) 2010 Florida Building Code, Plumbing (D) 2010 Florida Fire Prevention Code	
Fire Zone District:	City of St. Petersburg, Florida	
		Code Reference
Use Classification:	*Group:* Outdoor Assembly Area (A5)[1]	(A) 1004.8
Risk Category:	II	(A) Table 1604.5
Fire Protection Systems	Automatic Sprinkler System[2]	(A) 903
Building Height and Area	*Outdoor (Pier) Area Proposed*: 1,2067 SF *Area Allowed:* Unlimited *Height Proposed:* 108'-0" MSL *Height Allowed:* Unlimited[3] *Number of Stories Proposed:* Pending *Number of Stories Allowed:* Unlimited	(A) Table 503
Construction Type:	IIB	(A) Table 601
Occupancy Separation:	NA	(A) Table 508.4
Accessory Occupancies[6]:	*Group*: M Mercantile	(A) 508.2

LIFE SAFETY REPORT
(continued)

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Occupant Load:	*Number of Occupants:* 1 person per 15 sf	
Overwater Drive and Bridge, Bike Path & Balconies	*Occupant Load:* 3,396 Persons	
Occupant Load:	*Number of Occupants:* 1 person per 30 sf	
Tram Drive Lane	*Occupant Load:* 724 Persons	
Occupant Load:	*Number of Occupants:* 1 person per 7 sf	
Gathering Areas	*Occupant Load:* 1,280 Persons	
Occupant Load:	*Number of Occupants:* 1 person per 15 sf	
Promontory Grill	*Occupant Load:* 216 Persons	
Occupant Load:	*Number of Occupants:* 1 person per 60 sf	
Floating Dock	*Occupant Load:* 105 Persons	
Occupant Load:	*Number of Occupants:* 2 people per unit	
Retail	*Occupant Load:* 8 Persons	
Occupant Load:	*Number of Occupants:* 18” per person	
Bench Seating	*Occupant Load:* 225 Persons	
Means of Egress:	*Total Pier Occupant Load:* 5,954 Persons	
	Number of Exits Proposed: 2	
	Number of Exits Required: 4 (egress analysis justification provided)	(A) Table 1021.1
	Travel Distance to Exit @ OWB: 1,580 ft OWD[7]	(A) Table 1016.1
	Travel Distance to Exit @ OWD: 1,485 ft OWB[7]	
	Travel Distance to Exit Allowed: Unlimited	(A) 1005.1
	Total Egress Width Proposed: 360 inches	
	Total Egress Width Required: 5954 x 0.06 inch = 357.24 inches	
Egress Illumination	Per Code	(A) 1006

Fire Resistance Ratings **(Type IIB)**	*Primary Structural Frame:* 0 hours	(A) Table 601
	Bearing Walls Exterior: 0 hours	
	Bearing Walls Interior: NA	
	Nonbearing Walls and Partitions Interior: 0 hours	
	Floor Construction: 0 hours	
	Roof Construction: 0 hours	
Exterior Walls	*Fire Separation Distance Proposed:* NA	(A) Table 705.8
	Fire Separation Distance Allowed: Per Code	
Fire and Smoke Separations	*Fire Walls Proposed:* NA	
	Fire Walls Required: Per Code	(A) 706
	Fire Barriers Proposed: NA	
	Fire Barriers Required: Per Code	(A) 707
	Shaft Enclosures Proposed: NA	
	Shaft Enclosures Required: Per Code	
	Fire Partitions Proposed: NA	(A) 708
	Fire Partitions Required: Per Code	
	Smoke Barriers Proposed: NA	
	Smoke Barriers Required: Per Code	(A) 709
	Smoke Partitions Proposed: NA	
	Smoke Partitions Required: Per Code	(A) 710
	Provide UL Design Details on Drawings	
		(A) 711
Penetrations Fire Protection	Per Code	(A) 713
	Provide UL Design Details on Drawings	
Rated Openings	*Fire Doors Proposed:* NA	
	Fire Door Ratings Required: Per Code	(A) Table 715.4
Interior Finish Requirements	Per Code	(A) Table 803.9
Corridors	NA	(A) Table 1018.1
Accessibility	Florida Accessibility Code 2012	(B) 1003
	Marina: Recreational Boating Facility	

LIFE SAFETY REPORT
(continued)

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Plumbing Fixtures	*Water Closets Proposed:* 7	(C) Table 403.1
	Water Closets Required: Pending[9]	
	Lavatories Proposed: 8	
	Lavatories Required: Pending[9]	
	Drinking Fountains Proposed: Pending	
	Drinking Fountains Required: Pending[9]	
	Service Sinks Proposed: Pending	
	Service Sinks Required: Pending[9]	(C) 403.2
	Separate Facilities for Each Sex Provided: Yes	
	Separate Facilities for Each Sex Required: Yes	
	Unisex Toilet Room Provided: Yes	(C) 403.5
	Unisex Toilet Room Required: Yes	

Footnotes

Note 1:

Should be provided with adequate means of egress with an occupant load assigned/agreed by the building official in accordance with the anticipated use. (A) 1004.8

If the aggregate area of the Mercantile occupancies is greater than 10 percent of the total area of the pier, the Use Classification would be Mixed Use.

Note 2:

Fire Protection Sprinklers provided within enclosed spaces (retail units, store rooms etc.) (A) 508

Note 3:

Height may be restricted by FAA regulations (Albert Whitted Airport) or by local code.

Note 4:

Calculated as Outdoor Recreation Area. See *Note 1*.

Note 5:

The Codes do not specify the number of persons per square foot for outdoor recreation areas. See *Note 1*.

Note 6:

Ancillary occupancies to the main occupancy of the building. (A) 508.2

Aggregate accessory occupancies shall not occupy more than 10 percent of the building area of the story in which they are located…

Assembly accessory occupancies:

Restaurants and bars with occupancy loads 50 persons or greater, exhibition halls, amusement arcades.

Mercantile accessory occupancies :

Shops, bait shop, boat rental, restaurants and bars with occupancy loads of less than 50 persons.

Note 7:

Travel distance from land to end of pier.

Maximum evacuation time Proposed: 19 minutes.

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(continued)

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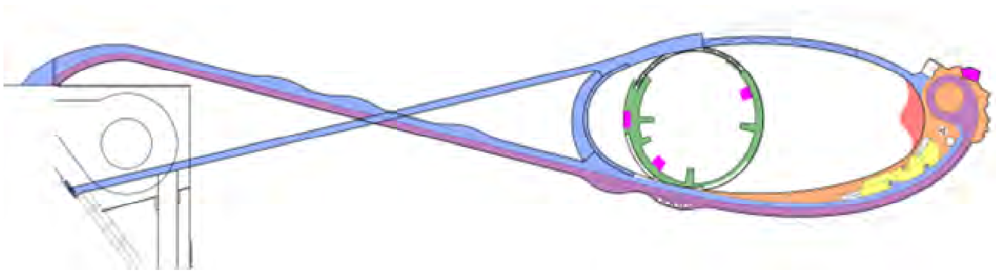
3 Use, Occupancy & Classification

3.1 Occupancy Classification

In accordance with the Building Code [FBC – Section 303], the Pier will be classified as an ‘assembly structure’ (A5) which is predominately intended for the viewing of, or participation in, outdoor activities. Other enclosed uses on the Pier (retail, storage, etc.) are all sufficiently small enough to be considered ‘ancillary’ uses to the Pier’s main A5 assembly designation.

3.2 Pier Occupant Load

A variety of occupant load factors will be adopted for the various use areas making up the Pier as indicated below;



- Gathering Areas (7sf/person)
- Promontory Grill - Tables & Chairs (15sf/person)
- Overwater Drive/Overwater Bridge/Bike Path (15sf/person)
- Tram Driveway (30sf/person)
- Floating Dock (60sf/person)
- Linear Seating (18”/person)
- Gelato/Bait Shops, Retail - 2 per unit
- Unoccupied Spaces

Figure 1 – Pier Occupant Load

Populating the projects 3D model geometry based on these Occupant Load Factors results in the following number of people;

Function of Space	Occupant Load Factor (sqft/person)	# of People
Gathering areas	7	1,280
Promontory Grill (chairs & tables)	15	216
Overwater Drive	15	1,513
Overwater Bridge	15	1,210
Bike Path	15	561
Balconies	7	112
Tram Driveway	30	724
Floating Dock	60	105
Bench/Linear Seating	18”/person	225
Gelato shop, Bait shop, Concession Stand & Retail Kiosk*	2 people per unit	8
	Total	**5,954**

Table 1 – Occupant Load Factors & total Pier occupant load

* There is no occupancy considered in bathrooms or on stairs

It is to be noted, that while this maximum occupant load of 5,954 people will be used for the Pier’s egress calculations, it is expected that the ‘normal-day’ occupancy would be significantly lower than this. The maximum calculated occupancy figures therefore represent a ‘worst case’ scenario in terms of event population, for events such as July 4th celebrations, New Year’s Eve, or similar.

LIFE SAFETY REPORT
(continued)

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3.3 Construction Type

Per Tables 503 & 601 of the FBC, the Pier will be designated *Type II B Construction*. For a Group A5 structure, this allows an Unlimited Area building with 0Hr fire rating – see Table 2 and Table 3 below:

TABLE 503
ALLOWABLE BUILDING HEIGHTS AND AREAS[a]
Building height limitations shown in feet above grade plane. Story limitations shown as stories above grade plane.
Building area limitations shown in square feet, as determined by the definition of "Area, building," per story

		TYPE OF CONSTRUCTION								
		TYPE I		TYPE II		TYPE III		TYPE IV	TYPE V	
		A	B	A	B	A	B	HT	A	B
	HEIGHT (feet)	UL	160	65	55	65	55	65	50	40
GROUP		STORIES (S) AREA (A)								
A-1	S A	UL UL	5 UL	3 15,500	2 8,500	3 14,000	2 8,500	3 15,000	2 11,500	1 5,500
A-2	S A	UL UL	11 UL	3 15,500	2 9,500	3 14,000	2 9,500	3 15,000	2 11,500	1 6,000
A-3	S A	UL UL	11 UL	3 15,500	2 9,500	3 14,000	2 9,500	3 15,000	2 11,500	1 6,000
A-4	S A	UL UL	11 UL	3 15,500	2 9,500	3 14,000	2 9,500	3 15,000	2 11,500	1 6,000
A-5	S A	UL UL	UL UL	UL UL	UL UL	UL UL	UL UL	UL UL	UL UL	UL UL

Table 2 – Florida Building Code Table 503 - Allowable building heights and areas

Table 503 of the FBC (above) limits the height of Type IIB construction to 55ft, with the height of a building defined as '*the vertical distance from the grade plane to the average height of the highest roof surface'*. Given that the pier does not have a roof and is an open structure, Type IIB construction is considered applicable and this has been confirmed with the local Authorities.

Type II B structures do not require structural fire resistance, as outlined below in Table 601, from the Florida Building Code, below:

TABLE 601
FIRE-RESISTANCE RATING REQUIREMENTS FOR BUILDING ELEMENTS (hours)

BUILDING ELEMENT	TYPE I		TYPE II		TYPE III		TYPE IV	TYPE V	
	A	B	A	B	A	B	HT	A	B
Primary structural frame[g] (see Section 202)	3[a, h]	2[a]	1	0	1	0	HT	1	0
Bearing walls Exterior[f, g] Interior	 4 4[a]	 3 3[a]	 1 1	 0 0	 2 1	 2 0	 2 2[a]/HT	 1 1	 0 0
Nonbearing walls and partitions Exterior	See Table 602								
Nonbearing walls and partitions Interior[e]	0	0	0	0	0	0	See Section 602.4.6	0	0
Floor construction and secondary members (see Section 202)	3[h]	2	1[d]	0[d, i]	1[d]	0[d, i]	HT	1	0[i]
Roof construction and secondary members (see Section 202)	$1^1/_2$[b, h]	1[b, c]	1[b, c]	0[c]	1[b, c]	0	HT	1[b, c]	0

Table 3 - Florida Building code Table 601 – Fire Resistance Rating Requirements for Building Elements of Type II B Construction

4 Means of Egress

4.1 Exits & Egress Capacity

As the pier is an external environment, any smoke from a fire will dissipate to the atmosphere rather than be contained within the populated area as it would within an enclosed building. As such, the occupants of the Pier are considered to be in a similar environment where the use of '*outdoor smoke protected assembly seating*' would be appropriate. Because of this, the width of the horizontal egress components will be based upon 0.06" per person applicable for such spaces [FBC – 1028.6.3].

Based upon the calculated maximum pier occupancy of 5,954 people, the total required egress width (based on 0.06" per person) is 29ft 9in. The pier is provided with a total of 30ft of clear exit capacity which comprises 20ft clear width on the 'Overwater Drive' and 10ft clear width on the 'Overwater Bridge'.

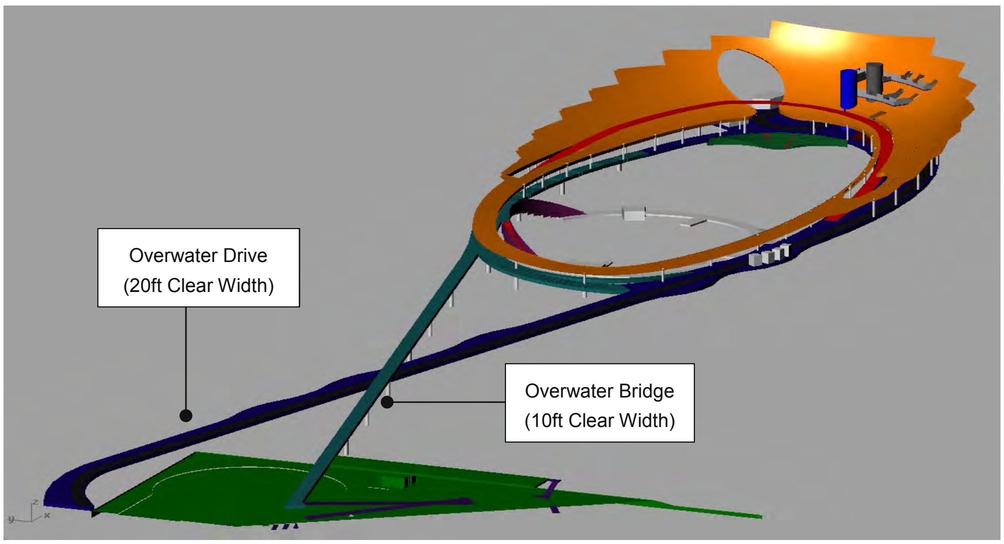

Figure 2 – Egress widths provided from the pier

The egress capacity provided by the pier is therefore considered compliant with the Building Code.

LIFE SAFETY REPORT
(continued)

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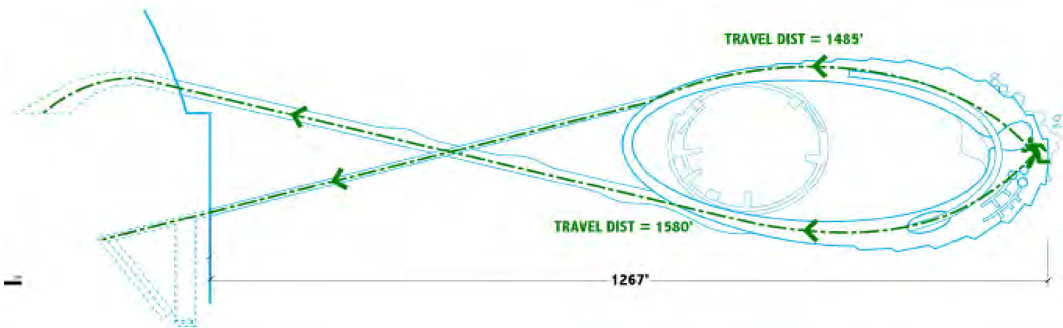
4.2 Travel Distances

For 'open air' assembly structures/buildings of Type I or Type II construction, travel distances are not limited by the Building Code BC [FBC - 1028.7, Ex 2]. The pier's current travel distances, measured from the furthest point of the pier to the point at which occupants reach the shore, are as given below;

- Egress via Overwater Drive = 1580ft
- Egress via Overwater Bridge = 1485ft



As no travel distance limits exist for a structure of this type, the distances experienced are therefore considered compliant.

However, while the Florida Building Code allows an unlimited travel distance for such a pier structure, it is appreciated that for a large public event, with a design occupancy approaching 6,000 people, the time taken to 'clear' the pier of people should still considered to be 'reasonable'.

For these reason, a performance based egress analysis of the pier has been conducted, the method and results of this study are presented within this report.

5 Performance Based Egress Design

Three separate scenarios have been examined as part of the piers performance based egress design - these are outlined in the sections below.

5.1 Scenario 1 – Full Pier Evacuation

Scenario 1 represents a condition where a full evacuation of the pier would be initiated. This could be as a consequence of a fire but equally due to bad weather or a security incident etc. This scenario takes into consideration the previously determined full pier occupancy of 5,954 people, distributed across the entire structure. The occupant load density has been modelled as per Figure 1. This scenario is referred to as the 'base case' for the egress simulations.

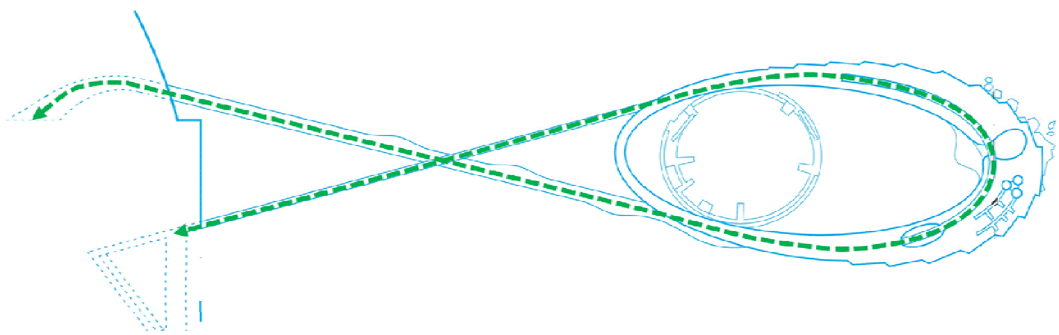


Figure 3 – Performance Based Design Scenario 1 – Full Pier Evacuation

5.2 Scenario 2 – Vehicle Fire

Scenario 2 represents an incident where a full evacuation of the pier would be initiated for a fire incident occurring at the most remote area of the pier. This scenario will assess the conditions affecting occupants in the immediate vicinity of the fire. The occupant load density has been modelled as per Figure 1.

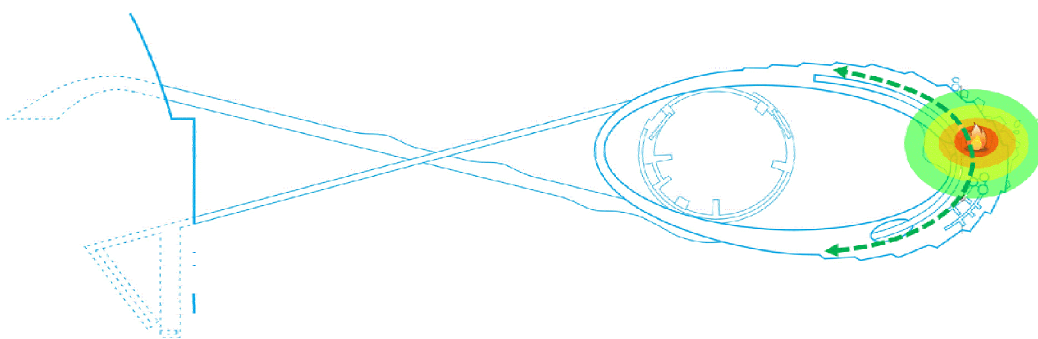


Figure 4 - Performance Based Design Scenario 2 – Fire Location

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5.3 Scenario 3 – Emergency Vehicle Attendance

Scenario 3 represents an incident where a full evacuation of the pier would be initiated at the same time as emergency personnel/vehicle being in attendance at the pier creating an obstruction in the flow of evacuees. This scenario has been produced at the request of the St. Petersburg Fire Department, in order to assess the effect that an emergency vehicle on the pier will have on the evacuating occupants, in terms of the evacuation from a fire incident locally at the end of the pier (as per Scenario 2), and the global evacuation time for the entire pier (as per Scenario 1).

The occupant load density has been modelled as per Figure 1, with the addition of a physical obstruction (8ft wide fire appliance) placed in the flow of occupants on the Overwater Drive.

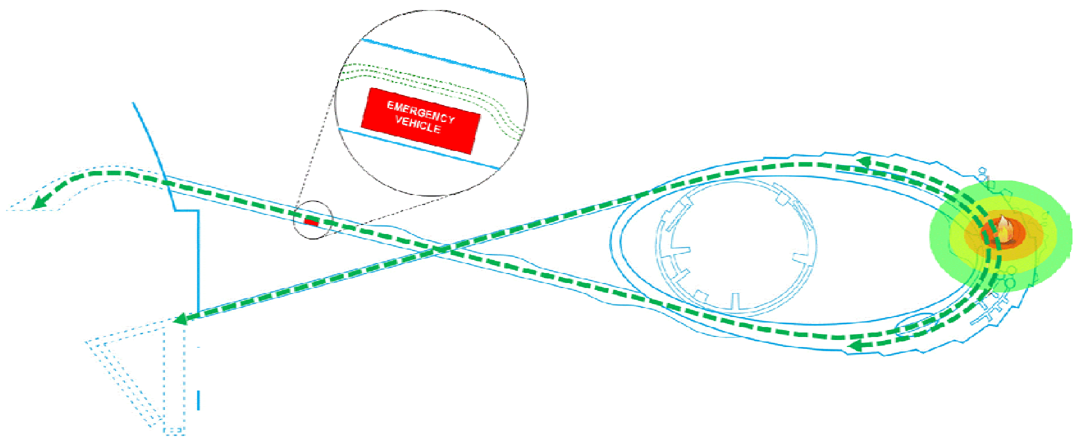

Figure 5 - Performance Based Design Scenario 3 – Emergency Vehicle Obstruction on the Pier

5.4 Performance Based Egress Design Approach

While the Florida Building Code places no limitation on distances of travel in open-air assembly structures, the St. Petersburg Building & Fire Department(s) have requested that the egress time of the pier is assessed in order to establish an overall 'safe' evacuation time for the structure at times of maximum occupation.

As part of this analysis, a performance-based design approach will be adopted in order to assess the following:

1. The *distance* required for an occupant to move away from a fire location such that the occupant is considered 'safe' from the effects of a fire

2. The *time* taken for occupants to move away from a fire incident to a 'safe' location

3. The *time* taken to completely evacuate the pier

This is seen as an appropriate approach on the basis that;

- As an outdoor space, there will be no smoke accumulation on the pier (smoke will dissipate into the atmosphere)
- Occupants will have sufficient distance/space to relocate to an area of relative safety, remote from a fire incident, while still remaining on the pier

A fire analysis and thermal radiation study have been performed to determine the effects on occupants from a single design fire scenario on the pier. Occupant safety will be determined by defining a 'safe zone' surrounding the source of the fire, which is based upon the levels of thermal radiation received as a function of distance from the fire.

A maximum radiative heat flux, based upon accepted research, will be selected for the acceptance criteria for this study. Due to the ability of smoke to dissipate into the atmosphere, the visibility through smoke, and other effects related to smoke will not form part of the pass/fail criteria.

In addition to this radiation study, a computational egress analysis will be performed to evaluate the time taken for occupants to reach the previously calculated 'safe distance' away from a fire incident. The computational egress model will also allow calculation of the overall pier evacuation time.

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6 Egress Model

6.1 Analysis Software

The egress analysis for the project was conducted using the SMARTMove people flow software. SMARTMove is a visual simulation tool for modeling of crowd flow with the view to optimization of egress routes and circulation spaces. The software uses network modeling and agent based simulation technologies to provide a fast, flexible and visual tool for the modeling of large people flows.

SMARTMove allows detailed simulation of people movement through a given space. The software's static network analysis capability is used for conceptual design and analyses of spaces, while the dynamic simulation capability allows testing of complex interaction of hundreds of thousands of people in scenarios such as day-to-day circulation, mass arrival/exodus, and emergency evacuations.

6.2 Input Parameters

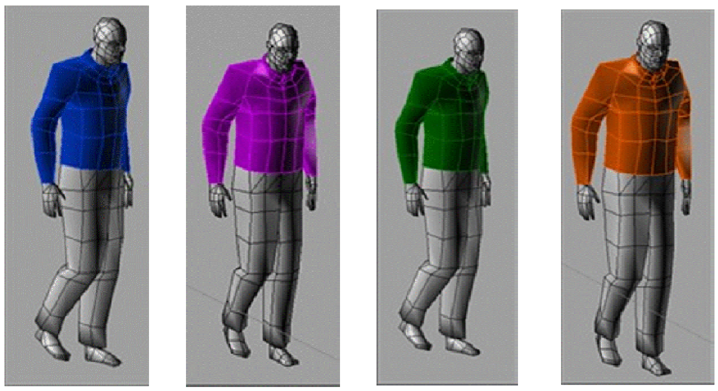
The following input parameters were used within the computational egress model;

Parameters	Value	Reference
Occupant Load	5,954 People	Calculated (refer to Section 3.2 of this report)
Occupant Distribution	Varies	Refer to Section 3.2 of this report
Occupant Type;		
Male (Adult)	28% of population (1,668 People)	US Census Bureau Data
Female (Adult)	31% of population (1,846 People)	US Census Bureau Data
Limited Mobility/Disabled	7% of population (417 People)	US Census Bureau Data
Children	22% of population (1,310 People)	US Census Bureau Data
Elderly	12% of population (714 People)	US Census Bureau Data
Walking Speed;		
Male, female & children	4.1ft/s (1.25m/s)	SFPE Table 3-13.5
Limited Mobility/Disabled, elderly	2.0ft/s (0.69m/s)	SFPE Table 3-13.2
Flow Rates;		
Horizontal	78 people/m/min	SFPE Table 3-13.5
Vertical (stairs)	56 people/m/min	SFPE Table 3-13.5

Table 4 – Egress model input data

6.3 Occupant Identification

Within the egress simulation, occupants can be identified by their color. The following colors are used to depict the different occupant types present;



Blue = Male	Purple = Female	Green = Children	Orange = Elderly/Mobility Impaired
28% of population (1,668 People in model)	31% of population (1,846 People in model)	22% of population (1,310 People in model)	12% of population (714 People in model) & 7% of population (417 People in model) respectively

Figure 6 – Occupant Identification within Egress Simulation

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6.4 Model Geometry

SMART Move evacuation modelling software is a Rhino-based plugin, allowing the model to be built and run within the exact architectural Rhino model. This allows the exact project geometry to be used within the calculations, including egress widths, physical obstructions (such as columns and handrails) and level changes experienced by the use of stairs and ramps.

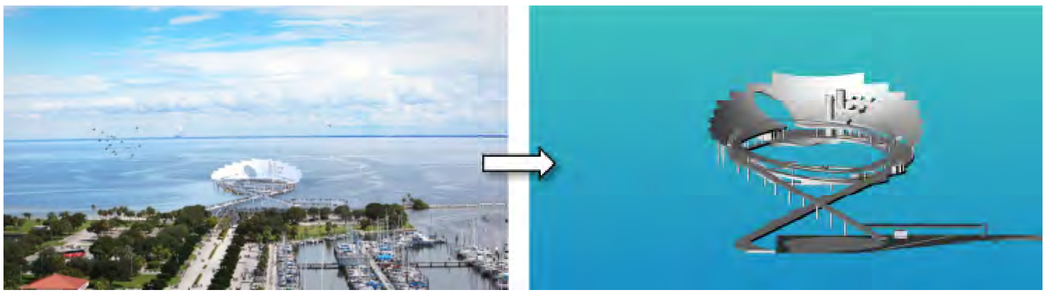

Figure 7 – Architectural rendering (left) and Rhino model used for Egress Simulation (right)

Figure 8 - Architectural rendering (left) and Rhino model used for Egress Simulation (right)

6.5 Occupant Load Visuals

Once the model has been populated (in accordance with the previously defined occupant load in Section 3.2 and Table 1 of this report), the 3D occupants can be loaded into the model to obtain a visual representation of the occupancy assumptions prior to their evacuation (i.e. at Time = 0 seconds). This T = 0 seconds condition is represented in the following Figures;

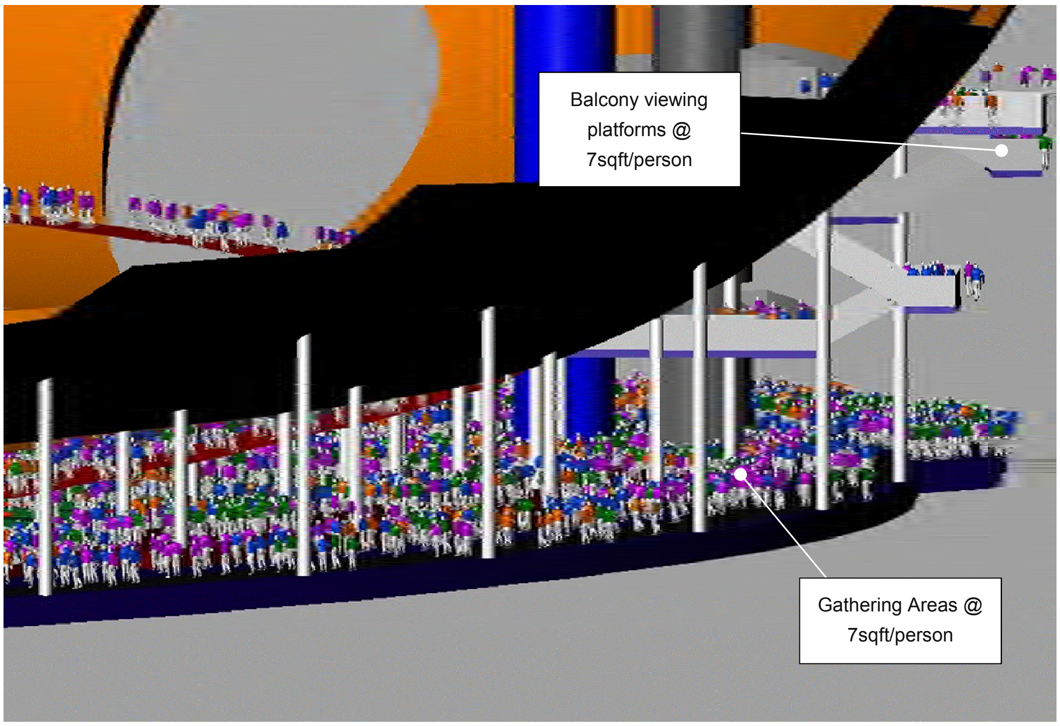

Figure 9 – Occupant loading within the evacuation model at Time = 0

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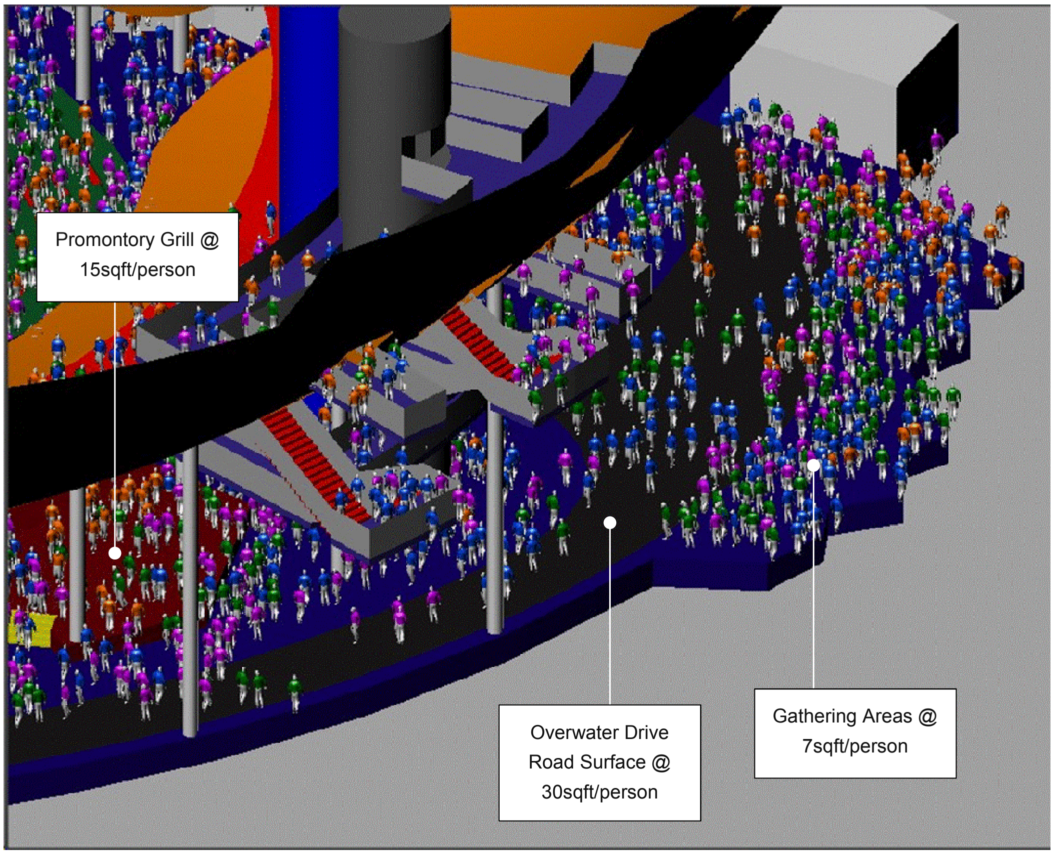

Figure 10 - Occupant loading within the evacuation model at Time = 0

7 Performance Based Design Scenario 1 – Results

The following Figures show the chronological progression of the entire pier evacuation. The first area of the pier to 'clear' of occupants is the *Overwater Bridge Steps*, shown below at Time = 0s, and cleared of occupants at Time = 37 seconds.

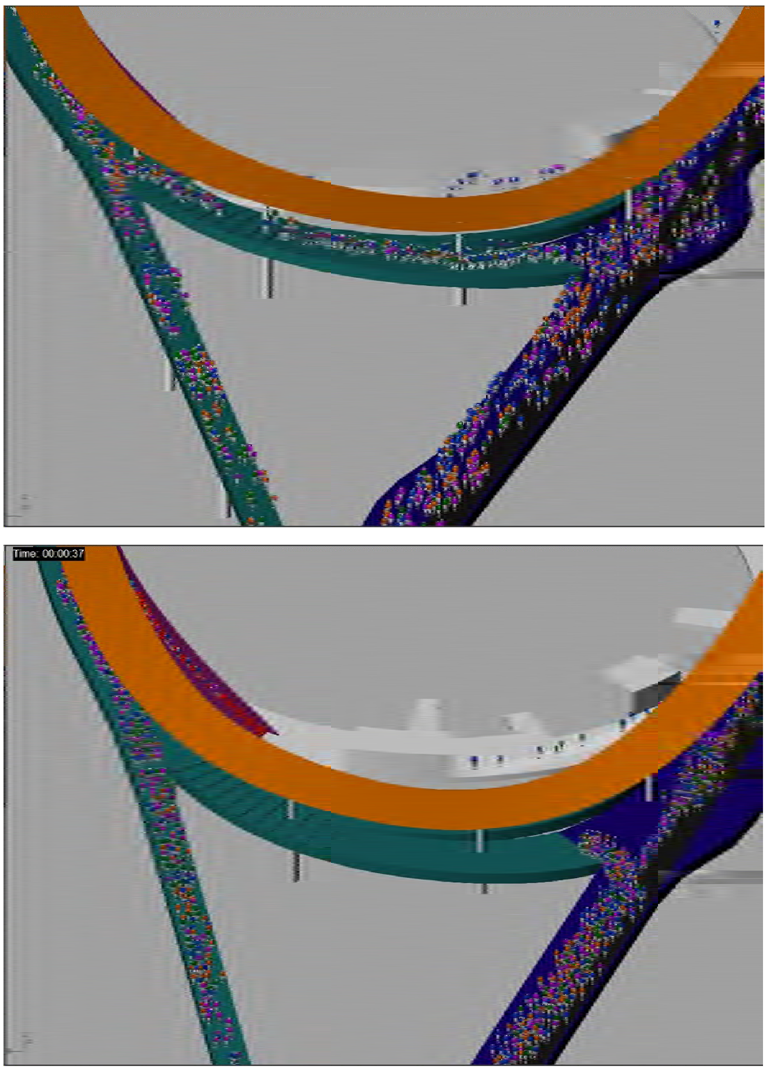

Figure 11 – Overwater Bridge Steps at Time = 0s (top) and Time = 37s (bottom)

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The next area of the pier to 'clear' of occupants is the Floating Dock, shown below at Time = 0, and clear of occupants after Time = 58 seconds;

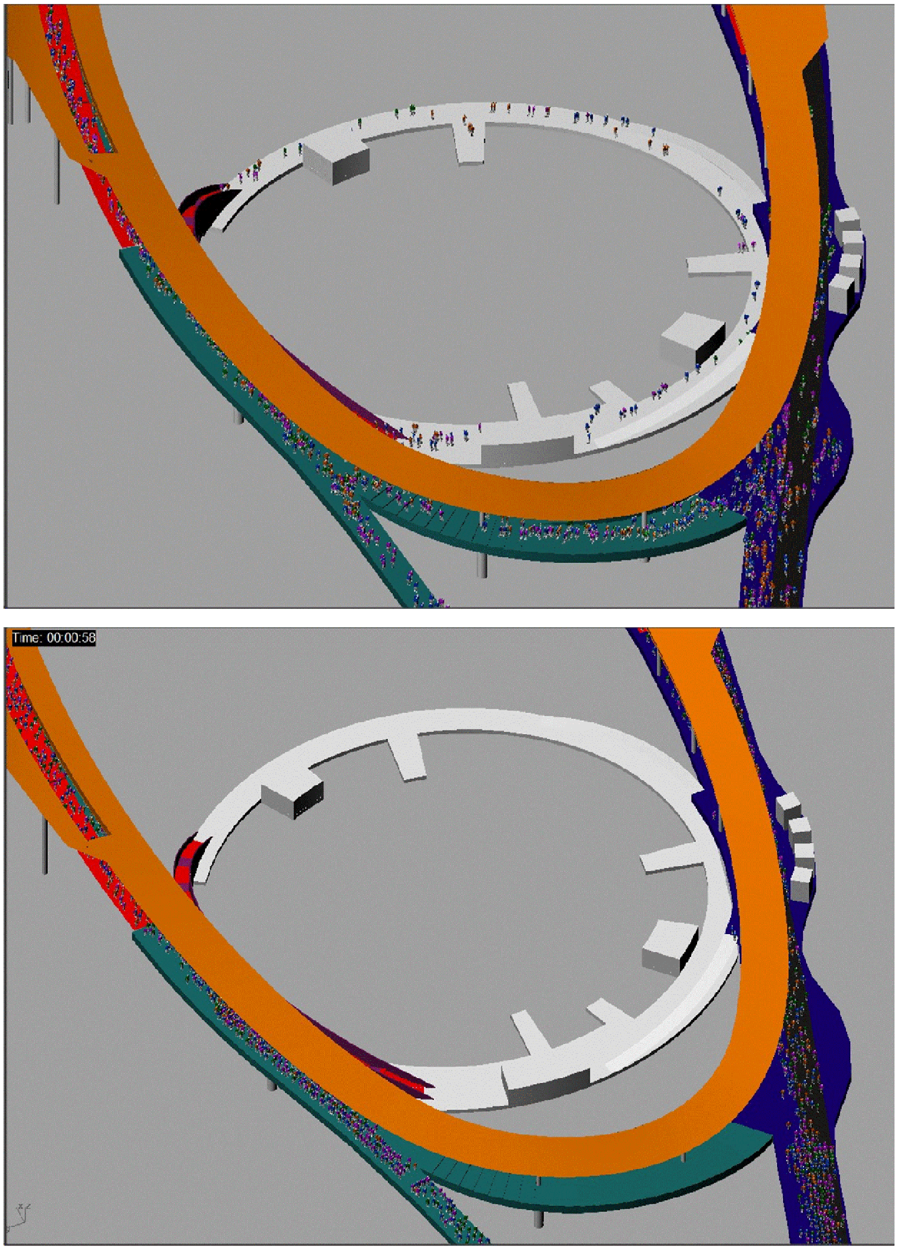

Figure 12 – Floating Dock at Time = 0s (top) and Time = 58s (bottom)

The viewing balconies, at the far end of the pier, are the next area to clear of occupants. These areas are shown fully occupied at Time = 0 seonds, and the balconies fully cleared of occupants onto the bike path below after Time = 1m 23s.

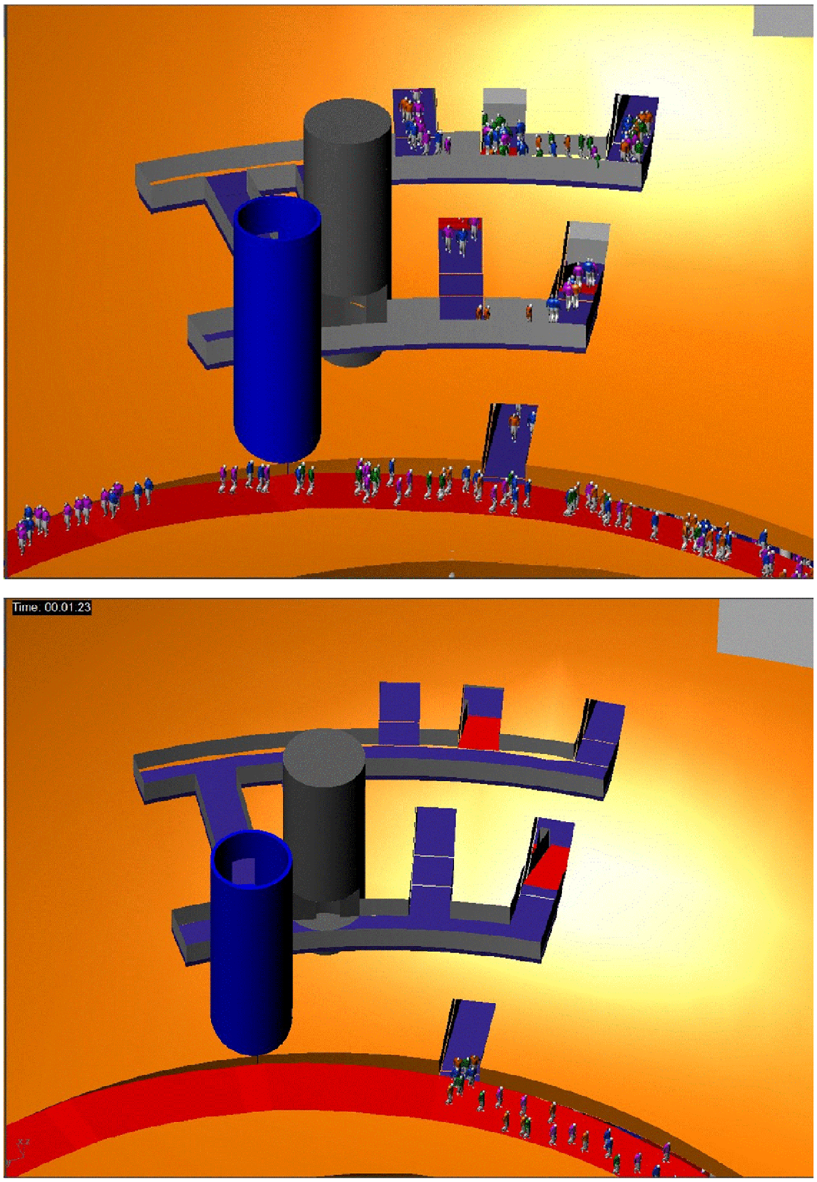

Figure 13 – Viewing balconies at Time = 0s (top) and Time = 1m 23s (bottom)

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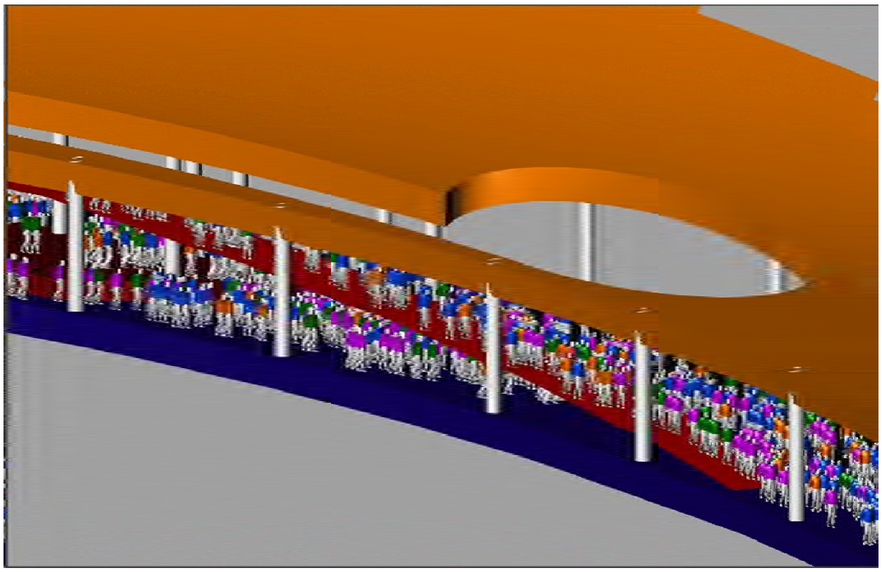
The bike path areas are cleared off occupants after 2m 35s:



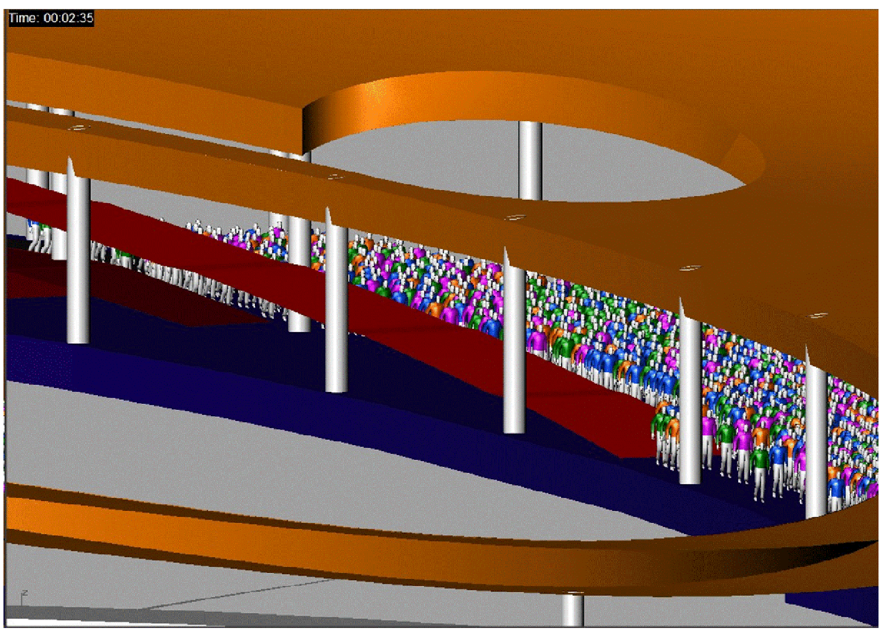


Figure 14 – Bike Path at Time = 0s (top) and Time = 2m 35ss (bottom)

Following the evacuation of all the areas at the head of the pier occupants are now queuing on the Overwater Bridge and Overwater Drive portions of the pier. The following figures show the population levels in these areas as a function of time (shown in the top left-hand corner of each image).

After 10 minutes, the majority of the Overwater Bridge and Overwater Drive are clear of occupants. A queue is forming towards the end of Overwater Drive, as well as on the pedestrian ramp serving Overwater Bridge.

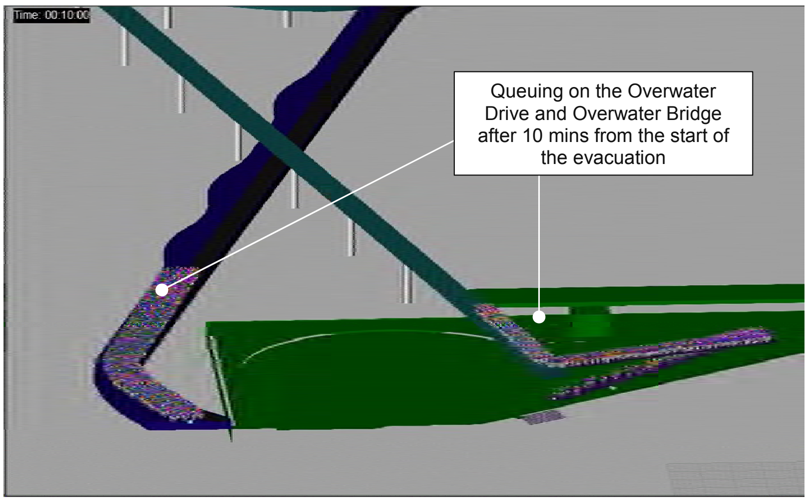


Figure 15 – Occupants on Overwater Drive and Overwater Bridge @ Time = 10mins

After 11m 56s, the Overwater Drive has completely cleared of occupants. The Overwater Bridge has also cleared however occupants form a queue on the Uplands Ramp:

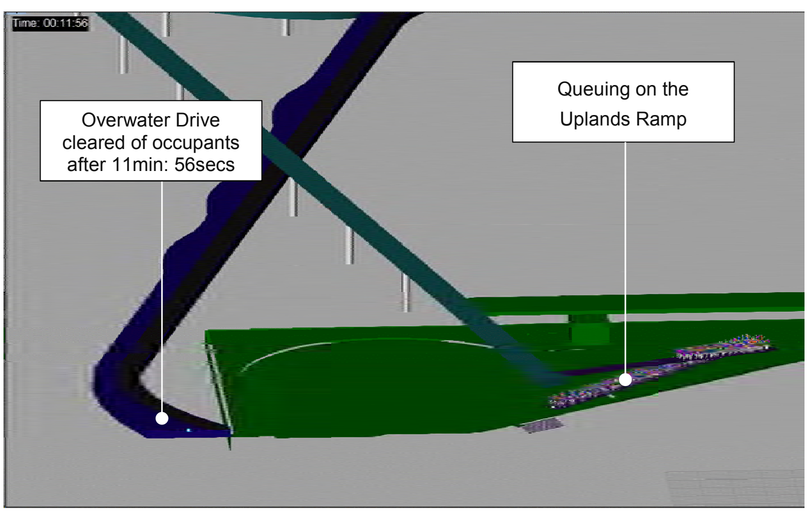


Figure 16 – Overwater Bridge clear and Uplands Ramps queuing @ Time = 11m56s

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The final occupants of the Uplands Ramp leave the structure after 13m14s, representing a total evacuation time for the pier.

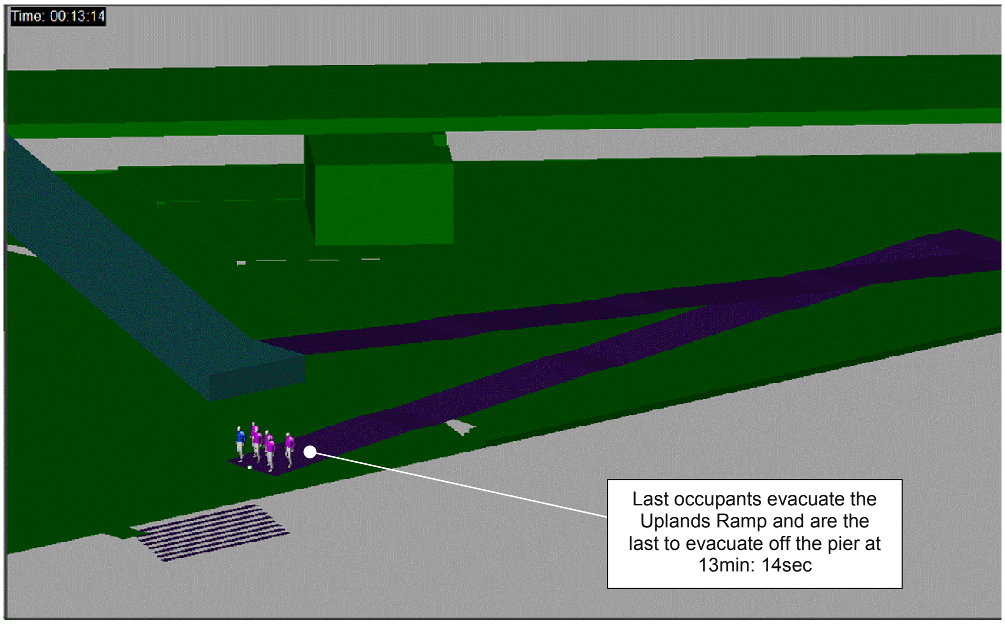

Figure 17 – Last occupants leave the Uplands Ramp after 13m 14s

8 Performance Based Design Scenario 2 - Results

8.1 Introduction

The following section describes the process undertaken to demonstrate safe conditions for Scenario 2, which introduces a fire incident at the most remote area of the pier, in order to assess conditions affecting occupants in the immediate vicinity of the fire, as well as monitoring the global evacuation time.

8.2 Design Fire Assumptions

The largest vehicle expected on the pier on a daily basis will be a food delivery truck servicing the Promontory Grill restaurant at the far end of the pier. The location of the fire has been assumed as the point at which the vehicle will be parked for the duration of the time on the pier and is shown below in Figure 18:

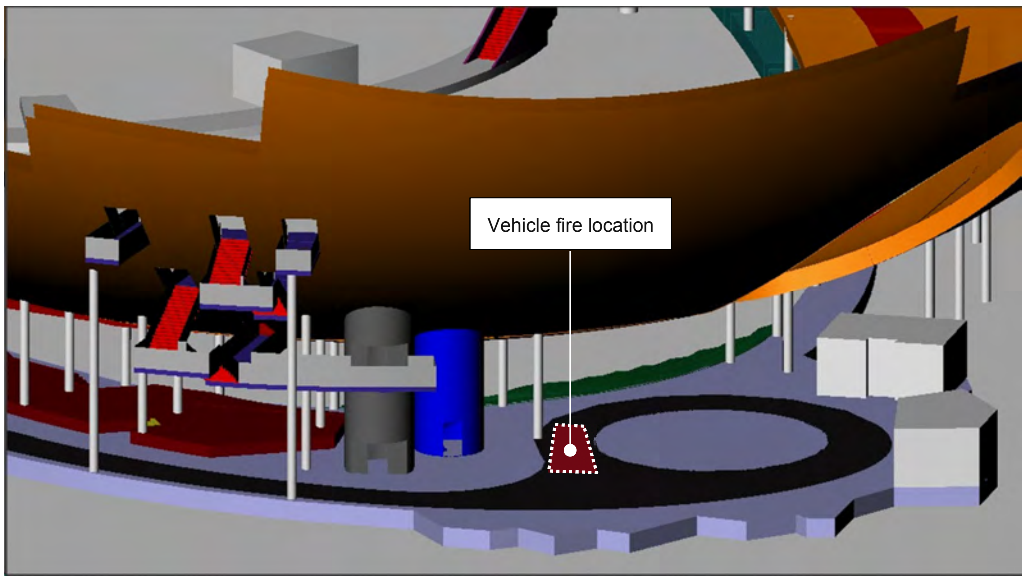

Figure 18 – Location of the fire incident on the pier

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The physical properties of the fire are based upon the assumption that the largest vehicle using the pier will be a 24ft box truck as shown in Figure 19.

The dimensions of the truck are taken as a 4ft cab, with a 24ft box and an overall length of 28ft. The vehicle height has been taken as 10ft 10inches (representative of a 2ft 9 inches ground clearance and 8ft 1inch high box section). The width of the vehicle is taken as 8ft.

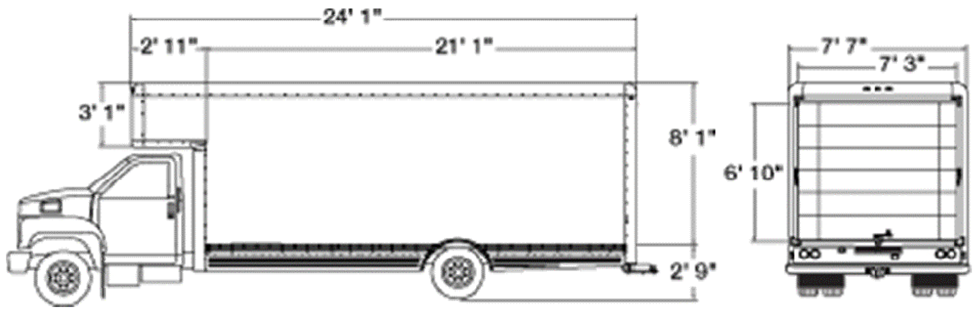

Figure 19 – 24ft Box Truck Dimensions

The assumed fire parameters are taken as:

- 15MW peak heat release rate (taken from PIARC Committee on Road Tunnels[1])
- 'Fast' fire growth rate (0.047kW/s^2)
- 10'10" High
- 8' Wide
- 11' Projected flame above truck
- 22' Overall Emitting Flame (NFPA 92 calculation)
- Consistent flame temperature of 1830F (1273k)

[1] FIRE AND SMOKE CONTROL IN ROAD TUNNELS, PIARC Committee on Road Tunnels (C5), PIARC, 1999

The diagram below, represents how the fire is represented within the thermal radiation model. The white portion of the diagram box is a representation of the vehicle itself with the orange section within the diagram representative of the flame height above the vehicle - calculated using NFPA 92 based upon the vehicle fire size. Both of these areas of the 3D model are defined as heat emitting, representative of the vehicle itself being involved in fire, as well as flames rising above the vehicle.

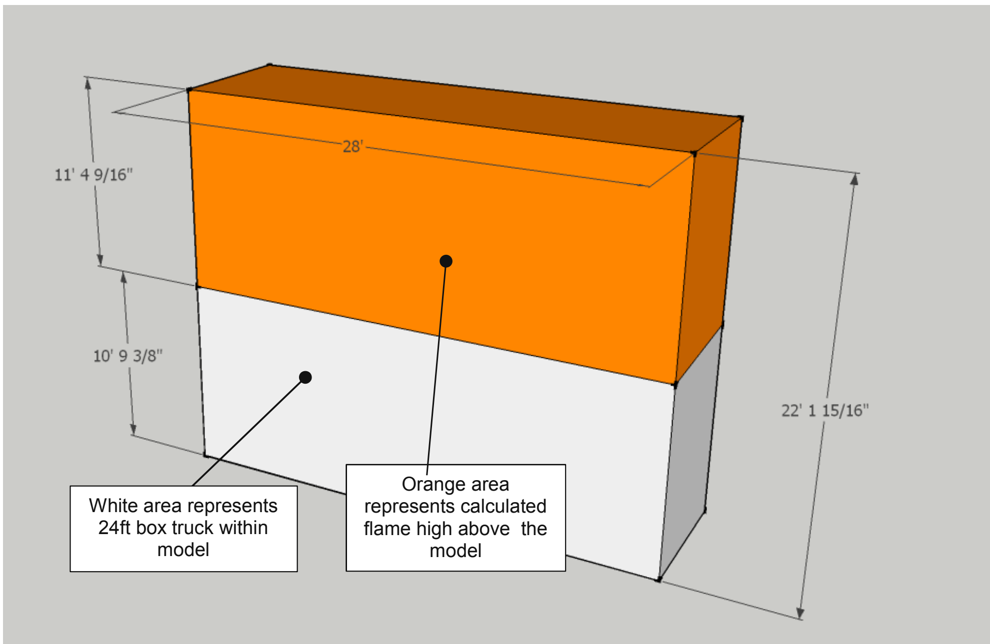

Figure 20 – Representation of vehicle fire within the thermal radiation model

The emitting temperature is taken as a worst case typical maximum flame temperature (experienced at the hottest part of an intermittent flame) and has been applied across the entire surface of the three dimensional object shown above. Given that flames are dynamic in their behavior, and contained cool(er) spots and hot spots in their makeup, applying the maximum temperature across the entire surface of the emitting object represents a conservative assumption.

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8.3 Calculation Method

The thermal radiation study is based upon the theory of thermal transfer between surfaces, specifically the analysis of the radiation between a hot *emitter* to cool *receiver* surfaces. In order to analyse a specific case, the geometry of interest is assessed as a series of 'panels' – these panels are two-dimensional planes within a three-dimensional environment which are constructed to represent a scale version of the structure or scenario of interest.

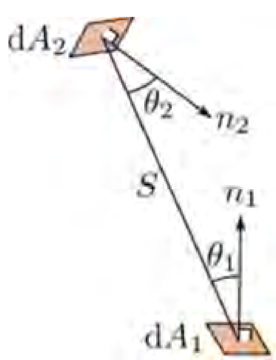
The level of thermal radiation received on an object is a function of several factors:

- The temperature of the emitting panel
- The initial temperature of the receiving panel
- The horizontal separation distance between the two objects
- The vertical relationship between the two objects (i.e. how high one object is in relation to the other)
- The extent of 'offset' between the two objects in relation to one another
- The face angle between the two objects (i.e. whether the objects are perpendicular to one another or whether they are angled away/towards one another)

All of these factors affect the fraction of radiation received by the panel. This fraction is referred to as the 'view factor'. This view factor is expressed as a constant between 0 and 1 that represents the fraction of radiation 'seen' by the receiving panel.

This view factor is calculated using the following relationship:

$$dF_{d1-d2} = \frac{\cos\theta_1 \cos\theta_2}{\pi S^2} dA_2$$ [*Equation 11, SFPE Handbook*]



Where:

dF_{d1-d2}	View Factor
θ_1	Angle of Panel 2 relative to normal of Panel 1
θ_2	Angle of Panel 1 relative to normal of Panel 2
S	Separation distance between the panels
A_1	Area of Panel 1
A_2	Area of Panel 2
n_1	Normal angle (perpendicular) relative to Panel 1
n_2	Normal angle (perpendicular) relative to Panel 2

Once the 'view factor' has been calculated, the radiative heat flux upon the receiving panel is calculated using the following equation:

$$Q = F_{1-2}\varepsilon\sigma(T_1^4 - T_2^4)$$

Where:

Q	Radiative Heat Flux (kW/m^2)
dF_{d1-d2}	View Factor (Previously calculated)
ε	Emissivity (Assumed to be 1.0 as a conservative assumption)
σ	Stefan-Boltzmann constant (5.67×10^{-8} W m^{-2} K^{-4})
T_1	Temperature of Panel 1
T_2	Temperature of Panel 2

The software adopted for this study (Thermal Radiation Analysis - TRA) solves these equations for multiple emitting and receiving panels of varying geometries, allowing an accurate three-dimensional model to be constructed for the scenario of interest.

The software is produced by '*Fire Engineering Software'* and can be downloaded free of charge from http://www.fire-engineering-software.com/tra.html.

8.4 Acceptance Criteria

The tenability limit for exposure of skin to radiant heat is commonly quoted as 2.5kW/m^2 with heat flux below this being tolerable for greater than 5 minutes [Table 2-6.19, SFPE Handbook of Fire Protection engineering, Third Edition].

Consequently, thermal radiation received below 2.5kW/m^2 is deemed to be *tenable* to occupants for an extended period of time, and they are therefore not placed at risk from an incident. The piers 'safe zone' will therefore consist of all areas adjacent to the fire incident that experience 2.5kW/m^2 or less.

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8.5 Radiation Model Construction

The thermal radiation model consists only of a portion of the pier at the far end of the Promontory since it is unnecessary to build the entire pier structure for this particular study. Within the thermal radiation model, the far end of the structure is represented, which contains the vehicle turning circle, surrounding gathering areas and Promontory Grill as shown in Figure 21;

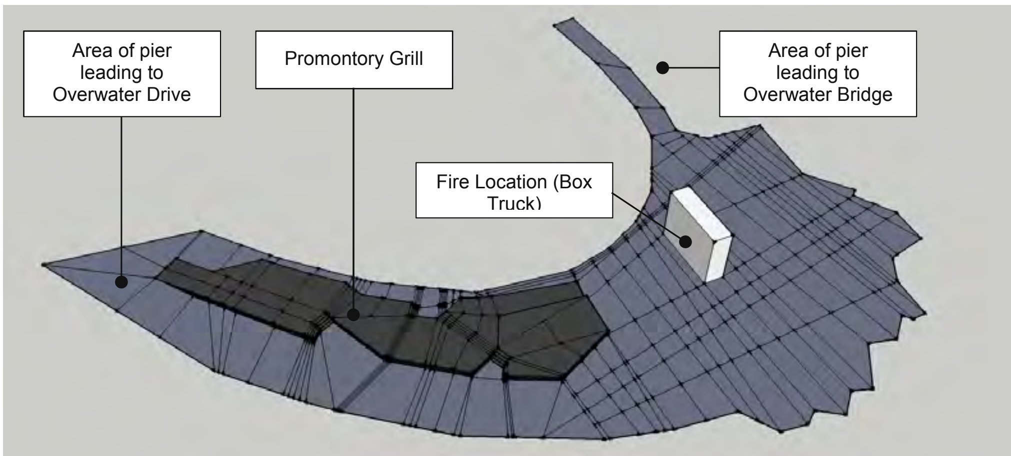

Figure 21 – Simplified pier model used for the thermal radiation analysis

A series of vertical measuring panels were added to the model to represent occupants on the pier in the immediate vicinity of the Promontory. The measuring panels, shown in Figure 22, have been placed at 10ft intervals radially from the center of the fire location. Each vertical measuring panel is 6ft high and 2ft wide, to represent a person, and allow for a more accurate measurement of the radiative heat flux in the vertical plane surrounding the incident.

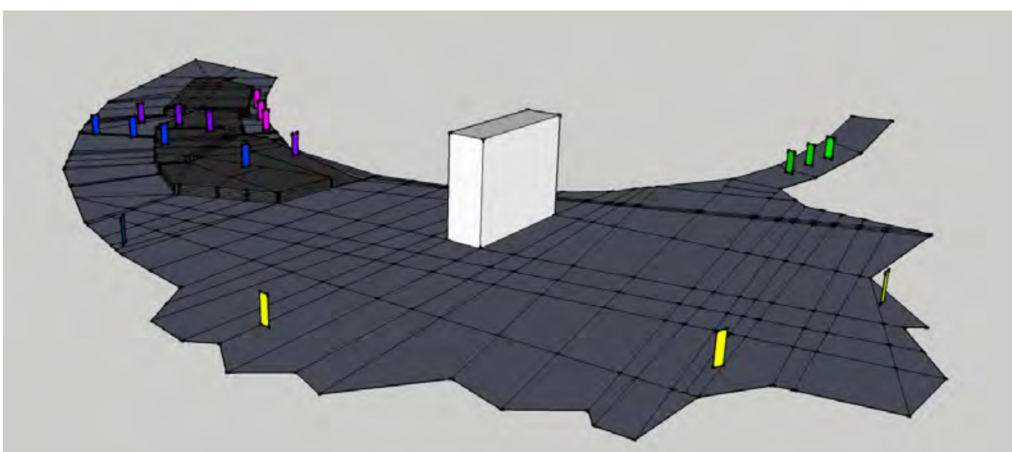

Figure 22 – Vertical measuring devices within the thermal radiation model

8.6 Thermal Radiation Analysis Results

The thermal radiation results are shown in Figure 23 and show a color scale on the walking surface of the pier, which establishes the extent of the incident radiation received upon the wlaking surface of the pier. As previously defined, the acceptibility criteria for thermal radiaiton is taken as 2.5kW/m^2, which is depicted by a red colored circular zone around the fire incident:

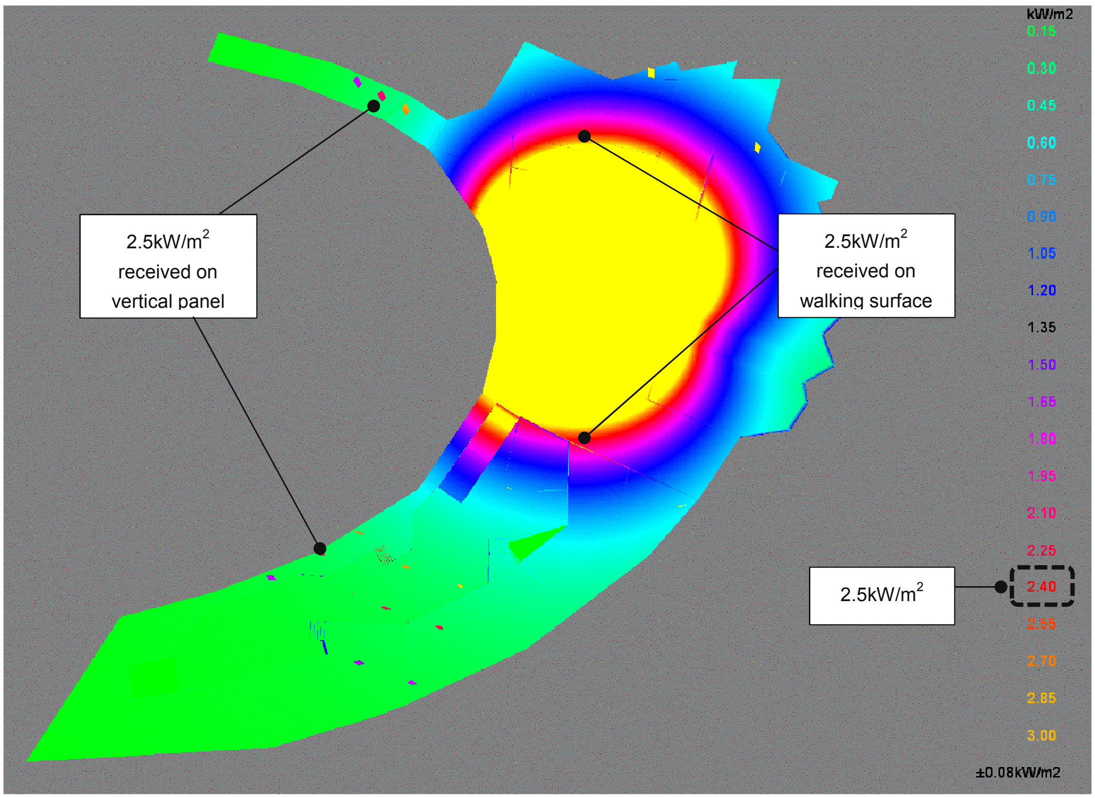

Figure 23 – Thermal radiation analysis results from a vehicle fire

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The results show that in order to receive radiation of 2.5kW/m^2 or less, occupants must move at least 115ft away from the fire incident, as indicated below in Figure 24, and therefore be considered *safe*.

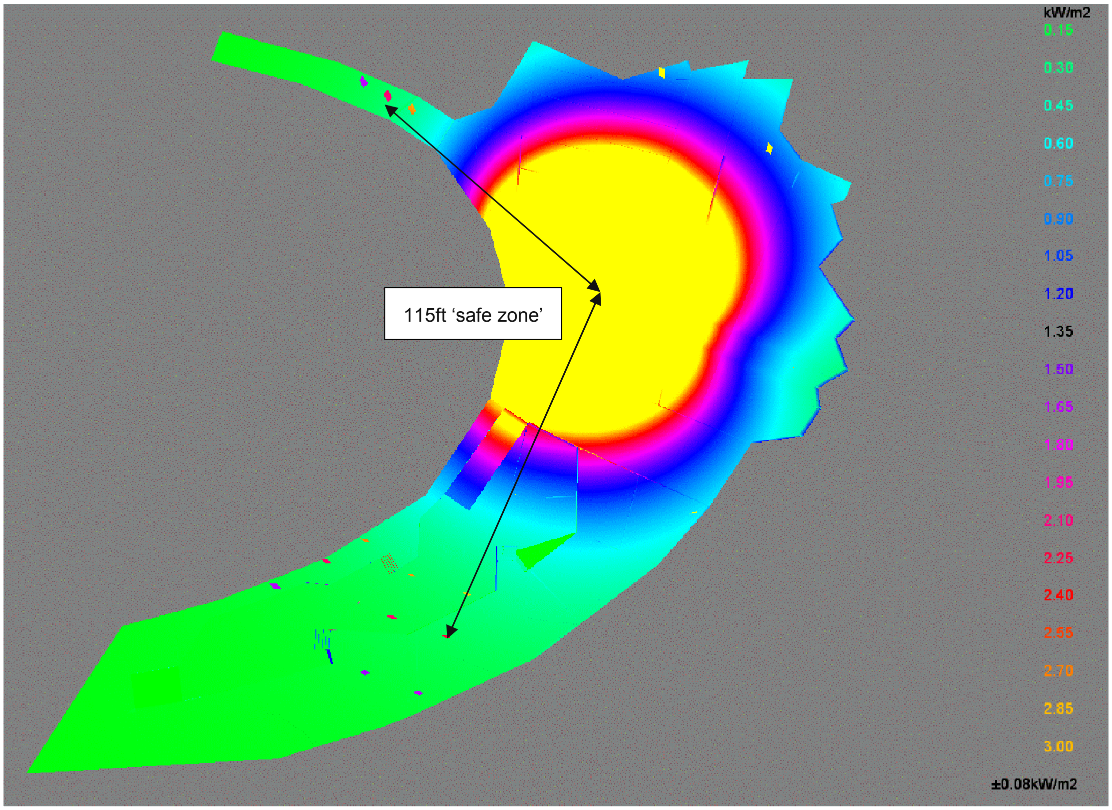

Figure 24 – Calculation of the 115ft 'safe distance' from the fire

8.7 Egress Simulation Results

The time taken for occupants to clear the 115ft 'safe area' is established by assessing the egress model, with a specific study on conditions in the vicinity of the fire. Figure 25 below shows the occupancy levels at the end of the pier at the beginning of the simulation (Time = 0s):

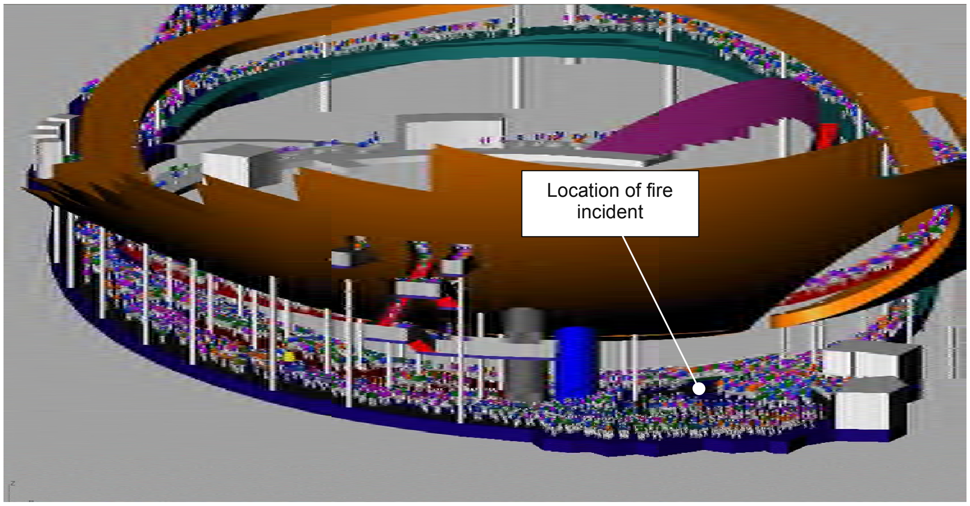

Figure 25 – Occupancy conditions at the end of the pier at Time = 0s

Figure 26 below shows the 'safe area' clears of occupants 2mins 25secs into the simulation:

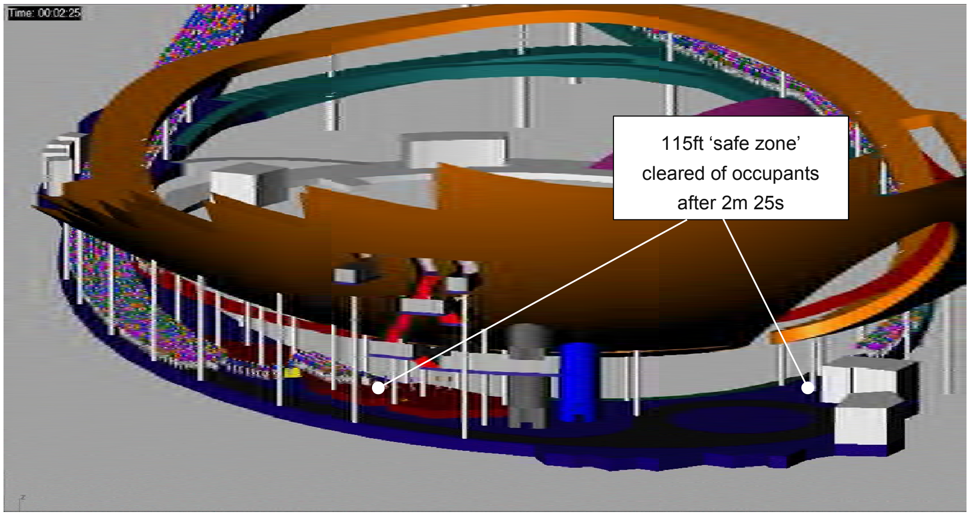

Figure 26 – 'Safe zone' clear of occupants after 2m 25s

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While it takes occupants 2minutes : 25 seconds to clear the 115ft 'safe zone', it is important to recognize that the fire does not reach its peak heat release rate for quite some time and therefore during the 2 minute 25 second period, occupants will not be exposed to the peak thermal radiation levels shown in Figure 23/Figure 24.

Instead, the fire will grow from ignition (at T = 0 seconds) up until its maximum heat output. It has been conservatively assumed that the fire will follow a 'fast' fire growth rate of 0.047kW/s^2.

The graph below shows the fire growth as a function of time for a 15MW (peak heat release rate) 'fast' fire, demonstrating that after 2 minute 25 seconds into the fire growth period the fire is only approximately 1000kW (1MW) in size. For comparison purposes, a 1MW fire would be roughly equivalent to a large trash can full of paper on fire.

Therefore the time taken to evacuate the 115ft 'safe zone' in relation to the actual size of the fire at the point in time results in all occupants being able to leave the vicinity of the fire incident before conditions become untenable.

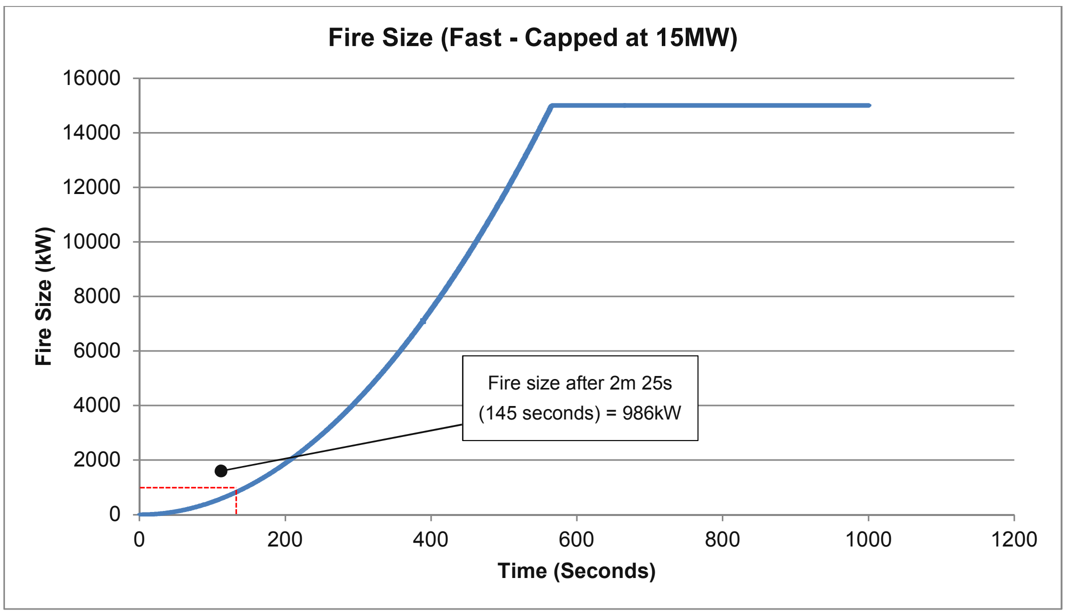


Figure 27 – Fire size as a function of time for a 15MW 'fast' fire

9 Performance Based Design Scenario 3 – Results

9.1 Introduction

The following section describes the process undertaken to demonstrate safe conditions for Scenario 3, which introduces an obstruction into the flow of evacuees (caused by an emergency or other similarly sized vehicle) on the Overwater Drive portion of the pier. The obstruction is placed in the flow of occupants while the pier is occupied at its full capacity of 5,954 people. This study will assess the conditions affecting occupants in the immediate vicinity of the previously introduced fire, as well as monitoring the impact the obstruction has on the pier's global evacuation time.

9.2 Evacuation Flow Obstruction

The obstruction present on Overwater Drive has been taken as a standard fire department pumping appliance, representative of the largest vehicle expected to be on the pier in either normal or emergency conditions. A 3D scale model of the vehicle has been used within the egress model as shown below in Figure 28.

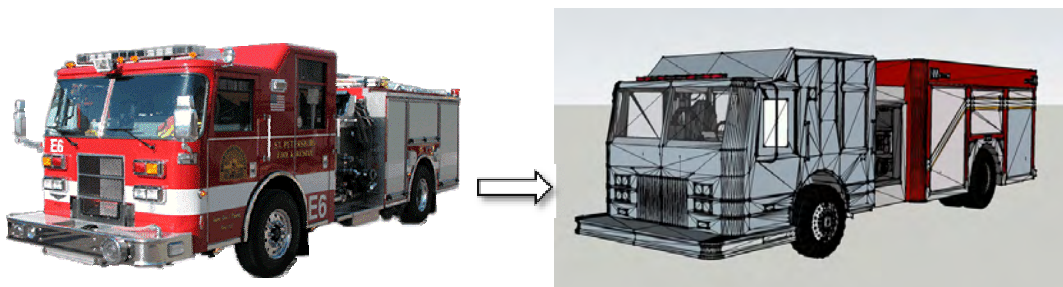


Figure 28 – Scale representation of the fire truck within the evacuation model

The vehicle obstruction has been placed within the model at Time = 0 seconds, within the Overwater Drive portion of the pier, representing a static obstruction at the narrowest point of the vehicle drive route. Several 'bumps-outs' are located along the Overwater Drive section of the pier which results in a temporarily width increase of the pier. However, in order to remain conservative the vehicle has not been located adjacent to one of these bumps-outs and it remains within the narrowest 20ft wide section of Overwater Drive.

The idealized Fire Department arrival time for an incident on the pier has been stated as 4 minutes : 30 seconds. As such, for the first 4m 30s of an incident, no obstruction will be present on the pier by a fire department vehicle (as it hasn't arrived yet), and the pier will have the maximum egress capacity available to the evacuating occupants. To remain conservative within the modelling undertaken, however, the vehicular obstruction is introduced immediately to the simulation, thereby resulting in a longer delayed egress time than would be experienced in reality.

LIFE SAFETY REPORT
(continued)

Buro Happold

The vehicle width used was 8ft which is considered commensurate with the type of fire department vehicle expected on the pier. Either side of the vehicle, a 2.5ft ‘clearance zone’ has been allowed to give the driver of the vehicle sufficient width to negotiate the vehicle down the pier. The remaining clear egress width once these intrusions have been taken into account is 7ft, as shown in Figure 29.

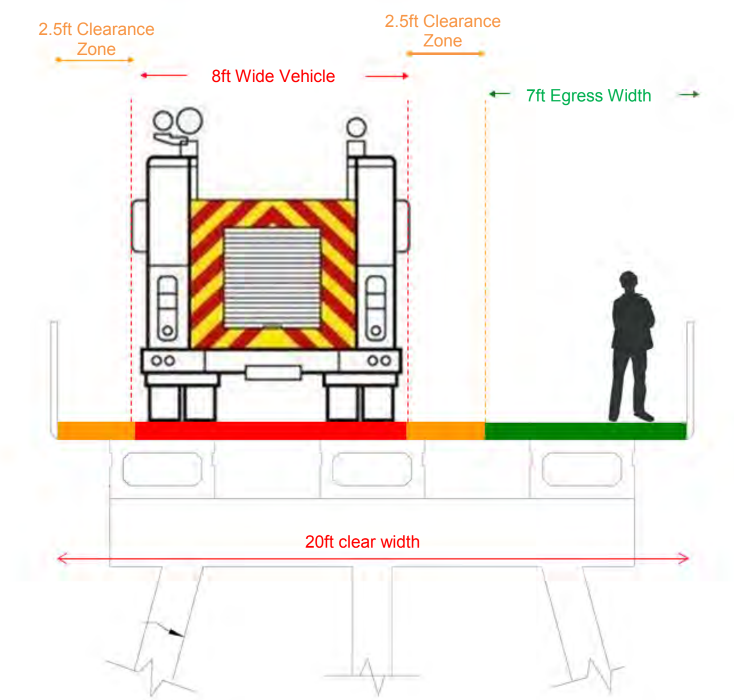


Figure 29 – Vehicle obstruction and remaining egress width on Overwater Drive

As per Scenario 2, the time taken for occupants to clear the 115ft 'safe zone' either side of the fire incident, has been assessed with the vehicular obstruction in place, as shown in Figure 30 below.

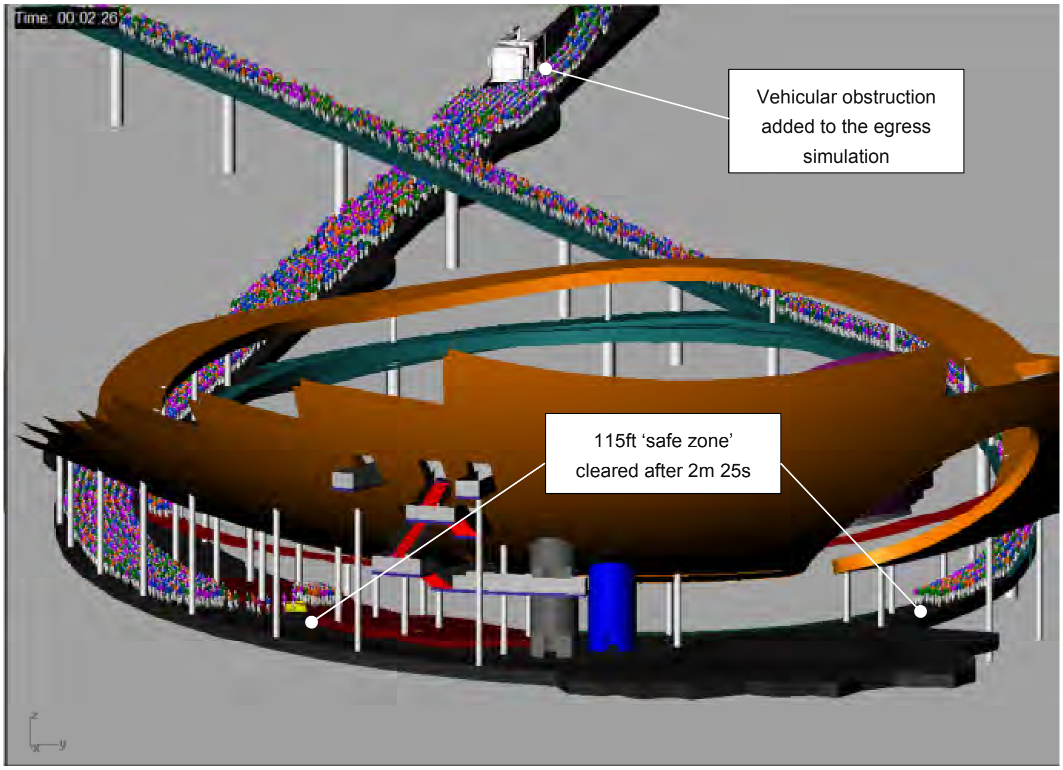


Figure 30 – Occupants evacuating the 'safe zone' at the end of the pier with the vehicular obstruction in place

The 115ft 'safe zone' has been shown to clear of occupants after 2m 25s, the same time as Scenario 2. This is because the vehicular obstruction within the model does not affect the flow of occupants at the end of the pier until they are closer to the obstruction. Sufficient floor area is provided along the pier to allow the occupants in the immediate vicinity of the fire incident to move away unobstructed before joining the queue of occupants further down the pier.

LIFE SAFETY REPORT
(continued)

Buro Happold

As occupants continue their escape down Overwater Drive, they approach the vehicular obstruction and their available egress width decreases. As a consequence of this reduced width, a queue begins to form in front of the vehicle – as shown after 15 minutes in Figure 31 below.

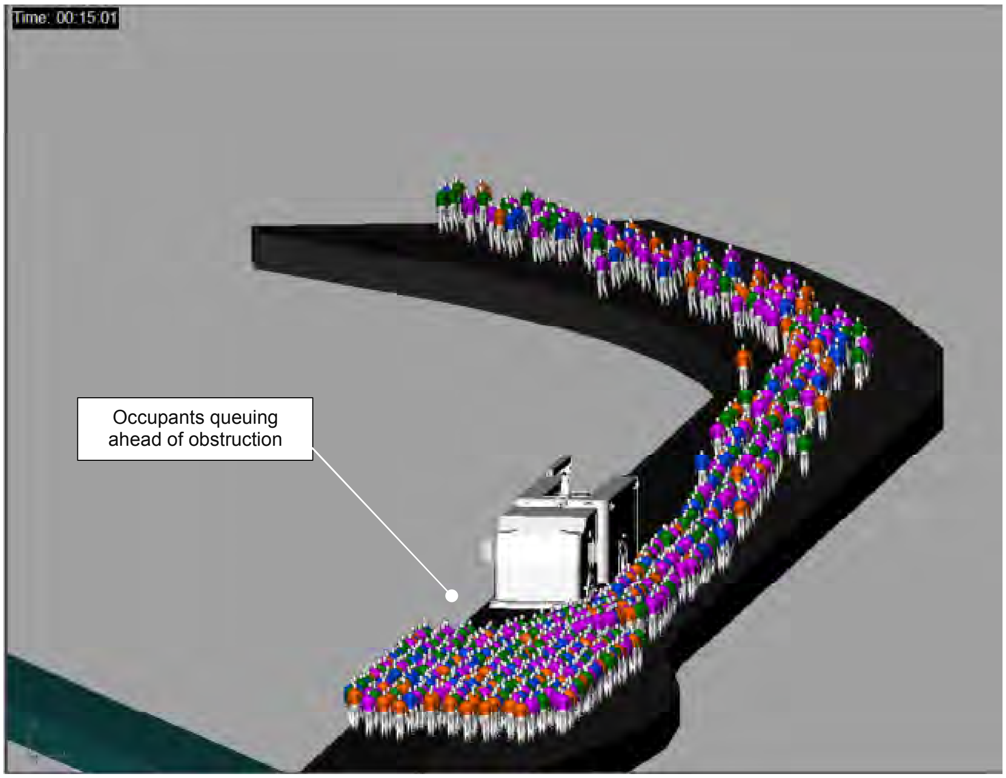


Figure 31 – Occupants queuing in front of the vehicular obstruction after 15 minutes

The last of the occupants to approach the vehicle obstruction does so after approximately 17 minutes, at which point no further people are queuing upstream occurs and the pedestrian flow begins to return to normal efficiency.

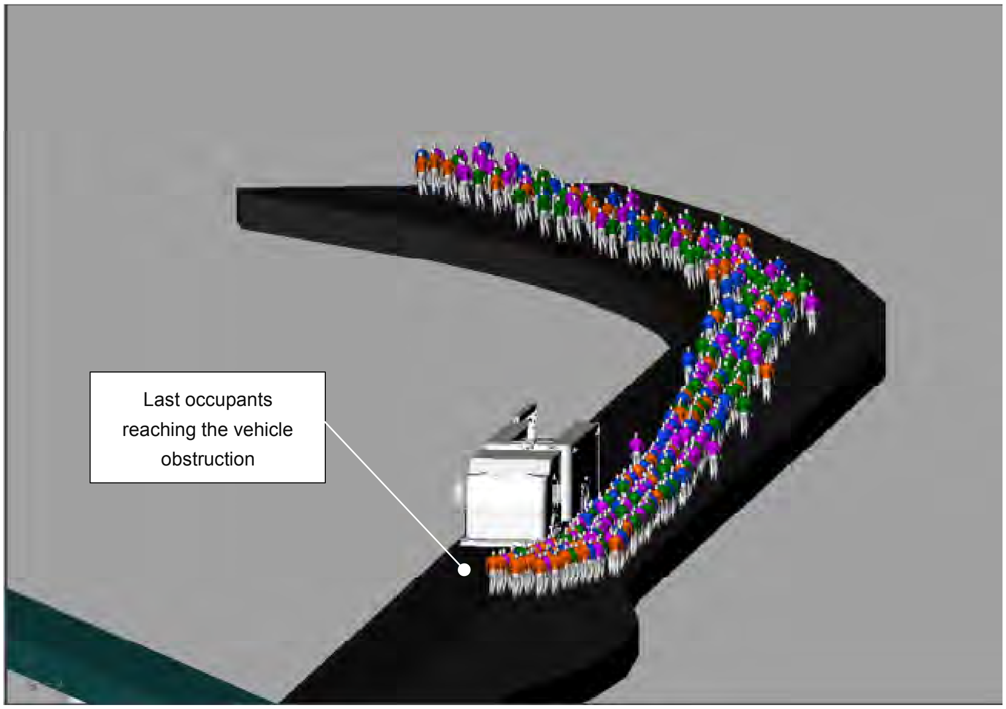


Figure 32 – Last occupants approach the vehicular obstruction after 17 minutes

LIFE SAFETY REPORT
(continued)

Buro Happold

The last occupants to leave the pier do so after 18m 26 seconds as shown in Figure 33:

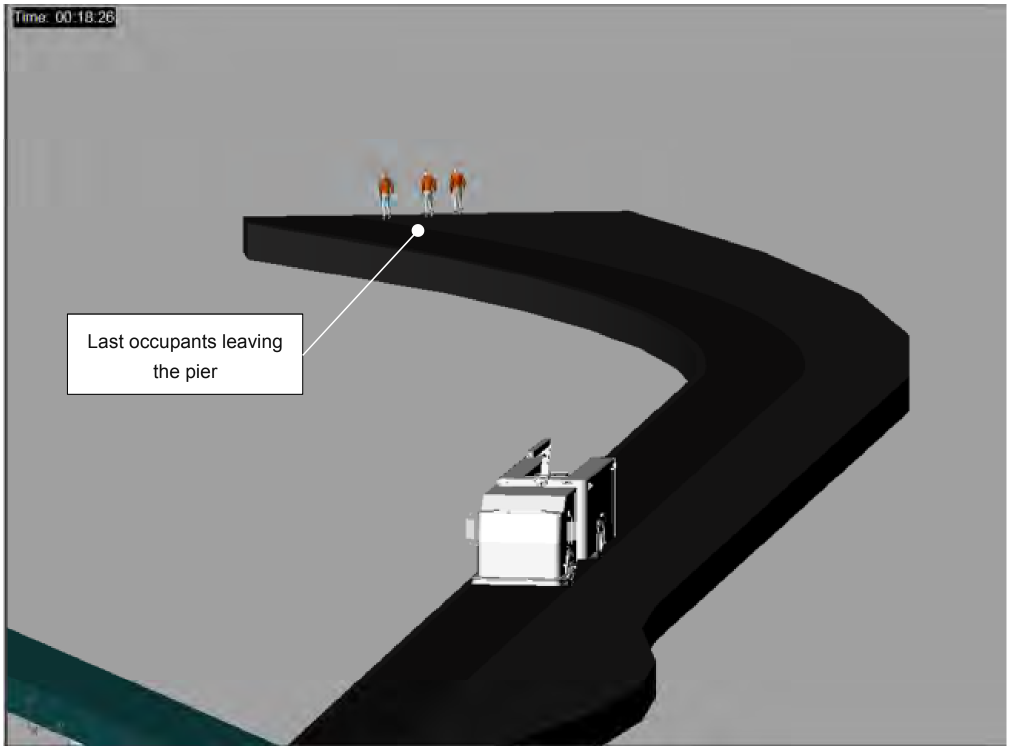


Figure 33 – Pier evacuation complete after 18m 26s

Comparing the results of Scenario 1 (full pier evacuation with no obstruction) with Scenario 3 (full pier evacuation with a vehicular obstruction) demonstrates an additional 5 minutes 12 seconds of egress time are required when an obstruction exists on Overwater Drive.

In summary, the performance based design results are given below:

	Scenario 1	Scenario 2	Scenario 3
'Safe Area' Egress Time	N/A	2m 25s	2m 25s
Total Egress Time	13m 14s	13m 14s	18m 26s

Table 5 – Summary of results from the performance based design scenarios

10 Fire Department Access

To enable effective fire-fighting operations on the pier, access for fire appliances will be made along Overwater Drive all the way to the end of the Promontory where a vehicle 'turning circle' will be provided – as indicated below:

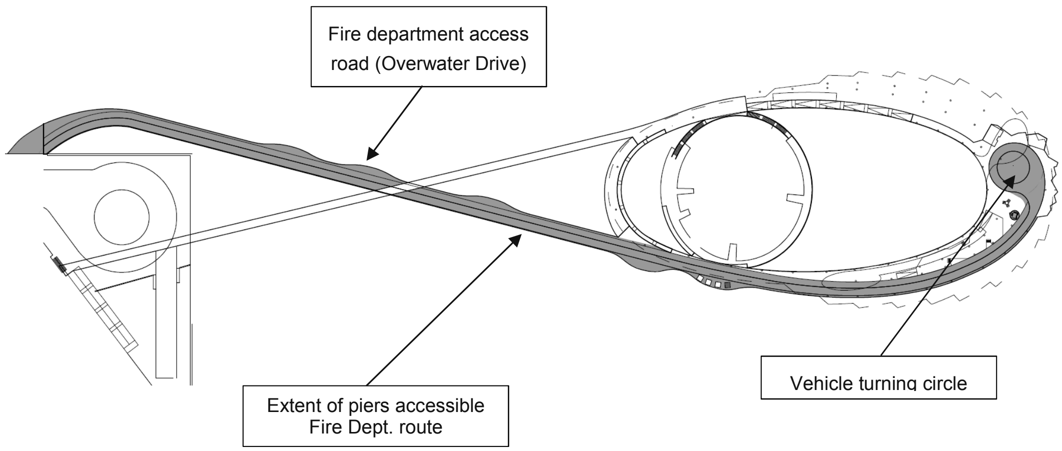


Figure 34 – Fire department vehicle access and turning circle

As the pier is part of a fire apparatus access road, it will be constructed and maintained in accordance with AASHTO regulations and designed for the imposed loads created by a fire appliance of up to 50,000 lbs.

Given the close interaction of vehicles and occupants in this scenario, an emergency management procedure will be created to enable the safe use of Overwater Drive for both vehicles and occupants in an emergency situation.

10.1 Fire Department Arrival Time

Per a request from the St. Petersburg Fire Department, an estimation of the time taken to reach the end of the pier with a vehicle to fight a fire, attend a medical emergency or other similar incident has been calculated taking into consideration how the moving vehicle would interact with a crowd of occupants leaving the pier, and what kind of arrival time might be expected if attending an event with the maximum pier occupancy.

The average response time for fire department vehicle(s) in St. Petersburg has been stated as approximately 4 minutes 30 seconds. if it is assumed that the evacuation of the pier starts at the same time the alarm signal is raised to the fire department, the pier would experience 4 minutes 30 seconds of *obstruction-free* egress before Fire Department vehicle(s) begin to arrive.

To account for this, the egress model has been used to determine how many occupants would be off the pier structure during this first 4m 30s period, and at what point along the pier the crowds would be after such a time.

LIFE SAFETY REPORT
(continued)

Buro Happold

Figure 35, below, is taken from the Scenario 1 'base case' egress simulation, showing the egress results 270 seconds (4m 30s) into the simulation:

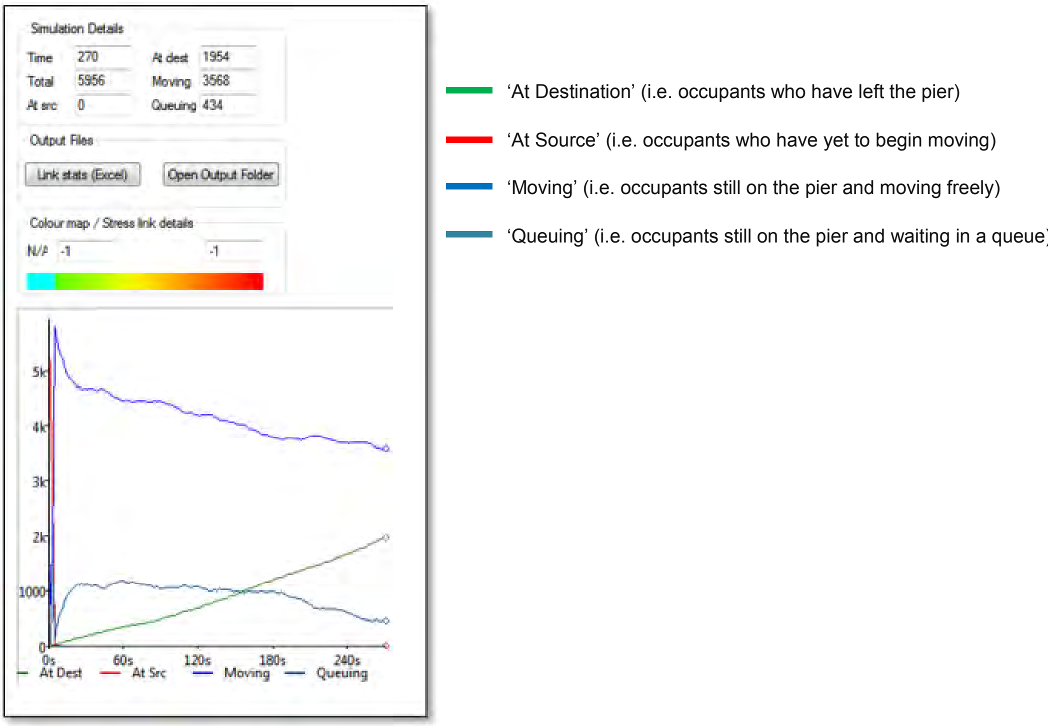


Figure 35 – Egress model results after 4m 30s

The egress model results show that after 4m 30s, 1,954 occupants have reached their destination (i.e. have completed their evacuation and are off the pier) and therefore 4,000 occupants remain on the pier.

The screenshot of the model below in Figure 36 shows that after 4m 30s, the 4,000 people remaining on the pier have cleared the zone at the far end and are approximately level with the Floating Dock area:

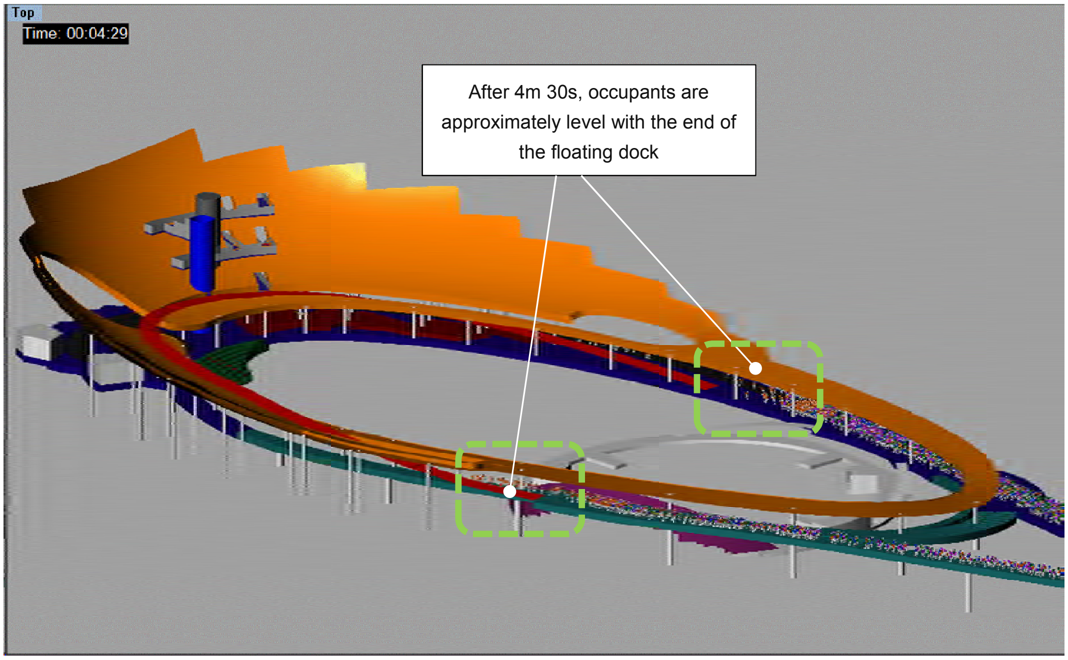


Figure 36 – Location of occupants 4m 30s into the egress simulation

After 4m 30s, the remaining 4,000 occupants on the pier are located within the first 1,145ft of Overwater Drive as indicated in Figure 37 below. Fire department vehicle(s) would therefore have to negotiate 1,145ft *worth* of crowd, before traveling the remaining distance to the end of the pier (480ft) in a crowd free environment (which would allow an increased drive speed).

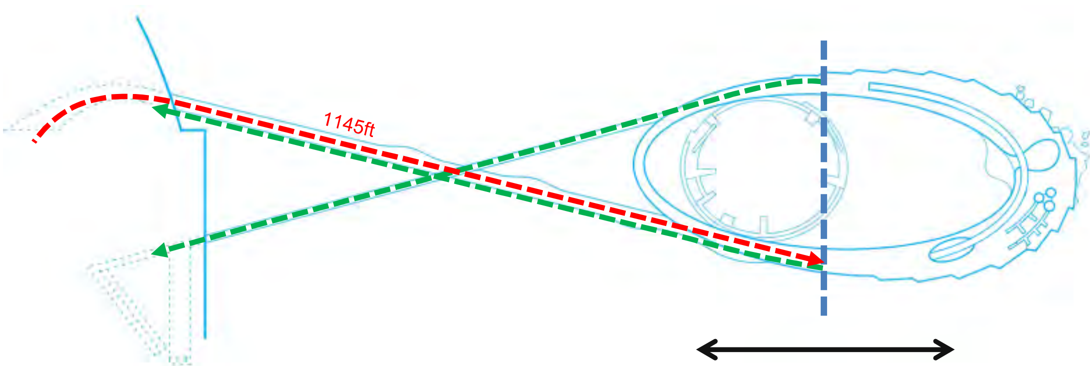


Figure 37 – Location of occupants 4m 30s into the simulation

LIFE SAFETY REPORT
(continued)

Based on the assumption that a vehicle can only travel at walking speed through the crowd (with walking speed taken as 4ft/second), the 1145ft long crowd would take 286 seconds (4m 46s) to navigate through with a vehicle*.

* This calculation discounts the fact that the 1145ft of crowd would be constantly shortening relative to the length of the pier over this time period as more occupants left the pier.

The remaining 480ft would be able to be negotiated at a faster speed (assumed to be a driving speed on the pier of 5mph – 7.3ft/s). The remainder of the pier would therefore take 66 seconds (1m 06s) to cover

Combining these three aspects of vehicle travel, the total time to reach the end of the pier would be:

- 4m 30s arrival time +
- 4m 46s drive time through crowd +
- 1m 06 s unhindered vehicle travel to end of pier
- **Total = 10m 22s**

11 Fire Protection Systems

11.1 Existing Fire-Fighting Water Service & Hydrants

The existing pier is served by a 6" diameter potable water supply which is an extension of the municipal water main serving 2nd Ave North. Amongst other non-emergency water services (domestic water etc.), this water main supplies the two fire hydrants located on the pier as indicated below;

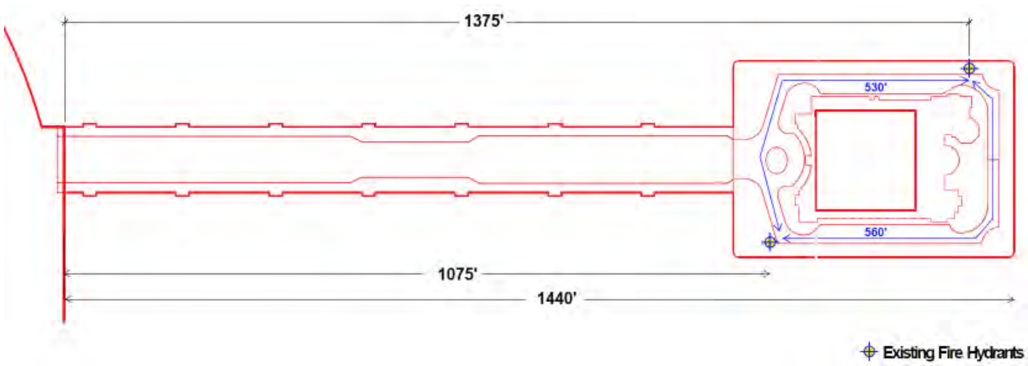


Figure 38 – Existing fire hydrant locations on the pier

11.2 New Fire-Fighting Water Service & Hydrants

As the new pier is only partially trafficable to Fire Department vehicles, the pier will contain both floor mounted fire hydrants and a Class I Standpipe system for fire-fighting purposes. This is indicated in the diagrams below (overview + detailed view);

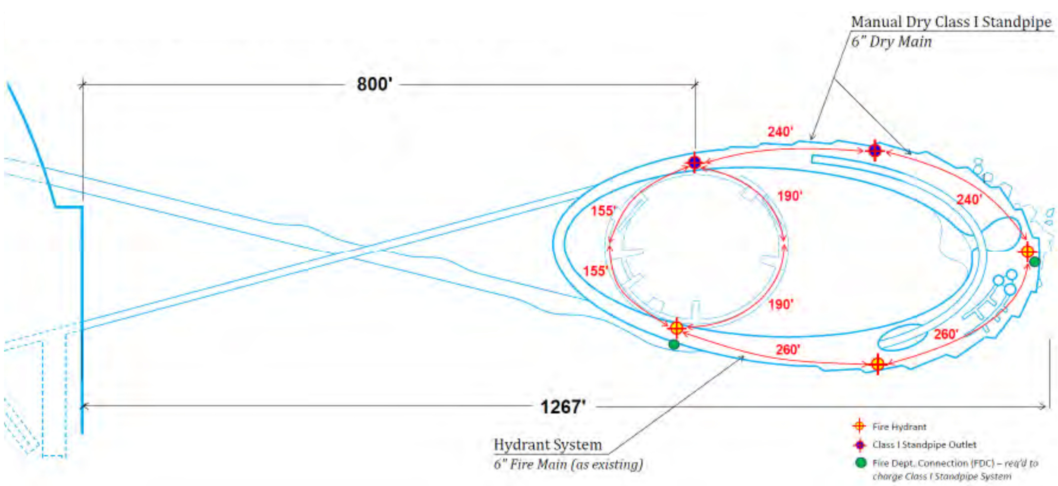


Figure 39 – New fire-fighting provisions on the pier (overview)

LIFE SAFETY REPORT
(continued)

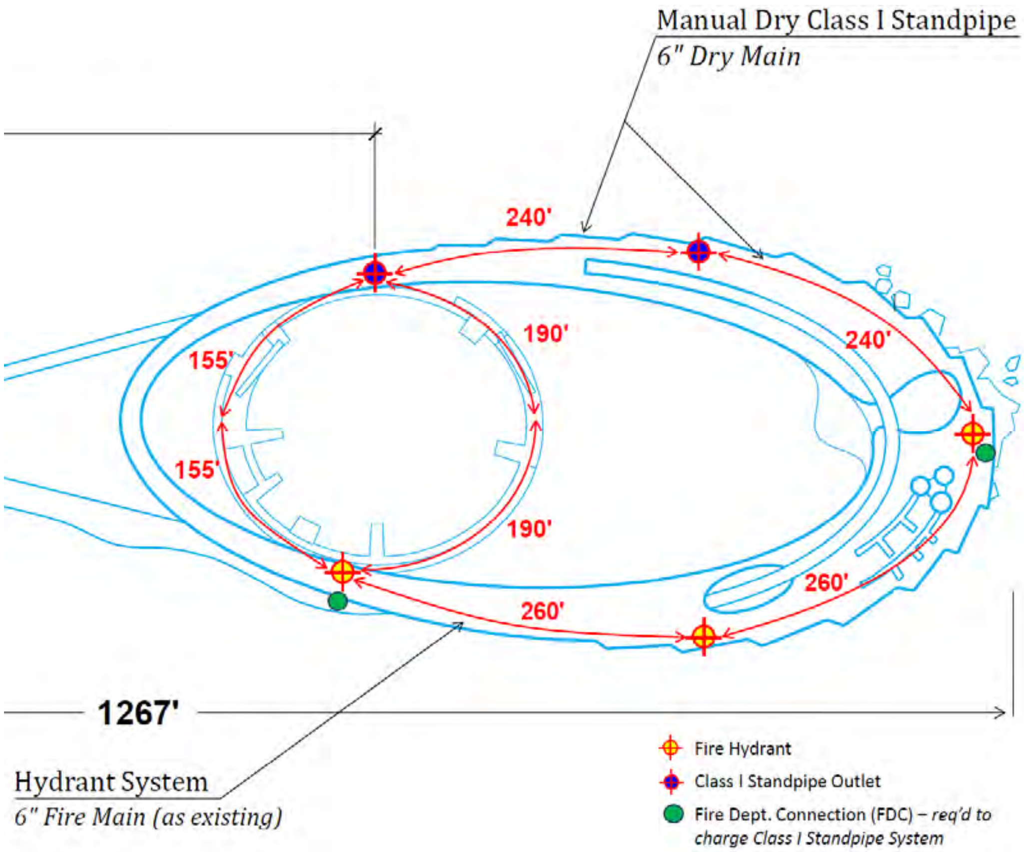


Figure 40 – New fire-fighting provisions on the pier (detailed view)

Similar to the existing pier, fire-fighting water supplies will only be provided to the east end of the pier and not the approach elements of Overwater Drive & Bridge

A fully charged municipal street hydrant system will be provided to areas of the pier which are trafficable to Fire Department vehicles eg. Overwater Drive to the Promontory turning circle. In areas of the pier where Fire Department vehicles are unable to drive, a Class I manual standpipe system will be provided. All systems will contain anti-corrosion fittings as required. The Class I manual dry standpipe will be charged from the adjacent hydrant system and therefore Fire Department Connections (FDC's) to enable this will be provided adjacent to the hydrant to the south of the floating dock/marina as well as next to the final hydrant on the system at the end of the Promontory (see diagrams above). The provision of two FDC's allows the dry standpipe system to be charged in both a clockwise and anti-clockwise direction.

In all instances, all areas of the piers 'head' will be within 150ft of either a fire hydrant or a 2.5" standpipe outlet (see Figures above)

11.3 Sprinkler System

All enclosed buildings on the pier will be sprinkler protected with the exception of any electrical rooms. Sprinklers will be designed based on the occupancy hazard of the design areas. All pipe sizes will be based on hydraulic calculations.

11.4 Portable Fire Extinguishers

In accordance with NFPA 303 [6.2], portable fire extinguishers will be provided along portions of the pier where boats/vessels could be moored (ie. the floating dock/marina) such that the maximum travel distance to an extinguisher does not exceed 75ft. In other areas of the 'head' of the pier, fire extinguishers will be provided near each hydrant/standpipe outlet such that the maximum travel distance to an extinguisher does not exceed 150ft. Hoseracks, hosereels or standpipe cabinets will not be provided.

11.5 Fire Warning Systems

As an exterior space, there is no ability to provide automatic fire detection on the pier. However, as each enclosed unit (concession store, gelato/bait shop etc.) are provided with sprinklers, the activation of any such sprinklers will create an evacuation condition on the pier – following an appropriate 'investigation' period by the piers security/management team. It is accepted that the primary form of summoning the Fire Department will be by people witnessing an incident calling them on cell phones. No 'Fire Telephones' or manual pull stations will be provided on the pier.

The pier will be provided with a public address system for occupant notification/warning for any type of emergency situation (fire/storm/security incident etc.). The public address system will have the ability to give both pre-recorded messages (in multiple languages if necessary) as well as 'live' directives for the police/Fire Dept. Such live messages will be broadcast from an off pier location such as the management/control office.

11.6 Egress Illumination

While illumination of the piers means of egress is not required by the FBC for open structures [1006.1, Exception 3], it has been decided that to increase the level of safety on the pier, above that required by code, a degree of egress illumination will be provided to all occupied areas of the pier to allow safe egress during in a nigh-time power failure.

All walking surfaces of the pier (inc. ramps & steps) will be provided with egress illumination that is at least an average of 1 footcandle (10 lux) and a minimum at any point of 0.1 footcandle (1 lux) measured along the path of egress at floor level. Illumination levels shall be permitted to decline to 0.6 footcandle (6 lux) average and a minimum at any point of 0.06 footcandle (0.6 lux) at the end of the emergency lighting time duration. A maximum-to-minimum illumination uniformity ratio of 40:1 shall not be exceeded. The required illumination shall be arranged so that the failure of any single lighting fixture will not result in an illumination level in any designated area of less than 0.2 footcandle (2 lux).

The emergency lighting system will be arranged to provide the required illumination automatically in the event of any interruption of the piers normal lighting. Where the maintenance of illumination requires changing from one power source to another, the maximum switch-over time will be 10 seconds and the total (minimum) time for emergency illumination will be 1.5hrs.

Note: Given the simply nature of the pier and the egress routes available to occupants, no EXIT signage is considered necessary on the pier as the egress routes provided are considered obvious for the occupants.

LIFE SAFETY REPORT
(continued)

Appendix A – Meeting Minutes

Summary of Meeting at St. Petersburg Fire and Rescue

Date: 8/8/2012
Time: 9:00 AM – 10:30 AM

Attendees:
Terry Barber: Deputy Fire Marshall
Phil Guglietti: Senior Plans Examiner Fire & Rescue
Rick Dunn: Building Official
Don Tyre: Senior Building Plans Examiner
Raul Quintana: Architect, City of St. Pete
Chris Ballestra: Director, Downtown Enterprise Facilities, City of St. Pete
Lisa Wannemacher: Principal, Wannemacher Jensen Architects, Inc.
Chris Dunn: Architect, Wannemacher Jensen Architects, Inc.

Points of discussion:

- The Pier is a structure and the City will classify it as an assembly building – it will not be classified as an Outdoor Recreation area.
- Concern is for worst case scenarios – 4th of July, New Years Eve, Concerts, etc.
- Occupancy Classification: Assembly – Open Air Stadium.
- All structural components will be non-combustible.
- Occupant Load: 7 sf per person, net area, 5 sf per person, net area (worst case)
- Subsequent to the meeting, Don Tyre called and indicated that a more realistic Occupant Load would be 15 sf per person net for most of the boardwalk areas and 7 sf per person net at the break-out balconies, promontory and any other high assembly spaces.
- Areas within net assembly area: Areas open to the public including; pedestrian walkways, viewing platforms, promontory, marina walkways, etc.
- Areas not within net assembly area: Vehicle access ways (TBD if this is allowable), stairways, rest rooms, planters, and areas not open to the public (marina office, beer garden office/prep, etc.)
- Because the design is not yet complete, it is acceptable to utilize a percentage of non-occupiable space to determine that net area.
- The prescriptive method for determining required egress width – requires .2 inches of exit width per occupant. Because the structure is essentially open – the performance method will allow us to use .06 inches per person. Our design currently provides a total of 36 feet or 432 inches of exit width which would allow for a maximum occupant load of 7,200 persons.
- Vehicle access way along the 24ft wide overwater drive will accommodate only the Public Tram, Service Vehicles and Emergency Vehicles.
- Methods of separating vehicle access ways from pedestrian areas: surface markings, change in surface materials, physical barriers (permanent and/or removable) – do not use curbs that would cause a tripping hazard.

LIFE SAFETY REPORT
(continued)

Summary of Meeting at St. Petersburg Fire and Rescue
St. Petersburg Pier

- During special events, it is important to keep the vehicle lane clear and open for the Tram and also for emergency vehicles.
- Consider installing permanent sleeves down the center of the drive that would receive bollards to help control access ways during major events.
- Controlling access during special events may allow us to take the vehicle access way areas (12 ft x 1,690 ft = 20,280 sf) out of the occupant load calculation.
- Break-Out Balconies along the bridges will provide “areas of refuge” where persons can get out of the way of moving pedestrians and the public tram.
- Egress and evacuation requirements: Performance based determination rather than prescriptive.
- Performance based method of determining requirements: Computer models.
- Acceptable computer model: “Stranded Crowd Model”
- Computer Model Input Data: Occupant Load, total egress width, travel distance to exit, demographics, etc.
- Performance data obtained from Computer Model: Evacuation flow rates, total evacuation time, etc.
- Fire Code Prescriptive Evacuation Time: 11 minutes.
- Prescriptive Fire Department Apparatus Requirements: Access way; width (20 feet), turn around area, load bearing capacity (Fire Truck Weight), vertical clearance (13’-6”)
- Fire Chief Jim Large will determine the final Performance based Fire Apparatus Requirements.
- The City’s ladder truck weighs 75,000 lbs.
- The City’s smaller fire fighting vehicle is between 42,000 and 49,000 lbs.
- The City does not currently own a fire fighting water vessel – the City of Tampa’s cost $2.5 million.
- Fire Protection (Sprinklers) required at enclosed portions of Marina: Bait Shop, Boat Rental Kiosk, and at enclosed areas of the Promontory: Gelato Stand, Rest Rooms, etc.
- Grill at the Promontory will require a Fire Suppression Hood.
- Fire line standpipes are required along the Pier.
- Elevated Viewing Platform requirements: Elevator, egress stair(s), (2) means of egress.
- Elevator may require generator if sufficient accessible egress is not provided.
- If a ramp(s) can connect to the upper viewing platform, it will lessen the need for a ladder truck at the Promontory – the lower the height of the viewing platform, the better.
- All pedestrian circulation ramps must be accessible, however, ease of use will be a consideration. 2% slopes are preferable to 5% slopes.
- Handrails – load can be rated for pedestrians, not vehicles
- Handrails – nothing in the code prohibits horizontal elements – however, risk management may be an issue.
- The Pier will close during predicted Storm Emergencies.
- Spontaneous storm emergencies will also occur – closure will be difficult.
- Risk Category: II or III (still to be determined) – however, Risk Category II seems to be acceptable for the bridge structure, provided it meet the lateral wind loads prescribed by the State code adopted in March of 2012.

Summary of Meeting at St. Petersburg Fire and Rescue
St. Petersburg Pier

- Elevation of Structure above High Water Line (Storm) – bottom of pile cap versus bottom of box beam.
- If the pile cap is designed in such a way that it is not defined as a "horizontal member" it may be acceptable to utilize the bottom of the box beam as the lowest horizontal member.
- Consider that the piles and pile caps are sub-structure and the box beams and decking compose the super-structure.
- A follow up meeting with this group will be scheduled well before the completion of the Basis of Design.
- A follow up meeting is also necessary with Fire Chief Jim Large, Terry Barber and Bob Bassett to confirm fire fighting apparatus requirements.

LIFE SAFETY REPORT
(continued)

Meeting Minutes (Rev 01)

Buro Happold

project	**The New St. Petersburg Pier**
subject	Conceptual Fire Safety Strategy Presentation
date	26 September 2012
time	10am – 12pm
place	St. Petersburg City Council Offices
present	Chris Ballestra – St. Petersburg, City Development Administration J. Raul Quintana - St. Petersburg, Engineering & Capital Improvements Bryan Eichler – St. Petersburg, Engineering & Capital Improvements Donald L Tyre – St. Petersburg, Construction Services and Permitting (DT) Rick Dunn - St. Petersburg, Construction Services and Permitting Robert Bassett – St. Petersburg, Fire & Rescue (RB) Phil Guglietti - St. Petersburg, Fire & Rescue Tom Gibson – St. Petersburg Engineering (TG) Mike Conners – St. Petersburg Engineering Lisa Wannemacher – Wannemacher Jensen Architects Inc. (LW) Carl Keogh – Buro Happold (CK)
distribution	Above + St. Petersburg Pier Design Team

The following meeting minutes represent the items discussed by the team above as a consequence of the fire strategy presentation given by Buro Happold. For all items within the presentation not mentioned below, the team made no comment and it is assumed that these represent an acceptable concept to pursue as part of the piers developing design criteria.

Item		Action
1.0	The proposal for a dry pipe standpipe system for the pier was queried by RB. He expressed concern that as a consequence of the length of the system (and the pressure losses this creates) it may take an extended period of time to charge the fire main and that the pressure achieved at the most remote outlets may be insufficient for fire-fighting. Of particular concern was the pressure & flow achievable at the outlets within the direct vicinity of the marina. RB stated that boat fires are not an uncommon occurrence and require the use of foam for effective fire-fighting which requires a specific minimum flow and pressure to be provided (RB to provide data for this). CK accepted RB's concerns and stated that the team would examine the issues to establish the viability of the dry standpipe system. If sufficient flow and pressure was not achievable then an extension to the existing municipal hydrant system running out to the pier down 2nd Ave would be considered. In such an instance a hydrant within close proximity of the marina would be advantageous.	RB & Buro Happold
2.0	RB stated that while they have a fire boat, it was not capable of fire-fighting and should not be considered as part of the piers fire strategy.	Note
3.0	RB & DT accepted that code did not require sprinkler protection for the buildings on the pier under 500ft^2. They did however request that the team consider sprinkler protection to all enclosed buildings (irrespective of their size) as a consequence of vehicular access being limited to selected Fire Dept. appliances. An NFPA compliant sprinkler system, fed from the pier's domestic water supply system, would be considered acceptable to the Fire Dept./City.	Buro Happold
4.0	Fire vehicle access along the pier was discussed and RB accepted that vehicles opposing the flow of evacuees would occur in an emergency situation. In instances when the maximum occupancy were present (NYE/4 July etc.) it was accepted that specific event management would be employed (to a greater extent than in normal day operation) and that the team would engage the Cities Risk Management Department to progress these discussions that will feed into the piers overall management strategy. Tom Gibson to contact Risk Management.	Design Team & TG
5.0	As part of the pier's egress analysis, a 'time line' establishing the pre-determined attendance times of the Fire Depts. response would be included. RB stated that the Dept. can provide all information required by CK in order to complete this portion of the analysis.	RB & Buro Happold

6.0	RB initially expressed concern regarding the elevated platforms at the end of the promontory and stated that elevated hose-streams and/or rescue may be required in this location. LW explained that the piers canopy would block any ladder access to the elevated platforms from the pier deck and that all platforms were provided with both an access stair and accessible ramp. RB accepted that as a consequence of this, ladder access to these platforms (for either rescue or fire-fighting) seemed unnecessary. For information purposes, LW to provide RB with section through pier indicating indicative heights of observation platforms.	Design Team
7.0	RB stated that the minimum Fire Dept. vehicle attendance at any incident on the pier would be 2 large appliances and 1 or 2 smaller accessory vehicles (although anything up to a maximum of 7 appliances may be deployed). The largest of these appliances would be a maximum of 47,000Ibs with a 55ft reach ladder. The current 50,000Ib weight limit design was therefore seen as acceptable to the Fire Dept.	Note
8.0	DT queried if the egress analysis would also examine the time taken for an EMS vehicle to attend to a non-fire incident on the pier (eg. somebody suffering a heart attack etc.) during maximum pier occupation. CK stated that this was not currently being specifically assessed however the final results of the egress model could give a 'sense' of what this time might be. It was however concluded that such instances require to be addressed as part of the piers overall management strategy and that this discussion will be initiated at the appropriate time with City Risk Management.	Design Team
9.0	Summary of Next Steps • Completion the Action Items • Production of Fire Safety Design Criteria • Follow-up presentations of interim and final modeling results **POST MEETING NOTE** The exit capacity provisions noted within the presentation for smoke protected assembly seating (0.1" per person) can be modified to 0.06" per person (FBC – 1028.6.3) for 'outdoor' smoke protected assembly seating. This approach increases the exit capacity provided and is to be adopted within the subsequent egress analysis.	

The minutes detailed herein reflect Buro Happold's recollection of the discussions held during the meeting detailed above. If you feel that these minutes are inaccurate; proposed additions, corrections and/or comments must be submitted to Buro Happold in writing within five working days of the date of these minutes. If no written responses are received within this period, these minutes will be deemed the official record of the meeting.

LIFE SAFETY REPORT
(continued)

Meeting Minutes/Notes

project	**The New St. Petersburg Pier**
subject	Fire & Life Safety Design – Meeting #2
date	10 January 2013
time	1.30pm – 3.30pm
place	St. Petersburg City Council Offices
present	Chris Ballestra – CoSP J. Raul Quintana - CoSP Donald Tyre – CoSP Rick Dunn – CoSP Rick Herrmann – CoSP Mike Ryle - CoSP Mike Domante - St. Petersburg, Fire & Rescue, Fire Chief Robert Bassett – St. Petersburg, Fire & Rescue, Assistant Fire Chief: Operations Phil Guglietti - St. Petersburg, Fire & Rescue Tom Gibson – CoSP Lisa Wannemacher – WJA Carl Keogh – BH
distribution	Above + St. Petersburg Pier Design Team

Buro Happold

Item		Action
1.0	The Design Team provided an introduction to the project, and an overview of its components, for those new to the team and not fully familiar with the design.	
2.0	Buro Happold gave a brief overview of the previously presented conceptual fire strategy work (from 26 September 2012) highlighting where developments/refinements within the design had occurred since the September 2012 presentation. The key changes are discussed below.	
3.0	The reduction in length, and overall square footage, of the pier were presented and it was explained that this resulted in a reduction in overall occupancy of the pier which was seen as a positive from a safety perspective.	
4.0	The reduction in width of the Overwater Drive from 24ft to 20ft was discussed. While the Fire Dept. conceded they could operate their vehicles within such a reduced width there was concern that the remaining width for occupants to egress past an approaching fire truck has now been reduced by 4ft. They therefore reserved further comment on this item until they are able to review the results of the egress analysis. They Dept. did however state that the original 24ft width would be preferred by them.	
5.0	A proposed reduction in the height of the canopy (from 13'-6") was discussed. The Fire Dept. stated that 13'-6" represents the minimum height required by code and that, given it was not possible to pre-determine which type of fire appliance (or fire company) may attend an incident at any given time, they were reluctant to relax the height requirement as this gives them the flexibility to drive on the pier with a variety of appliance types. Mike Domante did however agree to take one more look at this issue to see if there was any flexibility in the 13'-6" figure. Note: It was stated by the Fire Dept. that for all EMS services (not just fire) a fire truck would be dispatched to the pier. The Fire Dept. appreciated that as an exterior structure the fire risk associated with the pier was fairly low and more of a concern to them, from a speed of availability of access point of view, was a medical emergency occurring at the end of the pier and that this scenario should be considered by the team when developing the design.	Fire Dept.
5.0	The vehicle turn around at the promontory was discussed and it was stated by the Fire Dept. that, as they had previously agreed that access to the pier by a ladder truck was not considered necessary, a turning circle less than 100ft in diameter would be acceptable – the final figure for this turn around was not however discussed further within the meeting and would be subject to a follow up call/discussion between the Fire Dept. and BH. It was additionally noted by the Fire Dept. that	BH

instead of a turning circle, a 'T' or 'Y' shaped turning road could instead be provided.

6.0 The Fire Dept. noted that when driving down the pier it might be necessary to drive off the concrete portion of Overwater Drive and onto the IPE timber deck portion to avoid people etc. They highlighted to the team that the IPE timber deck should ideally be rated to support the maximum agreed weight of a fire vehicle (23 tons) otherwise their trucks will split the timber decking when driving on to it.

7.0 The Building Dept. stated that the project would be given a plan tracking number so that reviews/comments from the City agencies could be recorded and tracked in a more formalized manner. When the Depts. 'E-Filing' service is up and running (planned to be 1st March) this plan number will be converted to an E filing number.

8.0 With the reintroduction of motorized boats into the marina, the Fire Dept. stated that they would require foam fire-fighting capability in this area. They stated that foam fire-fighting (for which they carry the appropriate equipment on all fire appliances) requires a specific pressure and flow from the available water supply. BH to contact Fire Dept., outside of meeting, in order to establish the required pressure and flow for foam fire-fighting. BH then to propose fire-fighting water strategy (either an extension of the 2nd Ave North Hydrants or a pressurized fire main) in order to achieve these requirements. The Fire Dept. stated that provided they could reach all parts of the floating marina portion of the pier, within 150ft of a hydrant/standpipe outlet on the fixed portion of the pier, then the hydrant/standpipe system did not need to extend onto the floating marina. BH

9.0 Schedule within the team was discussed and the following was tentatively agreed;

The minutes detailed herein reflect Buro Happold's recollection of the discussions held during the meeting detailed above. If you feel that these minutes are inaccurate; proposed additions, corrections and/or comments must be submitted to Buro Happold in writing within five working days of the date of these minutes. If no written responses are received within this period, these minutes will be deemed the official record of the meeting.

LIFE SAFETY REPORT
(continued)

Wannemacher Jensen Architects, Inc.

The St. Petersburg Pier

PROJECT MEETING: Fire and Life Safety Meeting | LOCATION: City Conference room #600 | MEETING DATE: 03/27/2013

ATTEND	INITIALS	ATTENDEE	COMPANY NAME
N	RQ	Raul Quintana	City of St. Petersburg
Y	CB	Chris Ballestra	City of St. Petersburg
Y	PG	Phil Guglietti	City of St. Petersburg
Y	DT	Don Tyre	City of St. Petersburg
Y	TB	Terry Barber	City of St. Petersburg Fire Department
N	RD	Rick Dunn	City of St. Petersburg
Y	IM	Iain Macfarlane	Buro Happold (BH)
N	CK	Carl Keogh	Buro Happold
Y	LW	Lisa Wannemacher	Wannemacher Jensen Architects, Inc. (WJA)
Y	SW	Sean Williams	Wannemacher Jensen Architects, Inc.

These minutes reflect the meeting to the best of Wannemacher Jensen Architects knowledge. If there are any errors or omissions, please contact us in writing upon receipt. The minutes of the meeting are as follows:

ITEM	DESCRIPTION	STATUS	ACTION BY	DUE
<u>Topic: Intro</u>				
0327.01	CK introduced the process and egress information. There are 2 parts to the presentation; Egress Analysis and Fire Fighting Water			
<u>Topic: Egress Analysis</u>				
0327.02	CK stated there will be 5,954 people on the worst case scenario. CK explained the color coded diagram of the different type of occupancies that made up the total occupancy.			
0327.03	LW suggested the Overwater Bridge (OWB) would possible be 11’-0” to 12’-0” clear and the Overwater Drive (OWD) would be 21’-0” to 22’-0” clear. CK stated the increase in the width would add to the population but would benefit the scenario where there was an emergency vehicle obstruction on the bridge.			
0327.04	CK reviewed the 3 scenarios that BH modeled. Scenario 1 is a model showing how long it will take to egress the pier in a non-emergency event, ie. after the fireworks are over. Scenario 2 is a model showing a fire event at the Promontory and Scenario 3 is a model showing a fire event at the end of the pier with an emergency vehicle headed to the event on the OWD.			
0327.05	IM defined the occupant parameters for the pier which were taken from the latest census. The model assumes 28% male, 31% female, 19% elderly, 7% mobility challenged and 22% children. LW reviewed the changes to egress and accessibility at the observation platforms which allowed access to the bike ramp.			
0327.06	Scenario 1 showed the egress time for the west end of the pier connecting the OWB to the OWD would egress in 37 seconds; the marina would egress in 58 seconds; the viewing platforms would egress 1 minute 23 seconds; the bike path would egress in 2 minutes 35 seconds. The OWB and OWD would egress in a little more than 10 minutes. The OWD would egress at 11 minutes and 56 seconds and the OWB would be clear at 13 minutes 14 seconds.			
0327.07	Scenario 2: Vehicle fire (box truck approximately 10’ high by 24’ long), 15 MW fire, used NFPA 92 for the model parameters. The fire would be 1830 deg F. for the flame. IM stated that the comfortable zone would be at 115’-0”, this is where the heat is not too hot to harm bystanders. IM showed that the area at the end of the Promontory would be clear of 115’-0” at approximately 2 minutes and 25 seconds. This Scenario would clear the occupants at the same time as scenario 1.			

ITEM	DESCRIPTION	STATUS	ACTION BY	DUE
0327.08	Scenario 3: Same as scenario 2 but with an emergency vehicle working its way to the fire event at the Promontory. The vehicle was stationary in the model as the program is not designed for vehicle movement. This scenario clears at 18 minutes 26 second, a little more than 5 minutes over the other scenarios.			
0327.09	PG asked if the design team added in the time it took for the fire truck to get from the station to the pier. LW stated they reviewed that time with the fire marshal previously and it was approximately 4 minutes and 30 seconds to make the distance. IM stated that it would take 8 minutes and 30 seconds for the fire truck to get to the end of the promontory through the crowd that was clearing the pier. LW stated we will add it to our analysis. DT stated that people will probably remain on the pier to observe the fire.			
<u>Topic: Water design – Fire Hydrants</u>				
0327.10	CK reviewed the elements of the water for fire fighting and the past discussion of using a dry-pipe solution which would not be feasible as it took too long to charge.			
0327.11	BH proposed 5 fire hydrants. TB commented on the length of the closed loop to keep the main at 6" and suggested changing the 2 northern fire hydrants to standpipes.			
0327.12	CK stated there will be 3 fire hydrants with a flow rate at 1500gmp and they will be connected to a 6" main coming from the existing main at 2nd avenue north. PG stated the team should look at NFPA 303 in regards to the pier. There should be a hydrant and standpipe every 300'-0". PG stated that the design will require a RPZ if it is used for domestic water as well. LW confirmed that the domestic and other services. PG stated if the main is a dead-end system it will require an 8" pipe; 6" if it is a loop. LW proposed a portion of the system be dry-pipe at the Marina. This may be a challenge for maintenance and pressure in the system.			
0327.13	DT stated the presentation shown today could be sent to the fire chief and he can review it for any issues. DT asked the team to include a note on the Standard operating procedure for the pier on a full event. The A/E team will make the changes discussed today and email the revised presentation to WJA for a presentation to the Chief next week. DT requested a report with the life safety sheets with the recommendations to be submitted at the submission of the building permit for them and city engineering.			

PREPARED BY: Sean Williams |Wannemacher Jensen Architects, Inc.

STRUCTURAL SCHEMATIC REPORT

Buro Happold

ST. PETERSBURG PIER

Structural Schematic Report

Job no 030343

April 2013

Revision 00

Buro Happold

Revision	Description	Issued by	Date	Checked
00	Structural Schematic Report	SO	April 24, 2013	JPC

O:\030343 St Petersburg Pier (Support to BHNY #30734)\F4 Structures\03 Reports\St. Petersburg Pier Structural Schematic Design Report 00.docx

STRUCTURAL SCHEMATIC REPORT (continued)

Buro Happold

This report has been prepared for the sole benefit, use and information of Michael Maltzan Architecture for the purposes set out in the report or instructions commissioning it. The liability of Buro Happold (BH) in respect of the information contained in the report will not extend to any third party.

author	**Sean O'Neill**
signature	
date	**April 24, 2013**
approved	**Jean-Pierre Chakar**
signature	
date	**April 2, 2013**

Contents

STRUCTURAL SCHEMATIC REPORT (continued)

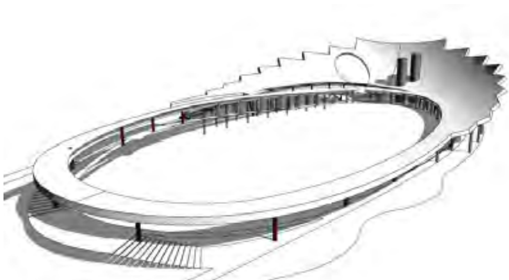
1 Executive Summary

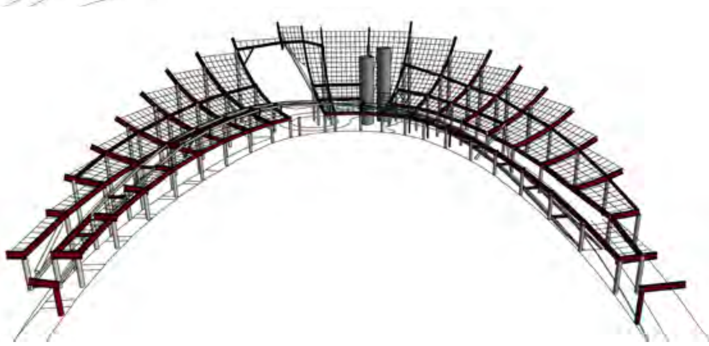
The St. Petersburg Pier is an oval shaped pedestrian/bicycle accessed structure jutting into the Gulf of Mexico from the coast of St. Petersburg, Florida. The superstructure consists of a steel-framed, doubly -curved system supported on vertical columns and kickers that is clad in aluminum to produce an aesthetically pleasing and durable canopy in a hurricane prone region. The superstructure is supported on pile caps near sea level.

The overall dimensions of the canopy site are approximately 650 ft x 310 ft and the total area of cladding is 146,920 sq. ft. A bicycle path from the mainland approaches the canopy from the west, wraps around the structure, and criss-crosses itself before returning to the shore. Pedestrians and service vehicles utilize a deck spanning between pile caps below the canopy.

Currently, the overall thickness of the shell build-up is limited to 54 in. for architectural reasons. This dimension will be revised as the design progresses.

A Structural Design Criteria listing all relevant codes and standards for the project can be found in Appendix A of this report. It covers both strength and servicability. Reaction forces from the pile caps due to each column and kicker for each load case are found in Appendix B. Appendices C and D contains the RWDI desk top studies of the the wind loading on structural components and components and cladding, respectively.





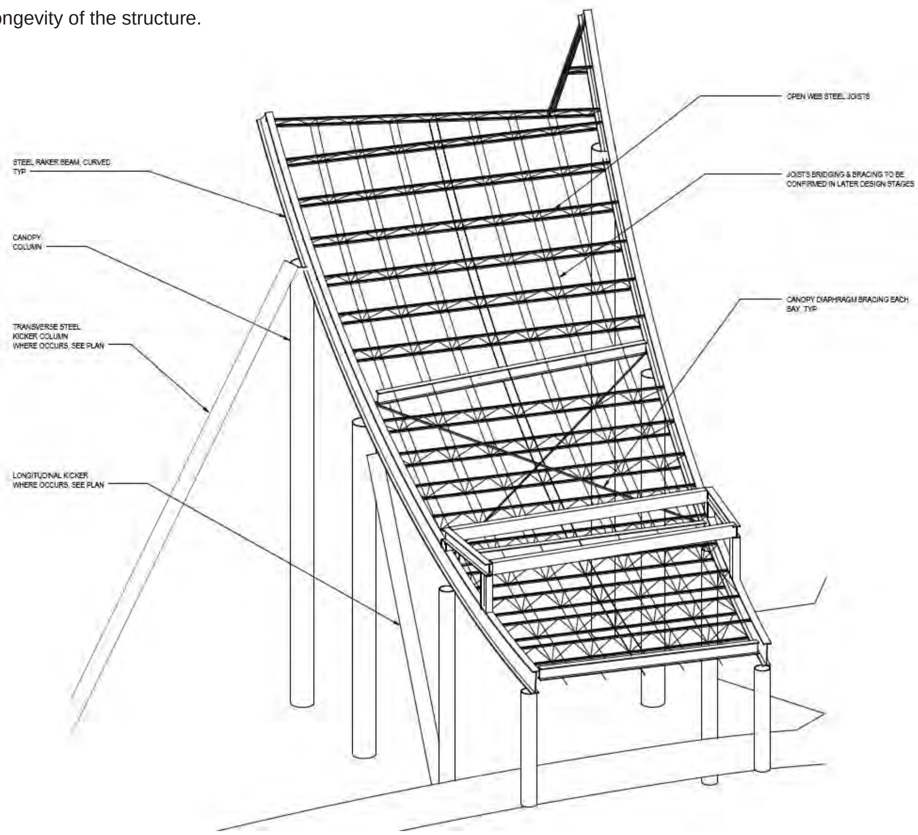
2 Structural Systems Description

2.1 General Overview

The St. Petersburg Pier canopy utilizes a radial pattern of rakers supported on lines of columns resisting gravity loads. Kickers are added intermittently (in both the longitudinal and transverse directions) to help resist the lateral loads on the structure. The canopy is supported on pile caps connected via a concrete deck for public access, referred to hereafter as the pier.

Regularly spaced open web steel joists act as secondary members spanning between raker beams to transfer loads to the rakers. All columns are moment connected at the tops, in the plane of the canopy, to W section drag members. Diaphragm bracing, X-bracing within the depth of the canopy, provides the rigidity required for the canopy to act as a single unit under all loads applied.

All exposed steel should be hot dip galvanized to a minimum thickness of 5 mils to minimize corrosion and maximize the longevity of the structure.



STRUCTURAL SCHEMATIC REPORT (continued)

2.2 Pier Structure

The pier structure will be constructed primarily of precast and cast in place reinforced concrete. Special marine-grade concrete will be used for all components to provide additional durability in the marine environment. The Over Water Drive and the Promontory will be supported principally by 18” x 18” square precast concrete piles with lengths estimate to be between 70’ and 100’. The tops of the pile groups will be tied together with precast or cast-in-place reinforced concrete pile caps. The Over Water Bridge will be supported by single 48’ steel caissons progressed and grouted into the bottom of the Bay. Precast or cast-in-place capitals will be placed upon each caisson.

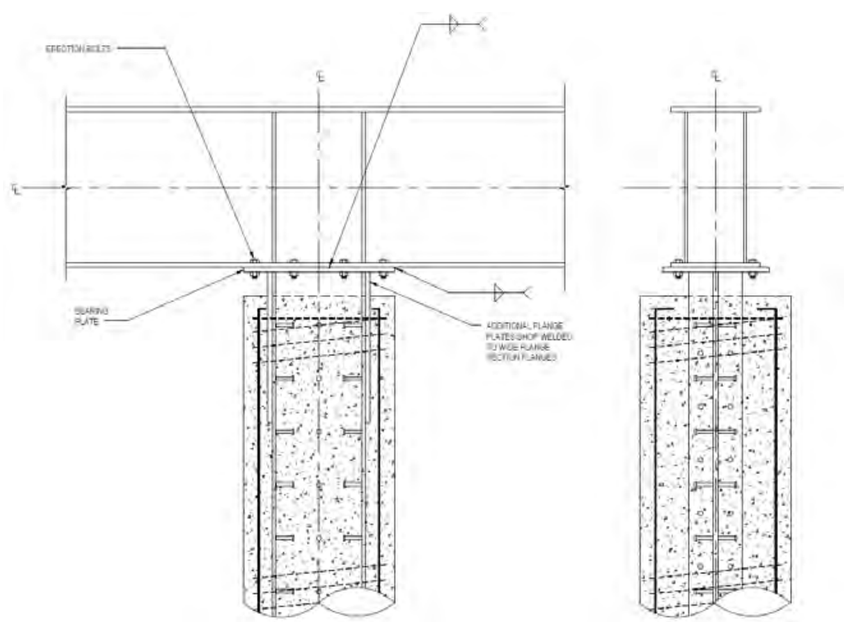
The pile caps and capitals will support the deck structure for the Overwater Bridge, Over Water Drive, and Promontory. Standard Florida DOT 36” deep Florida I-Beams (FIB-36) will span longitudinally between the pile and caisson bents. The FIB-36s will support an 8½” thick Florida DOT standard bridge deck. Utilities for the Pier will be hung from the deck.

At the locations of the existing caissons which support the existing Inverted Pyramid building, efforts will be made to reuse these caissons to support the deck and possibly the canopy.

2.3 Raker Beams

Rakers are composed of 36” deep built-up box girders curved to fit the profile of the canopy. They range between 15” and 30” in width. Currently, the maximum flange thickness assumed is 1”. The geometry of the canopy has been optimized so that the curvature of all the rakers corresponds to a single radius circular arc.

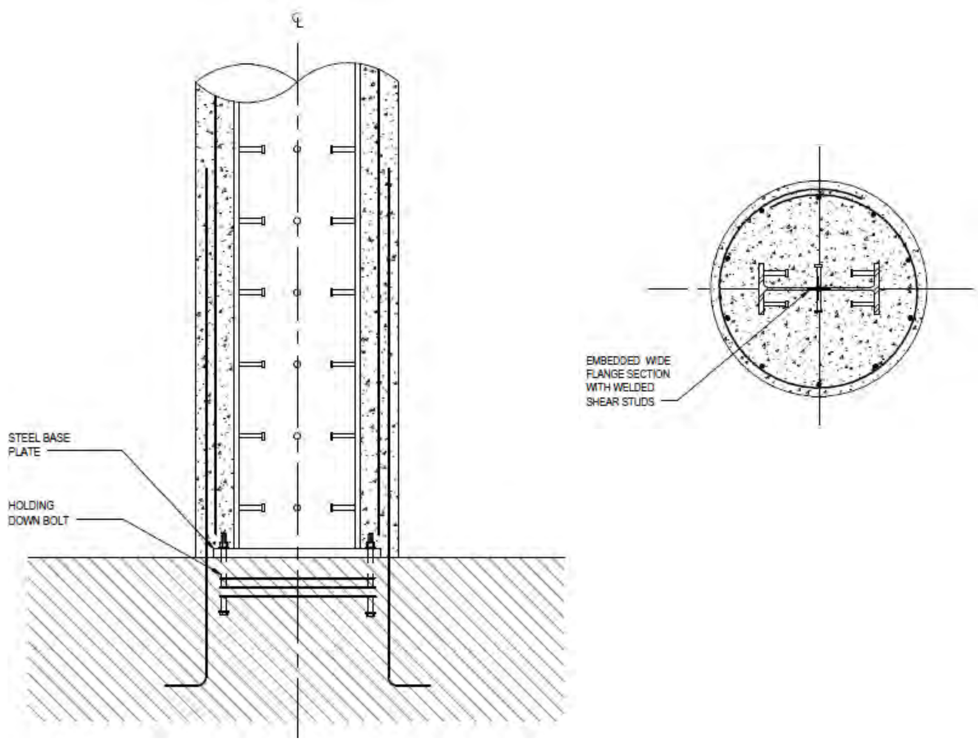
The lengths of the rakers range from 30’ to 125’. Where a splice is required for construction, a full moment splice shall be utilized.



2.4 Columns

Vertical columns are steel W sections encased in concrete. The concrete provides additional stiffness and capacity and increases the protection of the steel member. The assumed concrete strength is f'c = 5000 psi.

In order to create frame action and reduce the drift, it is anticipated that the connection between the columns and the raker beams will be a moment connection.



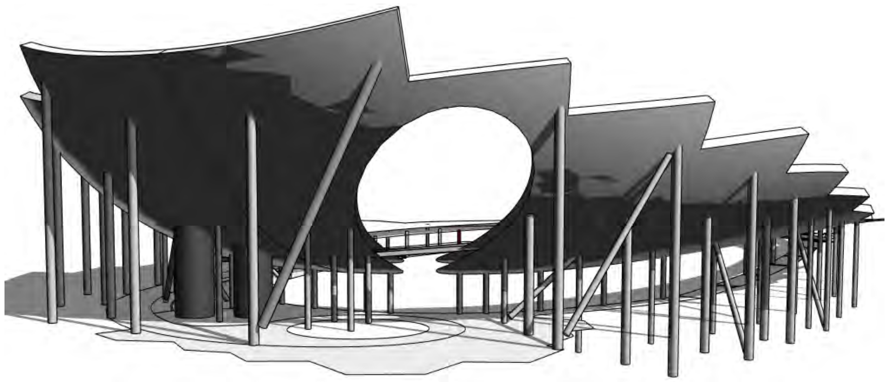
2.5 Kickers

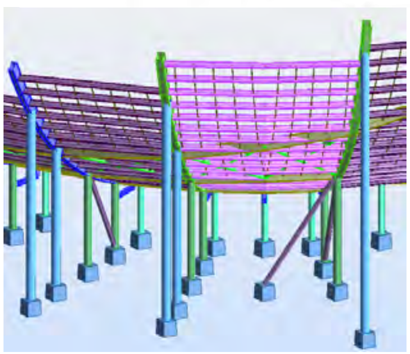
Slanted kickers are utilized to help with the global stability of the canopy. These kickers are assumed to be HSS sections as they need to resist compression and tension forces, depending on the wind load direction.

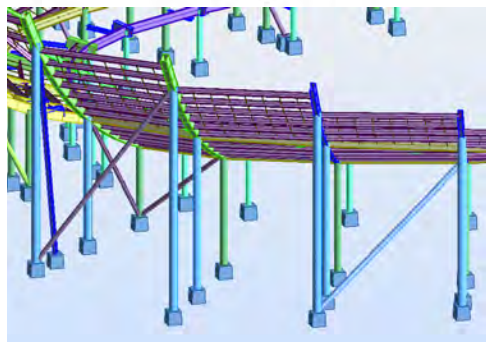
The lengths of the kickers range from 25' to 80'. They vary in depth from 14" to 20" with estimated wall thicknesses ranging from ½" to 1".

One unique long kicker (approximately 100' in length) is required to support the canopy near the large architectural opening on the east side. The diameter of this kicker is assumed to be 28".

STRUCTURAL SCHEMATIC REPORT (continued)

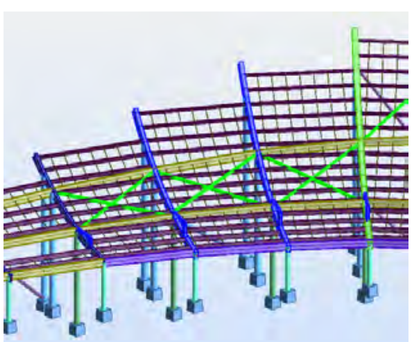


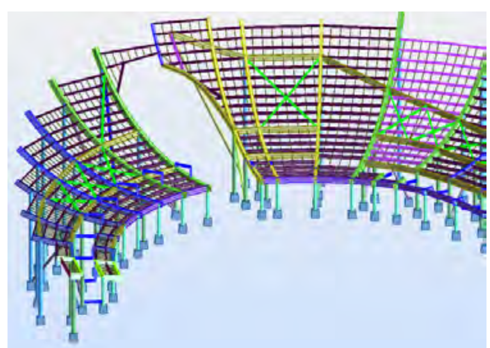




2.6 Diaphragm Bracing

In plane X-bracing within the structural depth of the canopy is required to provide diaphragm action and insure lateral stability of the column-raker beam-kicker system.



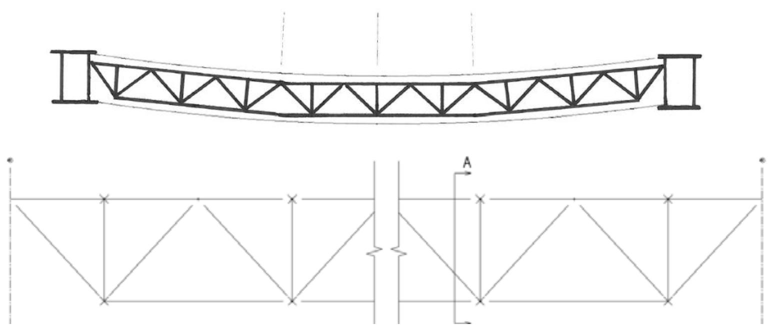


2.7 Secondary Members

Open web steel joists (LH type joists) spanning between raker beams spaced approximately 6' on center support the skin and transfer wind and gravity loads from the skin to the rakers. Truss depths range between 32" and 36". The spans vary between 25' and 50'. Only a handful of joists are expected to span more than 50'.

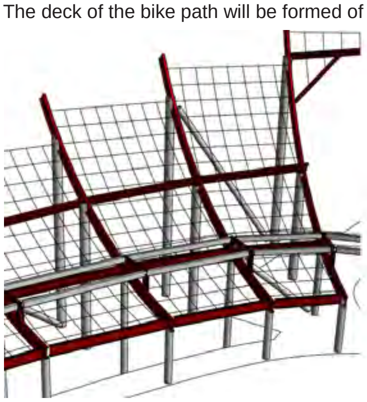
Bridging elements will be used to stabilize the trusses and reduce out of plane bending moments caused by the joist being placed perpendicular to the raker beam curvature.

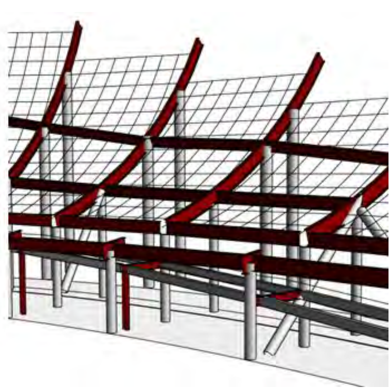
The geometry of the canopy has been rationalized so that only 25-30% of the joists are expected to be either curved or kinked.



2.8 Bike Path

The bike path is a 12' wide steel framed structure cutting through the canopy. The bike path will be supported at the raker locations. The bike path will be either suspended or posted from the canopy depending on whether it is running under or over the structure. The main structure of the bike path will be HSS stringers with in-plane bracing for stiffness. The deck of the bike path will be formed of concrete over metal deck.





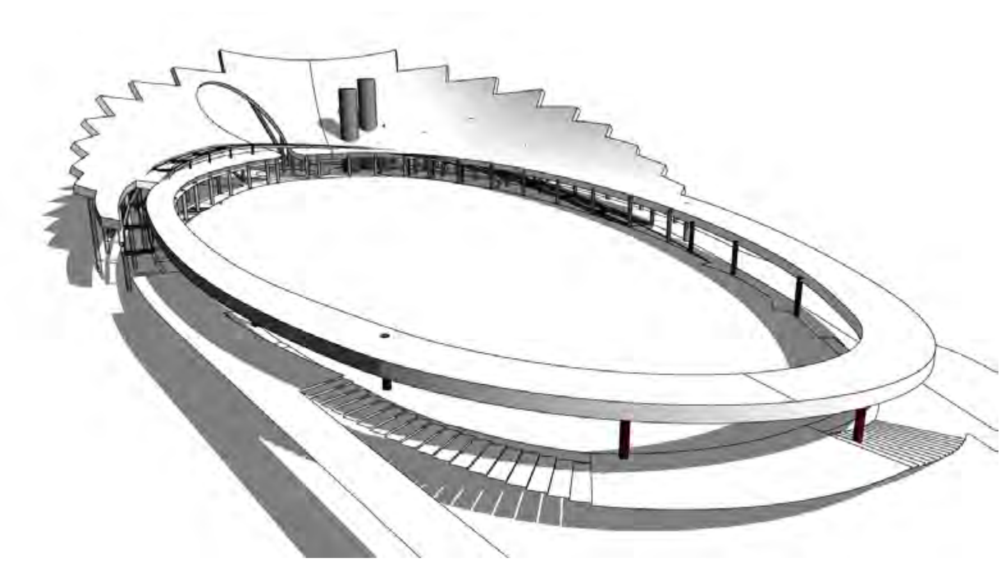
STRUCTURAL SCHEMATIC REPORT (continued)

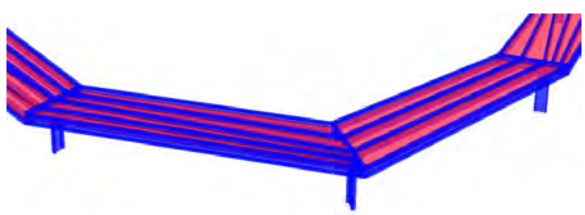
Buro Happold

2.9 West Structure T-Frames

The canopy on the west side of the structure is approximately 20' wide. Each bay is supported on a T-frame consisting of a steel column encased in concrete cantilevering from the deck that is moment connected to cantilevered W section beams.

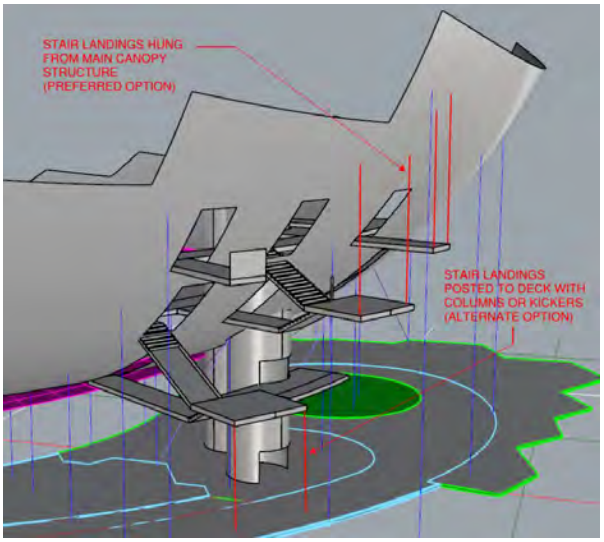
Secondary members span between T-frames to support the cladding. They will be W sections approximately 27" deep with bracing to increase out-of-plane stiffness.

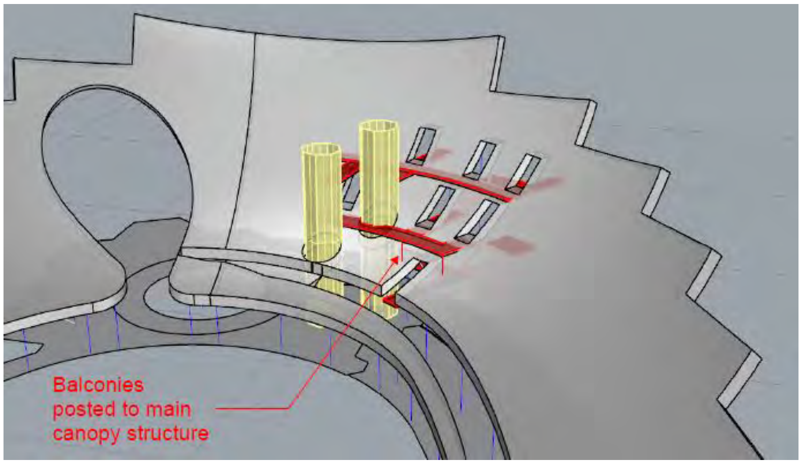




2.10 Stairs and Balconies

Pedestrians access balconies on the canopy via external stairs adjacent to the cores. Stair landings can be hung from rakers or secondary beams or supported by the deck via columns or kickers. Hanging is the preferred option. The balconies themselves will be framed out of steel and posted to the canopy structure.





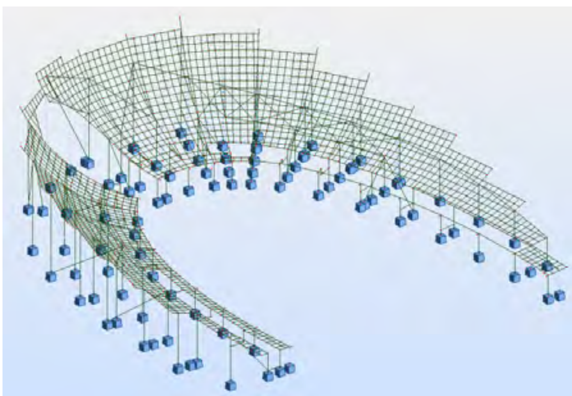
STRUCTURAL SCHEMATIC REPORT (continued)

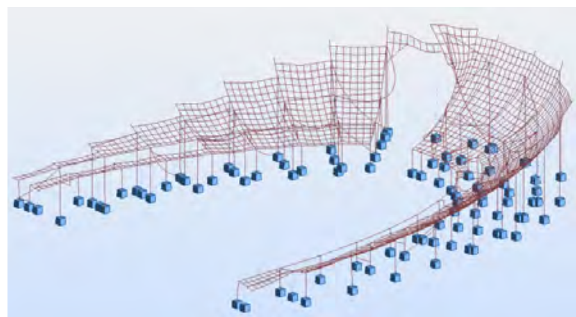
3 Lateral Performance

3.1 Analysis Model Description

Autodesk Robot Structural Analysis was used to analyze the canopy structure. Robot is a finite element software that is capable of linear and nonlinear analysis. Linear analysis and Allowable Stress Design were used for schematic design. A nonlinear analysis will be performed at a later design stage.

In addition to the self weight of the structure, a superimposed dead load of 22 psf for cladding/finishes and a roof live load of 12 psf were applied. Wind loads on the main structure were taken from the RWDI desktop study in Appendix C. A temperature differential of +20F/-45F was included. A total dead load of 20 psf and a live load of 90 psf were taken for the bike path.





3.2 Dynamic Behavior

The target for the dynamic performance of the canopy is to satisfy a minimum frequency above 1 Hz where there is at least 10% of the total mass of the structure participating in the given dynamic mode – the critical mode.

Periods and frequencies for the first three modes where there is at least a 10% mass contribution in the X direction are tabulated below.

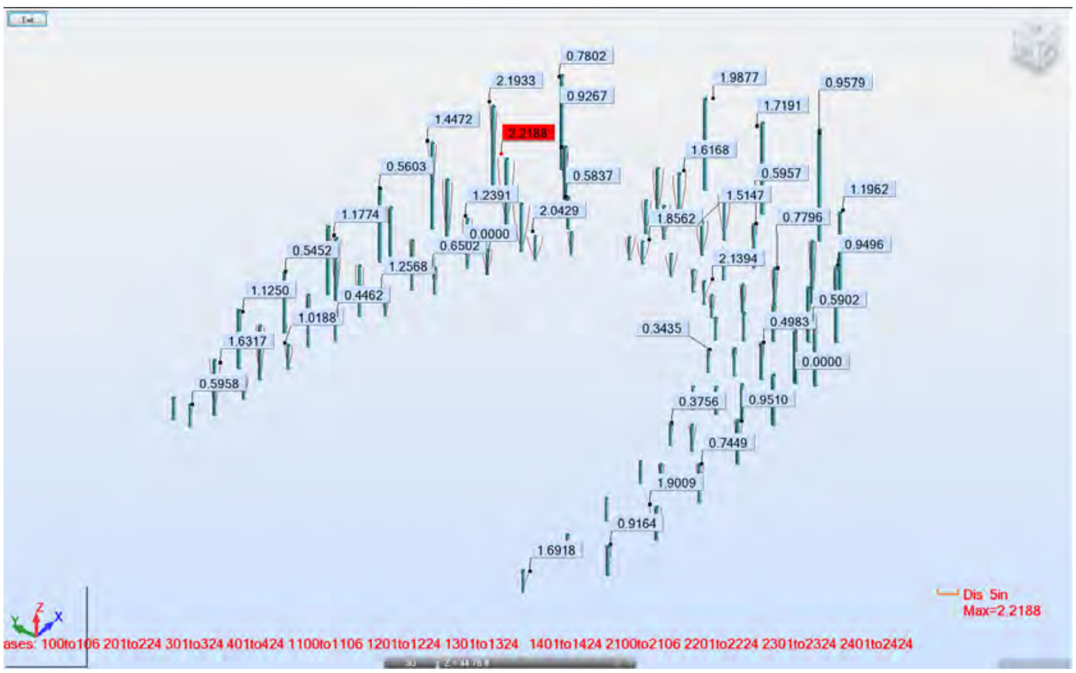
Mode	Period (sec)	Frequency (Hz)
1	0.63	1.58
2	0.61	1.63
3	0.53	1.89

Periods and frequencies for the first three modes where there is at least a 10% mass contribution in the Y direction are tabulated below.

Mode	Period (sec)	Frequency (Hz)
1	0.82	1.22
2	0.80	1.26
3	0.76	1.32

3.3 Deflection Performance

The canopy has been analysed for all load cases and code load combinations. Deflection in the canopy has been limited to a value of L/300. As can be seen from the image below, the maximum deflection recorded is 2.2".



STRUCTURAL SCHEMATIC REPORT (continued)

4 Estimated Schematic Design Steel Quantities

The following table summarizes steel quantities based on the schematic design analysis carried out to date. The quantities are preliminary and will be refined as the design progresses. All quantities listed are for steel elements alone and do not include an allowance for connections, stiffeners, cover plates, backing plates, miscellaneous fixings, etc. Allowances for the bike path framing and balcony/stair framing are not included; these features are subject to change. However, framing weights of these elements are not expected to exceed the total steel weight shown in the table below.

The steel quantities listed below are based on a canopy true area of 62,390 sq. ft.

Column Weight (psf)	**Kicker Weight (psf)**	**Raker Beam Weight (psf)**	**Joist & Bridging Weight (psf)**	**Drag Beam Weight (psf)**	**Diaphragm Bracing Weight (psf)**	**Total Steel Weight (psf)**
1.8	1.0	5.0	7.5	4.0	0.7	20.0

Appendix A Design Criteria

STRUCTURAL SCHEMATIC REPORT (continued)

Buro Happold

Contents

STRUCTURAL SCHEMATIC REPORT (continued)

1 Introduction

The Structural Design Criteria has been prepared to inform the Owner, Architect and others of the assumptions made by Buro Happold in the preparation of the structural design for the St. Petersburg Pier canopy. It includes a listing of the relevant design standards as well as the assumptions made about floor occupancies, design loads, material strengths and properties, performance criteria, fire rating requirements for structural members, and the like.

In addition, the Structural Design Criteria is used by the structural engineering team to maintain a current summary of design assumptions so as to promote consistency in the assumptions made by individual engineers. As such, some of the information included in this Structural Design Criteria may be more technical than needed by the Owner or Architect.

Finally, the Structural Design Criteria is a work–in-progress and will be revised as the project progresses into the more detailed phases of design. The following will be used within the text to denote information that is not yet available or information that needs further verification.

♣	Buro Happold Structure
♦	Buro Happold MEP
♥	Architect
♠	Client

2 Project Location and Description

The St. Petersburg Pier is an oval shaped pedestrian/bicycle accessed structure jutting into the Gulf of Mexico from the coast of St. Petersburg, Florida. The superstructure consists of a steel-framed, doubly -curved system supported on vertical columns and kickers that is clad in aluminum to produce an aesthetically pleasing and durable canopy in a hurricane prone region. The superstructure is supported on pile caps near sea level.

The overall dimensions of the canopy site are approximately 650 ft x 310 ft and the total area of cladding is 146,920 sq. ft. A bicycle path from the mainland approaches the canopy from the west, wraps around the structure, and criss-crosses itself before returning to the shore. Pedestrians and service vehicles utilize a deck spanning between pile caps below the canopy.

Currently, the overall thickness of the shell build-up is limited to 54 in. for architectural reasons. This dimension will be revised as the design progresses.

STRUCTURAL SCHEMATIC REPORT (continued)

Buro Happold

3 Design Standards

The structure is designed to meet or exceed the minimum requirements of the following code:

Building Code	2010 Florida Building Code

The structure is designed to meet or exceed the minimum requirements of the following reference standards, as modified by the Building Code:

Steel	AISC-ASD 325-05: "Manual of Steel Construction," Thirteenth Edition, 2005, by the American Institute of Steel Construction AISC-LRFD 325-05: "Manual of Steel Construction," Thirteenth Edition, 2005, by the American Institute of Steel Construction AISC 360-05: "Specification for Structural Steel Buildings," 2005, by the American Institute of Steel Construction
Welding	AWS D1.1-04: "Structural Welding Code - Steel," by the American Welding Society AWS C5.4-93: "Recommended Practice for Stud Welding," 1993, by the American Welding Society AWS D1.4-98: "Structural Welding Code – Reinforcing Steel," by the American Welding Society
Concrete	ACI 318-08: "Building Code Requirements for Reinforced Concrete," 2008, by the American Concrete Institute
Precast Concrete and Prestressed Concrete	ACI 318-08: "Building Code Requirements for Reinforced Concrete," 2008, by the American Concrete Institute MNL-120-10 "PCI Design Handbook," Seventh Edition, by the Precast/Prestressed Concrete Institute
Masonry	ACI 530-08: "Building Code Requirements for Masonry Structures," 2008, by the American Concrete Institute ACI 530.1-08: "Specification for Masonry Structures," 2008, by the American Concrete Institute
Timber	AF&PA NDS-05: "National Design Specification for Wood Construction," 2005, by the American Forest and Paper Association
Glued Laminated Timber	AITC A 190.1-07: "Structural Glued Laminated Timber," 2007, by the American Institute of Timber Construction

Cold-Formed Steel	AISI-NASPEC 2004: "North American Specification for the Design of Cold-Formed Steel Structural Members", 2004
Aluminum	AA ADM 1-05: "Specifications for Aluminum Structures," by the Aluminum Association AAF-10: "Guide to Aluminum Construction in High Wind Areas," 2010, by the Aluminum Association of Florida
Open Web Steel Joists	SJI: "Standard Specification, Load Tables and Weight Tables for Steel Joists and Joist Girders," 2010, by the Steel Joist Institute
Steel Deck	SDI No. 31: "Design Manual for Composite Decks, Form Decks, and Roof Decks," by the Steel Deck Institute
Wind Loads	ASCE 7-10: "Minimum Design Loads for Buildings and Other Structures, Chapters 26-31" 2010, by the American Society of Civil Engineers
Seismic Loads	ASCE 7-10: "Minimum Design Loads for Buildings and Other Structures, Chapters 11-23" 2010, by the American Society of Civil Engineers

STRUCTURAL SCHEMATIC REPORT (continued)

4 Reference Documents

The following reference documents are used for the structural design:

Site Investigation Report:	Not Required
Glazing Performance Specification:	Not Required
Site Survey	Not Required

5 Materials

The materials listed in this section are the preferred materials/grades/sizes for design purposes. See the Drawings and Specifications for the project requirements for construction.

5.1 Concrete

Concrete grades and locations are as follows:

* f'c	Cement Type	Density	Locations
5000	II	Normal	All members

* f'c = 28-day compressive strength of cylinder 6"∅ x12"

Note:

1. ACI 318-08 Table 4.3.1 outlines concrete mix requirements for concrete exposed to seawater (classification C2 as per Table 4.2.1). A minimum f'c=5000 psi is required for concrete exposed to seawater.
2. Maximum water-cement ratio is 0.40 for basement floors and foundations.
3. For concrete used in moisture-sensitive floor and exposed to earth or weather, limit water soluble chloride ion content of 0.15 percent by weight of cement as noted in Specifications.
4. Maximum drying shrinkage shall be 0.05%, and maximum wetting expansion shall be 0.03%.

5.2 Young's Modulus

f'c	Density	Short-term Ec (psi)	Long-term Ec (psi)	*Dynamic Ec (psi)
3000	Normal	3.12×10^6	♣	♣
4000	Normal	4.03×10^6	♣	♣

* For use with floor vibration calculations (if required)

5.3 Other Concrete Properties

Property	Value	Notes
Density	*150 pcf/145pcf	Normal-weight
Poisson's Ratio	$\upsilon = 0.2$	
Coefficient of Thermal Expansion	$\alpha = 5.5 \times 10E\text{-}6/^{o}F$	

STRUCTURAL SCHEMATIC REPORT (continued)

5.4 Reinforcement

Deformed reinforcing bars: ASTM A615 Grade 60 (fy = 60 ksi)

Welded wire fabric: ASTM A497 for sizes D4.0 and larger (fy = 70ksi)

ASTM A185 for sizes smaller than W4.0
(fy = 65 ksi for sizes W1.2 and larger)
(fy = 56 ksi for sizes smaller than W1.2)

Standard bar sizes:

Bar Size	Nominal Dimensions (For Design)		Approximate Diameter to Outside Deformations (in)*
	Diameter (in)	Area (in2)	
#3	.375	.11	7/16”
#4	.500	.20	9/16”
#5	.625	.31	11/16”
#6	.750	.44	7/8”
#7	.875	.60	1”
#8	1.000	.79	1-1/8”
#9	1.128	1.00	1-1/4”
#10	1.270	1.27	1-7/16”
#11	1.410	1.56	1-5/8”
#14	1.693	2.25	1-7/8”
#18	2.257	4.00	2-1/2”

* Approximate diameter to outside deformations should be used only for detailing locations with congested rebar.

Source CRSI Detailing Manual page C-10 and ACI Detailing manual Supporting reference data page 195.

5.5 Reinforcement Strength Reduction Factors

As per ACI 318-08, Section 9.3:

Condition	Reduction Factor ø
Tension-controlled sections	0.90
Compression-controlled sections – members with spiral reinforcement	0.70
Compression-controlled sections – other reinforced members	0.65
Shear and torsion	0.75
Bearing on concrete	0.65

5.6 Concrete Cover

Concrete cover for cast in place concrete (non-prestressed) per ACI 318-08, Section 7.7.1.

Location	Use	Minimum Cover, in
Concrete cast against and permanently exposed to earth	All	3
Concrete exposed to earth or weather	All	2
Concrete NOT exposed to weather or in contact with ground	Slabs, walls, joists	3/4
	Beams, columns	1-1/2
	Shells, folded plate members	3/4

Concrete cover for precast concrete per ACI 318-08, Section 7.7.3.

Location	Use	Minimum Cover, in
Concrete exposed to earth or weather	All	1-1/2
Concrete NOT exposed to weather or in contact with ground	Slabs, walls, joists	3/4
	Beams, columns	1-1/2
	Shells, folded plate members	3/4

As per ACI 318-08 Table 4.2.1, concrete exposed to spray from seawater is classified as category C, severity – severe, class – C2. For reinforced concrete, Section 7.7.6 recommends a cover of at least 2” for walls and slabs and 2-1/2” for other members. These values are 1-1/2” and 2”, respectively, for precast concrete members manufactured under factory conditions.

STRUCTURAL SCHEMATIC REPORT (continued)

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5.7 Structural Steel

Table below summarizes the material grades for structural steel used in the project, unless otherwise noted.

Type of Section	Material Specification	Fy ksi	Fu ksi	Select shapes from
Wide Flange	ASTM A992 Grade 50	50	65	AISC Manual
Channels	ASTM A36	36	58	AISC Manual
Angles (misc)	ASTM A36	36	58	AISC Manual
Angles (joists)	ASTM A572 Grade 50	50	65	AISC Manual
Plates	ASTM A36	36	58	See AISC Manual for standard thicknesses
Built-up sections	ASTM A572 Grade 50	50	65	Plate thicknesses not to exceed 1”
HSS Rectangular or Square	ASTM A500 Grade B	46	58	AISC Manual
HSS Round	ASTM A500 Grade B	42	58	AISC Manual
Pipe	A501	36	58	AISC Manual, ASTM specs
Pipe (alternate)	A53, Grade B Type E or S	35	60	AISC Manual, ASTM specs

5.8 Steel properties:

Density:	490 pcf
Young’s Modulus:	E = 29x10E6 psi
Poisson’s Ratio:	$\upsilon = 0.30$
Coefficient of thermal expansion:	$\alpha = 6.5\text{x}10^{-6}/^{o}\text{F}$

Other considerations:

Steel Availability: refer to AISC Modern Steel Construction or check website for specific sizes:

http://www.aisc.org/Template.cfm?Section=Steel_Availability

5.9 Bolts

Bolt Materials

A325 - for general use

Preferred sizes: 3/4"∅, 7/8"∅

fy = 92 ksi, fu = 120 ksi (1/2"∅ to 1"∅)
fy = 81 ksi, fu = 105 ksi (1-1/8"∅ to 1-1/2"∅)

A490 – for higher strength connections
Preferred sizes: 1"∅, 1-1/8"∅
Proof stress = 120 ksi,
fu = 150 ksi (1/2"∅ to 1-1/2"∅)

A307 - for secondary connections (where specifically noted)
Preferred sizes: 3/4"∅, 7/8"∅
fu = 60 ksi

5.10 Bolt Tensioning

All bolts are bearing bolts (N - threads included) unless specifically noted as slip-critical (SC).
All bolted connections must be designed and constructed per the requirements of AISC "Manual of Steel Construction" including AISC "Specification for Structural Joints Using ASTM A325 or A490 Bolts". In addition to these requirements the following requirements must also be met:

1. Slip-Critical Connections: Slip-Critical bolts shall be fully tensioned with frying surface preparation Class A. Slip-Critical connections shall be used in the following locations:
    a. Wherever required in the AISC Provisions
    b. Wherever noted on the drawings
    c. Whenever oversized holes are used.
    d. At all connections for members directly or indirectly supporting mechanical equipment and stairs.
    e. At all cantilever and moment connections.
    f. At all connections to plate girders and supporting connections.
2. Wind Connections: Seismic/Wind connections shall be fully tensioned with fraying surface preparation Class A. Bolts are designed as bearing connections. Wind connections shall used at all beams, braces and columns in braced frames or moment frames and where noted on the plans. These connections do not need to be designed as Slip-Critical unless noted on the plans.
3. Pre-Tensioned Bolted Connections: Pre-Tensioned Bolted Connections shall be fully tensioned and used in the following locations:
    a. Wherever required in the AISC Provisions
    b. Wherever noted on the drawings
    c. For all bolts with tension loads (hangers or braces)
4. Snug-Tight bolted Connections: Snug-Tight Bolted connections may be used where permitted by AISC provisions, and at locations not noted above.

5.11 Anchor Bolts:

F1554 Grade 55

STRUCTURAL SCHEMATIC REPORT (continued)

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fy = 55 ksi, with supplemental requirement S1 for weldability
fu = 75-95 ksi

5.12 Post-Installed Anchors:

Anchors:	"HILTI" HAS-E (ISO 898 Class 5.8) threaded rods or similar
Preferred sizes:	5/8" ∅ minimum for general use
Adhesive:	HILTI HVU capsules for general use HILTI HIT HY 20 with screen tube for hollow masonry HILTI HIT HY 150 for solid masonry or concrete HILTI HIT RE 500 for solid masonry or concrete

5.13 Stud Shear Connectors

Type:	Headed shear studs conforming to AWS D1.1, Type B fy = 50 ksi, fu = 60 ksi
Typical size:	3/4"øx♣" (as-welded length = ♣"), UON
Stud value for composite design:	♣ kips/stud (before reductions)

5.14 Welding Electrodes

Grade:	E70xx (fu = 70 ksi)
Minimum weld size:	1/4" UON; see also AISC spec

5.15 Steel Deck

Profiles:	by United Steel Deck, UON
Grade:	fy = 33 ksi
Minimum thickness:	♣ gage
Shoring:	Assume unshored, typically
Span condition:	Assume single spans, typically

Span Limits for Composite Slab-on-Deck

♣

5.16 Masonry

Concrete block:	ASTM C90 Grade N1 Compressive strength = 2800 psi
Mortar:	ASTM C270 Type M
Grout:	f'c = 2000 psi
Masonry strength:	f'm = 2000 psi
Strength determination:	Unit strength method, or Prism test method

5.17 Water Proofing

Water proofing materials and locations are to be coordinated with the architect.

6 Gravity Loads

General design criteria for dead and live loads are given in this section.

6.1 Material Self-Weight

Dead loads have been calculated using the following assumed densities:

Concrete (normal weight):	150 pcf
Concrete (lightweight):	120 pcf
Steel:	490 pcf

6.2 Live Loads – General

Live loads are generally in accordance with ASCE 7-10

Live loads assumed per occupancy are as follows:

Occupancy or Use	Uniform Load[1] psf	Concentrated Load[2] lbs
Assembly Areas and Theaters		
Fixed Seating	60 NR	-
Lobbies, Movable Seats	100 NR	-
Stages and Platforms	125 NR	-
Garages, Car Parking[4]		
Passenger cars only	40	3000[5]
Buses, Trucks, and mixed usage	640 plf[7] NR	18000, 26000[6]
Office:		
Code minimum, no storage	50	2000
File rooms	150	As required
Copy rooms	100	2000
Corridors and Lobbies at first floor	100 NR	2000
Corridors above first floor	80	2000
Mechanical Room	150 NR	As required
Roof		
Code minimum, flat	20	-
Promenade	60	-
Assembly (Public)	100 NR	-

STRUCTURAL SCHEMATIC REPORT (continued)

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Occupancy or Use	Uniform Load[1] psf	Concentrated Load[2] lbs
Plaza (assumed) Vehicular driveway, areas subjected to trucking	250[3] NR 250 NR	- 8000
Public Areas	100	-
Stairs and Exits	100 NR	-
Storage Light Heavy	 125 NR 250 NR	 - -
Walkways and Elevated Platforms (other than exitways)	60	-
Dining Rooms and Restaurants	100 NR	-
Residential Living Area Balconies Stairs	 40 60 100	 - - 300
Retail First floor Upper floors Wholesale, all floors	 100 75 125	 1000 1000 1000

1. Uniform loads marked "NR" are non-reducible.
2. Specified concentrated loads shall act over an area of 6.25 ft^2 unless otherwise noted. Wheel loads shall act on an area of 20 in^2.
3. Where clear height of garage entrance exceeds 7', loads for buses, trucks and mixed usage shall be used.
4. HS20-44 Truck loading, uniform load is applied over a 10' width within a 12' lane simultaneously with the concentrated load specified, 18000 lbs for moment controlled design and 26000 lbs for shear controlled design.
5. The loading applies to stack room floors that support non-mobile, double-faced library bookstacks, subject to the following limitations:
    a. The nominal bookstack unit height shall not exceed 90":
    b. The nominal shelf depth shall not exceed 12" for each face; and
    c. Parallel rows of double-faced bookstacks shall be separated by aisles not less than 36" wide.

6.3 Live Load Reduction

Live loads may be reduced in accordance with Florida Building Code 2010. For reference, the live load reduction provisions of this standard are summarized in this section.

6.3.1 *Reducible Loads*

The following live loads do not qualify for reduction:

Mechanical rooms

Storage areas

Loads that have been specifically determined based on the knowledge of proposed use of the structure. Loads that exceed 100 psf shall not be reduced except the live load for members supporting two or more floors are permitted to be reduced by a max. of 20% but live load shall not be less than the reduced live load calculated

Live load of 100 psf or less shall not be reduced in public assembly occupancies

Live load in passenger car garages are permitted to be reduced by max 20% for members supporting 2 or more floors

Live loads shall not be reduced for one-way slabs unless they support more than one floor

Otherwise, the uniformly distributed floor may be reduced. Uniform live loads noted "NR" in this structural design criteria document are non-reducible.

6.3.2 *Live Load Reduction Method*

Members supporting floors for which a value of $K_{LL}A_T$ is 400 ft^2 or more are permitted to be designed for a reduced live load in accordance with the following equation:

$$L=L_0(0.25+15/(K_{LL}A_T)^{0.5} \quad \text{(FBC 16-22)}$$

Where:

L=reduced design live load per square meter [square foot] of area supported by the member

L_0=unreduced design live load per square meter [square foot] of area supported by the member

K_{LL}=live load element factor (see FBC 2010 table 1607.9.1)

A_T=tributary area, in square meters [square feet]. L shall not be less than $0.5L_0$ for members supporting one floor and L shall not be less than $0.4L_0$ for members supporting two or more floors.

6.4 Partition Loads

See load tables

6.5 Vehicle Loads

Fire truck live load of 250 psf has been assumed. Vehicle access routes and the specific vehicles and loading criteria shall be confirmed.

Cladding maintenance is proposed to be serviced by lift. A copy of the technical data of this machine will be included in future Appendix.

STRUCTURAL SCHEMATIC REPORT (continued)

7 Load Combinations

Load combinations shall meet the specifications of the Florida Building Code 2010 section 1605.

7.1 Strength Design

Ref 1605.2.1 Basic Load Combinations:

1.4D

1.2D + 1.6L + 0.5(L_r or S or R)

1.2D + 1.6(L_r or S or R) + (f_1L or 0.5W)

1.2D + 1.0W + f_1L + 0.5(L_r or S or R)

1.2D + 1.0E + f_1L + f_2S

0.9D + 1.0W

0.9D + 1.0E

Where:

f_1 = 1.0 for floors in public assembly, parking garage live loads, and loads exceeding 100 psf

f_1 = 0.5 otherwise

f_2 = 0.7 for saw tooth or similar roofs that do not shed snow off the structure.

f_2 = 0.2 otherwise

Note:

Where additional loads such as Fluids, F, lateral earth pressure, H, or thermal, T are applicable, loads shall be added to above combinations per ASCE 7 -10 sections 2.3.3 and 2.3.4.

7.2 Working Stress Design

Ref 1605.3.1 Basic Load Combinations:

D

D + L

D + (L_r or S or R)

D + 0.75L + 0.75(L_r or S or R)

D + (0.6W or 0.7E)

D + 0.75L + 0.75(0.6W) + 0.75(L_r or S or R)

D + 0.75L + 0.75(0.7E) + 0.75S

0.6D + 0.6W

0.6D + 0.7E

Note:

Where additional loads such as Fluids, F, lateral earth pressure, H, or thermal, T are applicable, loads shall be added to above combinations per ASCE 7 -10 sections 2.4.3, 2.4.4, and 2.4.5.

Flat roof snow loads $\leq$ 30psf do not need to be considered in combinations with seismic.
Flat roof snow loads > 30 psf: take 20% of snow load in combinations with Earthquake.
Combined effects of two or more transient loads can be multiplied by 75% (but never less than the sum of the effects of the dead load plus one of the transient loads. The factor 0.7 on E does not apply for this provision.
Increases in allowable stress specified in the appropriate materials section of this code or referenced standard shall **not** be used with these load combinations.

Load combinations shall meet the specifications of the Florida Building Code 2010 section 1605.

STRUCTURAL SCHEMATIC REPORT (continued)

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8 Wind Loads

Wind loads are determined in accordance with ASCE 7-10 Chapters 26-30. Wind study loads have also been provided by RWDI. The latter have been used for the analysis of the structure.

8.1 Basic Parameters

Basic Wind Speed:	145 mph	ASCE 7-10 Figure 26.5-1
Occupancy Category:	II	ASCE 7-10 Table 1.5-1
Exposure Category:	D	ASCE 7-10 Section 26.7.3
Mean Roof Height:	h	Varies, see drawings and calculations.
Wind Directionality Factor:	$K_d =$ 0.85	ASCE 7-10 Table 26.6-1
Topographic Factor:	$K_{zt} =$ 1.0	ASCE 7-10 Section 26.8.2
Gust Factor:	G	ASCE 7-10 Section 26.9

8.2 Velocity Pressure

Per the ASCE 7-10, the velocity pressure shall be the following:

Velocity pressure:qz = 0.00256 (Kz)(Kzt)(Kd*)(V^2), lb/ft^2, Velocity in ft/s (Eq. 27.3-1)

* See previous section for Gust Factor and Directionality Factor, see load combination section for proper use of directionality factor.

The design wind pressure is p = qh x G x Cn (Equation 27.4-3)

8.3 Wind Loads on Main Wind-Force Resisting System

ASCE 7-10 Table 27.4-1 outlines the procedure for calculating main wind force resisting loads for enclosed, partially enclosed, and open buildings of all heights.

Per the ASCE 7-10, the structure's Main Force Resisting Systems (for all heights) should be designed for wind pressures acting on the windward, leeward, sideward walls and the roof concurrently. Refer to sketches and detailed calculations for application of the loads to the structure.

Internal pressures of $\pm q_h GCp_i$ psf shall be combined algebraically to the external pressures. However, $GCp_i = 0$ for an open building.

8.4 Wind Loads on Components and Cladding

As per the ASCE 7-10, the structure's Component and Cladding Systems (for all heights) should be designed for both positive and negative wind pressures with internal pressures (where applicable). All structural elements that are the only support for areas of 700 square feet or less are to be designed for that area of components and cladding load regardless of the member's participation in the main wind force resisting system (ex. a central atrium roof beam that is part of the main wind force resisting system, but also has a tributary area of 700 square feet or less, shall be designed for the more severe of the main wind forces or the components and cladding forces).

Components and cladding should be designed using the information presented above in accordance with ASCE 7-10 Chapter 30 Part 5 for open buildings with a pitched free roof, monosloped roof, or troughed free roof. ASCE 7-10 Table 30.8-1 outlines the procedure for calculating component and cladding loads.

STRUCTURAL SCHEMATIC REPORT (continued)

9 Seismic Loads

For the schematic phase of design wind loading is assumed to govern over seismic loading. The structure is relatively light and is located in a hurricane prone region that historically is not subject to significant seismic events. A basic quantitative seismic analysis will be completed in later phases of design to verify this assumption.

10 Horizontal Impact Loads

From Florida Building Code 2010, Section 1607.7.

Railings, other than those for parking decks, including hand-railings, both interior and exterior, shall be designed to resist a lateral impact at the top equivalent to a minimum linear load of 50 lb/ft and a concentrated load of 200 lbs in any direction.

Where motor vehicles are parked by a driver, as differentiated from mechanical parking, enclosure walls, parapet walls, or barriers, at the perimeter of area and around floor openings shall be designed to resist a minimum single load of 6000 lbs applied 1'-6" or 2'-3", whichever is more onerous, above the floor or ramp.

**STRUCTURAL SCHEMATIC
REPORT (continued)**

11 Other Impact Loads

For structures carrying live loads which induce impact, the assumed load shall be increased as follows in accordance with Florida Building Code 2010 Section 1607.8:

11.1 Elevators

All elevators loads shall be increased by 100%.

11.2 Machinery

- Elevator machinery: 100%
- Light machinery, shaft or motor driven: 20%
- Reciprocating machinery or power driven units: 50%
- Hangers for floors or balconies: 33%

11.3 Crane Loads

Crane live loads shall be as indicated in Florida Building Code 2010 Section 1607.12. The maximum wheel loads of cranes shall be increased as follows:

- Monorail cranes (powered): 25%
- Cab operated or remotely operated bridge cranes (powered): 25%
- Pendant operated: 10%
- Bridge cranes or monorail cranes with hand-geared bridge, trolley and hoist: 0%

12 Thermal Loads

The structure shall be designed to resist self-straining forces arising from contraction or expansion resulting from temperature change, shrinkage, moisture change, creep in component materials, movement due to differential settlement, or combinations thereof. Proper detailing shall be provided to alleviate stresses that may be incurred. Where detailing cannot alleviate these stresses, calculations of self straining forces shall be performed. A temperature differential of +20/- 45°F has been taken based on regional climate data and an assumed construction schedule.

STRUCTURAL SCHEMATIC REPORT (continued)

13 Displacement Induced Loads

The canopy structure is supported on pile caps above sea level. The pile caps will displace, inducing forces in the structure. These forces will be quantified and accounted for in the analysis and design.

14 Performance Criteria

The performance criteria discussed here will be used during schematic design and may be enhanced per client or fabricator requirements. The limits discussed here combine code requirements and guidelines as well as Buro Happold's experience on past project performance.

14.1 Deflection Limits

The following deflection limits are based on IBC requirements

Construction	L	S or W	DL + LL
Roof Members Supporting plaster ceiling Supporting non-plaster ceiling Not supporting ceiling	 Span/360 Span/240 Span/180	 Span/360 Span/240 Span/180	 Span/240 Span/180 Span/120
Floor Members	Span/360	-	Span/240
Exterior Walls and Interior Partitions: With Brittle Finishes With Flexible Finishes	 - -	 Span/240 Span/120	 - -

More strict deflection criteria may be required for the following conditions:

Beams or slab supporting masonry: LL - Span/600 or 1 in (smallest)

14.2 Concrete Beam and Slab Deflections

Concrete Slabs and Beams shall be designed to the following deflection criteria (based on ACI 318-08 Table 9.5(b))

ACI Deflection Limits (BH Modified)

Type of Member	Deflection to be considered	Deflection Limitation
Flat roofs not supporting or attached to nonstructural elements likely to be damaged by large deflections	Immediate deflection due to live load **LL** using cracked section*. $\Delta = \Delta_{LLInst}$	Span/180 *note: ponding should be checked separately
Floors not supporting or attached to nonstructural elements likely to be damaged by large deflections	Immediate deflection due to live load **LL** using cracked section*.	Span/360

STRUCTURAL SCHEMATIC REPORT (continued)

Type of Member	Deflection to be considered	Deflection Limitation
	$\Delta = \Delta_{LLInst}$	
Typical Slab Roof or floor construction supporting or attached to nonstructural elements not likely to be damaged by large deflections	$\Delta_{LT} = \lambda\Delta_{DLInst} + (\lambda+1)\,\Delta_{SDL} + (1\text{-}F)\,\Delta_{LLInst} + F\,(\lambda+1)\,\Delta_{LLInst}$ Where: $\Delta_{DLInstt}$= Instantaneous deflection due to self-weight using cracked section*. Δ_{SDL} = Instantaneous deflection due to superimposed dead load using cracked section Δ_{LL} = Instantaneous deflection due to live load using cracked section*. λ = Long term deflection multiplier per ACI 9.5.2.5 F = 0.4 for office floors, 0.25 for residential.	Span/240

*For office floors live load contribution for long term deflection will be adjusted as deemed appropriate.

Camber should be calculated based on CDL deflection using CDL effective section properties (cracked if CDL causes section cracking)

14.3 Building Sway/Drift

The total building sway (measured at the roof, where H is the height from the base of the structure to the roof) is limited to L/300. A criteria of L/500 is not necessary as there are no adjacent structures and pedestrian access is limited.

15 Fire Resistance

The fire resistance rating requirements for building elements are as follows:

Element	Fire Resistance (Hours)
Structural frame including columns girders and trusses	3
Bearing walls exterior and interior	3
Non bearing walls and exterior partitions	To be determined
Non bearing walls and interior partitions	To be determined
Floor construction including beams	2
Roof construction including beams	1 ½

STRUCTURAL SCHEMATIC REPORT (continued)

16 Construction Methodology Governing Design

16.1 Expansion Joints

Expansion joints will be required in the deck between piles caps and in the canopy superstructure.

16.2 Precast Elements

All precast elements are designed to be simply supported during the construction phase and should not require temporary shoring.

Manufacturer's construction methodology should be adopted. The contractor shall get approval of the precast manufacture for any construction deviation arising on site.

16.3 Pour Strips

Pour strips shall remain open for a period of time to be determined by the engineer of record. During this time the slabs adjacent to the pour strips must remain shored.

Appendix B Column/Kicker Reaction Data

STRUCTURAL SCHEMATIC REPORT (continued)

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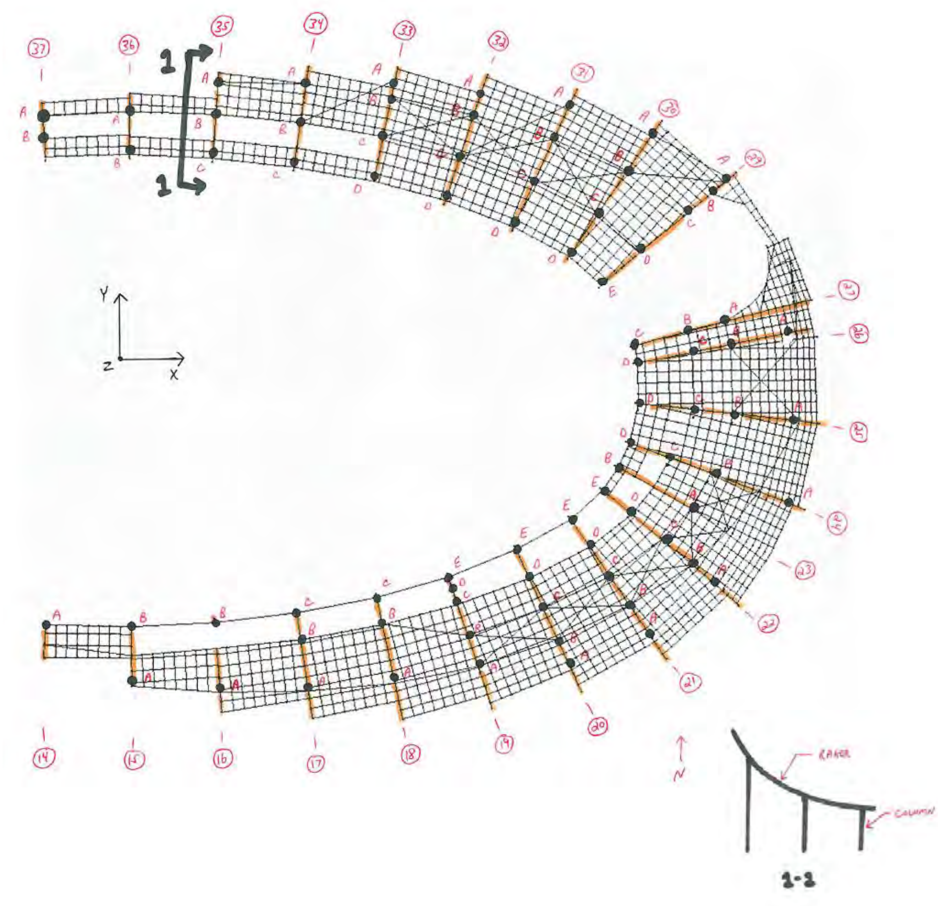
The diagram below shows schematically the locations of support points for columns or kickers. The table attached to this Appendix gives the reactions at each of these nodes for every load case in Robot model C002-029. Highlighted loads can be put into load combinations for the design of the pile caps. Positive FZ reactions indicate compression in columns. Negative FZ reactions indicate tension in columns.

All pile caps are assumed at an elevation of 12' above sea level (Z=12.0) in the revit model. The deck below the south portion of the canopy appears to be flat and rests on the pile caps. On the north side the deck slopes. Final deck setting out and elevations are to be coordinated with the architect.

Note that loads from the balconies near the cores, the deck that spans between pile caps, and wind loads on the bike path are not included in these combinations. The pile cap designer was requested to pad the values used for design accordingly. More accurate values will be available at later stages of design.



ST. PETERSBURG PIER COLUMN REACTIONS AS PER ROBOT MODEL C002-029

COLUMN DATA						DEAD LOADS								
						SW REACTIONS			SDL1 REACTIONS			SDL2 REACTIONS		
RAKER LINE	COLUMN NODE	COLUMN TYPE	X (ft)	Y (ft)	Z (ft)	FX (kip)	FY (kip)	FZ (kip)	FX (kip)	FY (kip)	FZ (kip)	FX (kip)	FY (kip)	FZ (kip)
37	4003	A	1353.66	540.74	25.5	1.24	10.21	19.33	-0.64	5.01	2.16	0.58	-1.09	18.72
	4005	B	1354.34	529.09	25.5	1.53	-10.41	20.28	0.55	-5.13	3.46	0.37	0.99	11.26
36	4009	A	1398.29	542.76	0	-0.02	-0.84	52.7	-0.02	-0.02	9.82	0.01	-1.53	24.47
	4011	B	1398.04	520.76	22.42	-0.6	1.04	26.4	-0.23	0.18	6.18	-0.07	1.57	4.56
35	13211	A	1444.06	558	0	0.04	-0.16	47.84	0.01	-0.06	4.32	0.01	-0.17	-1.3
	4013	B	1442.7	541.23	0	-0.04	-0.59	47.26	-0.01	-0.22	7.88	-0.07	-0.84	26.34
	4015	C	1440.89	518.72	19.42	0.13	0.67	22.65	0.06	0.3	5.45	0.06	1.16	4.83
34	13213	A	1488.87	556.58	0	0.04	-0.04	59.64	0.01	-0.02	7.91	0.01	-0.01	-0.99
	4017	B	1485.93	536.87	0	0.02	-0.12	47.79	0.01	-0.04	8.32	-0.03	-0.27	24.26
	4019	C	1482.52	513.95	16.83	0.07	0.39	23.54	0.02	0.17	5.9	0.12	0.76	5.28
33	13201	A	1534.35	557.36	0	-0.93	-0.42	56.18	-0.27	-0.13	4.69	-1.25	-0.53	0.85
	2006	B	1532.79	550.14	0	0.01	-0.05	56.8	-0.06	-0.02	6.4	0.01	-0.01	-0.35
	2008	C	1528.33	529.36	0	0.02	-0.02	53.84	0.01	-0.01	11.27	-0.01	-0.09	24.67
	4021	D	1523.4	506.47	14	0.07	0.36	23.55	0.03	0.12	5.67	0.07	0.31	5.5
32	13208	A	1578.38	550.54	0	-0.01	0	64.45	-0.03	0.01	8.2	0.01	0	-0.11
	2010	B	1574.93	540.28	0	0.07	-0.08	61.03	0.07	-0.06	7.06	0.01	0	-0.37
	4024	C	1567.75	518.96	0	0.02	-0.03	63.59	0.01	-0.01	14.01	-0.01	-0.08	23.99
	4025	D	1560.16	496.37	12	0.12	0.33	24.54	0.04	0.12	5.83	0.1	0.26	5.38
31	13104	A	1623.61	544.53	0	0.72	0.29	76.38	0.49	0.2	7.66	-0.81	-0.38	0.55
	2012	B	1615.74	527.58	0	-0.01	-0.02	70.38	-0.05	0.01	11.42	0.01	0	-0.6
	2014	C	1605.21	504.91	0	0.03	-0.03	59.42	0.01	-0.01	13.48	-0.03	-0.09	25.12
	4027	D	1594.82	482.53	12	0.16	0.41	23.29	0.06	0.16	5.54	0.14	0.3	5.1
30	13102	A	1666.19	530.14	0	0.01	-0.02	85.4	0	0	8.74	0	0	0.05
	2016	B	1652.67	510.42	0	0.05	-0.01	78.97	0.05	-0.02	13.52	0.01	-0.01	-0.54
	4030	C	1637.37	488.08	0	0.01	-0.02	60.74	0.01	0	12.75	-0.04	-0.08	25.35
	4031	D	1623.19	467.39	12	0.2	0.35	22.05	0.05	0.14	4.59	0.2	0.24	5.27

STRUCTURAL SCHEMATIC REPORT (continued)

ST. PETERSBURG PIER COLUMN REACTIONS AS PER ROBOT MODEL C002-029

COLUMN DATA						DEAD LOADS								
						SW REACTIONS			SDL1 REACTIONS			SDL2 REACTIONS		
RAKER LINE	COLUMN NODE	COLUMN TYPE	X (ft)	Y (ft)	Z (ft)	FX (kip)	FY (kip)	FZ (kip)	FX (kip)	FY (kip)	FZ (kip)	FX (kip)	FY (kip)	FZ (kip)
29	13106	A	1703.94	506.5	12	-0.56	0.29	74.97	-0.45	0.27	4.13	0.04	-0.02	-0.13
	2018	B	1695.51	499.43	12	2.76	2.2	35.35	0.36	0.25	3.4	0.01	0.01	0.11
	4033	C	1681.46	487.65	12	0.02	-0.02	63.02	-0.01	0.04	8.29	0.02	0	-0.6
	2020	D	1659.12	468.9	12	-2.94	-6.81	29.68	0.31	-1.75	2.45	0.22	-0.5	25.05
	4034	E	1639.59	452.51	12	-0.15	-0.04	15.44	-0.04	0.04	1.54	0.24	0.19	4.69
27	4036	A	1702.07	433.51	12	0.78	-0.05	63.48	0.18	0	8.13	0.03	0.03	-4.03
	2024	B	1683.15	428.44	12	2.33	0.02	25.08	0.56	0.05	-0.35	1.84	0.86	29.24
	4038	C	1656.51	421.3	12	0.37	-0.16	15.92	0.09	-0.1	1.38	0.09	1.64	-0.4
26	13011	A	1739.02	424.95	12	-1.76	22.96	153.85	-0.47	6.24	29.31	0	0.01	-0.1
	4040	B	1705.19	419.74	12	0.26	-0.34	47.34	0.1	-0.06	9.06	0.01	0.03	-0.79
	4042	C	1685.42	416.7	12	-0.02	-0.73	33.77	0.03	-0.12	4.66	-0.35	0.34	27.23
	4044	D	1657.75	412.43	12	0.59	-0.18	17.32	0.23	-0.09	2.76	0.14	1.76	6.86
25	13007	A	1740.05	382.98	12	0.08	-0.03	98.28	0.03	0	18.38	0	0.01	0.27
	4096	B	1706	386.54	12	0.59	-0.23	55.67	0.22	-0.02	14.11	0.02	0.03	-1.64
	4098	C	1686.11	388.61	12	0.98	-0.36	33.2	0.36	-0.01	4.89	-0.26	0.37	24.67
	4100	D	1658.26	391.52	12	1.95	-0.2	22.63	0.62	-0.1	4.79	0.6	1.56	8.38
24	13009	A	1739.04	339.42	12	0.05	-0.02	99.45	0.03	0.01	14.29	-0.01	0.01	0.04
	4092	B	1694.59	356.04	12	0.49	-0.77	79.05	0.26	-0.29	25.46	-0.12	0.06	7.46
	2048	C	1674.06	363.72	12	4.7	-2.51	30.24	1.5	-0.86	1.63	-12.47	4.71	9.46
	4094	D	1653.53	371.39	12	0.37	0.18	14.21	0.11	0.02	2.81	0.65	2.15	-25.48
23	4085	A	1684.49	337.94	12	-1.95	-3.49	-4.63	-0.83	-1.49	-2.71	1.28	2.29	4.14
	4089	B	1647.76	359.15	12	3.16	-1.75	27.44	0.35	-0.17	3.17	21.48	-11.74	88.64
22	13118	A	1700.77	296.15	12	-0.1	-0.06	77.32	-0.04	-0.03	13.97	-0.02	0.02	0
	13107	B	1687.48	307.31	12	0.13	0.27	68.1	0.11	0.17	12.51	-0.05	0.06	-0.46
	4078	C	1669.53	322.36	12	0.11	-0.03	48.64	0.06	-0.02	10.73	-0.13	0.1	0.4
	4079	D	1654.4	335.06	12	-0.19	0.2	29.47	0.09	-0.05	4.48	-1.52	1.59	28.66
	4081	E	1639.59	347.49	12	0.12	-0.39	10.47	0.07	-0.07	1.01	-0.44	-1.38	-23.77

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ST. PETERSBURG PIER COLUMN REACTIONS AS PER ROBOT MODEL C002-029

COLUMN DATA						DEAD LOADS								
						SW REACTIONS			SDL1 REACTIONS			SDL2 REACTIONS		
RAKER LINE	COLUMN NODE	COLUMN TYPE	X (ft)	Y (ft)	Z (ft)	FX (kip)	FY (kip)	FZ (kip)	FX (kip)	FY (kip)	FZ (kip)	FX (kip)	FY (kip)	FZ (kip)
21	13116	A	1664.39	272.53	12	-0.17	0.03	71.55	-0.08	-0.01	11.15	0	0	0.04
	13109	B	1654.98	286.26	12	-0.2	0.07	53.62	-0.03	0	6.27	-0.01	0	0.05
	4074	C	1642.99	303.74	12	-0.2	-0.23	39.02	-0.05	-0.06	5.94	-0.07	0	0.54
	2042	D	1632.82	318.59	12	2.41	-4.22	33.78	0.87	-1.48	5.87	-1.36	1.61	17.85
	4076	E	1623.2	332.61	12	0.05	-0.28	15.98	0.02	-0.01	1.8	0.08	-1.07	10.71
20	13120	A	1622.69	257.8	12	-0.13	0.04	61.86	-0.04	0.01	8.99	-0.01	-0.01	0.01
	13111	B	1617.57	268.81	12	-0.14	0.15	53.56	-0.04	0.03	7.4	-0.01	-0.02	-0.02
	4069	C	1608.78	287.73	12	-0.17	-0.24	45.76	-0.08	-0.08	9.21	-0.04	-0.05	-0.27
	4070	D	1601.72	302.92	12	-0.22	-0.15	26.61	0.01	-0.17	3.98	-0.55	0.61	20.81
	4072	E	1594.94	317.5	12	0.07	-0.41	17.12	0.02	-0.01	2.26	-0.1	-1.42	8.36
19	13113	A	1576.67	255.35	12	0.06	-0.33	70.77	0.07	-0.22	18.61	-0.01	-0.02	-0.06
	4063	B	1570.28	274.32	12	0.09	0.06	37.35	0.05	0.06	6.43	-0.03	-0.03	0.38
	4064	C	1565.08	289.72	12	-0.27	0.12	28.37	-0.02	0.06	4.28	-0.29	-0.05	16.71
	2036	D	1561.86	299.27	12	1.48	-4.68	5.42	0.25	-0.97	1.01	0.91	-3	3.14
	4066	E	1560.37	303.69	12	-0.1	-0.2	16.6	-0.02	0	2.36	-0.52	-0.01	11.73
18	2032	A	1533.07	250.25	12	-0.19	-0.51	68.04	0	-0.25	19.43	-0.03	-0.02	-0.01
	4059	B	1526.7	279.73	12	-14.99	1.88	19.71	-4.31	0.44	2.55	-3.56	-0.18	15.71
	4061	C	1523.71	293.58	12	-0.09	0.12	16.91	-0.02	0.23	2.2	-0.4	-0.04	11.82
17	2030	A	1488.74	246.6	12	-0.41	-0.22	56.61	-0.13	-0.09	13.07	-0.05	-0.01	0
	4055	B	1484.87	272.48	12	-2.2	-0.18	40.06	-0.88	-0.33	11.65	-0.27	-0.67	17.79
	4057	C	1482.84	286.08	12	-0.2	-0.89	18.66	-0.04	-0.17	2.7	-0.41	0.27	11.94
16	2028	A	1443.98	246.06	12	-0.47	1.33	46.25	-0.28	0.65	10.02	-0.07	0	0.01
	4053	B	1441.13	281.28	12	0.04	-0.09	16.19	0.14	0	2.55	-1.84	-0.38	-0.16
15	4046	A	1398.73	249.21	12	0.59	2.51	38.08	0.33	0.94	8.06	-0.07	-0.02	-0.08
	4050	B	1398.37	279.3	12	0.02	-2.17	34	0.07	-0.84	9.49	-0.5	-0.02	0.17
14	4001	A	1354.59	280.31	12	0.2	-0.64	20.37	0.18	-0.24	3.9	-1.52	-0.06	-0.36

STRUCTURAL SCHEMATIC REPORT (continued)

ST. PETERSBURG PIER COLUMN REACTIONS AS PER ROBOT MODEL C002-029

COLUMN DATA						DEAD LOADS						LIVE LOADS		
						DL REACTIONS			TOTAL DEAD LOAD REACTIONS			LLr REACTIONS		
RAKER LINE	COLUMN NODE	COLUMN TYPE	X (ft)	Y (ft)	Z (ft)	FX (kip)	FY (kip)	FZ (kip)	FX (kip)	FY (kip)	FZ (kip)	FX (kip)	FY (kip)	FZ (kip)
37	4003	A	1353.66	540.74	25.5	-0.77	6.01	2.59	0.41	20.14	42.8	-0.77	6.01	2.59
	4005	B	1354.34	529.09	25.5	0.66	-6.15	4.16	3.11	-20.7	39.16	0.66	-6.15	4.15
36	4009	A	1398.29	542.76	0	-0.02	-0.03	11.78	-0.05	-2.42	98.77	-0.02	-0.03	11.78
	4011	B	1398.04	520.76	22.42	-0.27	0.22	7.42	-1.17	3.01	44.56	-0.27	0.22	7.42
35	13211	A	1444.06	558	0	0.01	-0.07	5.19	0.07	-0.46	56.05	0.01	-0.07	5.19
	4013	B	1442.7	541.23	0	-0.01	-0.26	9.45	-0.13	-1.91	90.93	-0.01	-0.26	9.45
	4015	C	1440.89	518.72	19.42	0.07	0.36	6.54	0.32	2.49	39.47	0.07	0.36	6.54
34	13213	A	1488.87	556.58	0	0.01	-0.02	9.49	0.07	-0.09	76.05	0.01	-0.02	9.49
	4017	B	1485.93	536.87	0	0.01	-0.05	9.98	0.01	-0.48	90.35	0.01	-0.05	9.98
	4019	C	1482.52	513.95	16.83	0.02	0.2	7.08	0.23	1.52	41.8	0.02	0.2	7.07
33	13201	A	1534.35	557.36	0	-0.32	-0.15	5.62	-2.77	-1.23	67.34	-0.32	-0.15	5.62
	2006	B	1532.79	550.14	0	-0.07	-0.02	7.68	-0.11	-0.1	70.53	-0.07	-0.02	7.68
	2008	C	1528.33	529.36	0	0.01	-0.01	13.52	0.03	-0.13	103.3	0.01	-0.01	13.52
	4021	D	1523.4	506.47	14	0.04	0.14	6.81	0.21	0.93	41.53	0.04	0.14	6.8
32	13208	A	1578.38	550.54	0	-0.03	0.01	9.84	-0.06	0.02	82.38	-0.03	0.01	9.84
	2010	B	1574.93	540.28	0	0.09	-0.07	8.48	0.24	-0.21	76.2	0.09	-0.07	8.48
	4024	C	1567.75	518.96	0	0.01	-0.01	16.82	0.03	-0.13	118.41	0.01	-0.01	16.81
	4025	D	1560.16	496.37	12	0.05	0.15	6.99	0.31	0.86	42.74	0.05	0.15	6.99
31	13104	A	1623.61	544.53	0	0.58	0.23	9.19	0.98	0.34	93.78	0.58	0.23	9.19
	2012	B	1615.74	527.58	0	-0.06	0.02	13.7	-0.11	0.01	94.9	-0.06	0.02	13.7
	2014	C	1605.21	504.91	0	0.01	-0.01	16.17	0.02	-0.14	114.19	0.01	-0.01	16.17
	4027	D	1594.82	482.53	12	0.07	0.19	6.64	0.43	1.06	40.57	0.07	0.19	6.64
30	13102	A	1666.19	530.14	0	0	0	10.49	0.01	-0.02	104.68	0	0	10.49
	2016	B	1652.67	510.42	0	0.06	-0.02	16.22	0.17	-0.06	108.17	0.06	-0.02	16.22
	4030	C	1637.37	488.08	0	0.01	0	15.3	-0.01	-0.1	114.14	0.01	0	15.3
	4031	D	1623.19	467.39	12	0.06	0.16	5.51	0.51	0.89	37.42	0.06	0.16	5.51

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ST. PETERSBURG PIER COLUMN REACTIONS AS PER ROBOT MODEL C002-029

COLUMN DATA						DEAD LOADS						LIVE LOADS		
						DL REACTIONS			TOTAL DEAD LOAD REACTIONS			LLr REACTIONS		
RAKER LINE	COLUMN NODE	COLUMN TYPE	X (ft)	Y (ft)	Z (ft)	FX (kip)	FY (kip)	FZ (kip)	FX (kip)	FY (kip)	FZ (kip)	FX (kip)	FY (kip)	FZ (kip)
29	13106	A	1703.94	506.5	12	-0.54	0.33	4.96	-1.51	0.87	83.93	-0.54	0.33	4.96
	2018	B	1695.51	499.43	12	0.43	0.29	4.08	3.56	2.75	42.94	0.43	0.29	4.08
	4033	C	1681.46	487.65	12	-0.01	0.05	9.95	0.02	0.07	80.66	-0.01	0.05	9.94
	2020	D	1659.12	468.9	12	0.37	-2.1	2.93	-2.04	-11.16	60.11	0.37	-2.1	2.93
	4034	E	1639.59	452.51	12	-0.05	0.05	1.85	0	0.24	23.52	-0.05	0.05	1.85
27	4036	A	1702.07	433.51	12	0.22	0	9.76	1.21	-0.02	77.34	0.22	0	9.76
	2024	B	1683.15	428.44	12	0.67	0.06	-0.42	5.4	0.99	53.55	0.67	0.06	-0.42
	4038	C	1656.51	421.3	12	0.11	-0.12	1.66	0.66	1.26	18.56	0.11	-0.12	1.66
26	13011	A	1739.02	424.95	12	-0.57	7.48	35.18	-2.8	36.69	218.24	-0.57	7.48	35.18
	4040	B	1705.19	419.74	12	0.12	-0.07	10.88	0.49	-0.44	66.49	0.12	-0.07	10.88
	4042	C	1685.42	416.7	12	0.03	-0.15	5.59	-0.31	-0.66	71.25	0.03	-0.15	5.59
	4044	D	1657.75	412.43	12	0.28	-0.11	3.31	1.24	1.38	30.25	0.28	-0.11	3.31
25	13007	A	1740.05	382.98	12	0.03	0	22.06	0.14	-0.02	138.99	0.03	0	22.06
	4096	B	1706	386.54	12	0.26	-0.03	16.93	1.09	-0.25	85.07	0.26	-0.03	16.93
	4098	C	1686.11	388.61	12	0.44	-0.02	5.87	1.52	-0.02	68.63	0.44	-0.02	5.87
	4100	D	1658.26	391.52	12	0.75	-0.11	5.75	3.92	1.15	41.55	0.75	-0.11	5.75
24	13009	A	1739.04	339.42	12	0.04	0.01	17.15	0.11	0.01	130.93	0.04	0.01	17.15
	4092	B	1694.59	356.04	12	0.31	-0.35	30.55	0.94	-1.35	142.52	0.31	-0.35	30.55
	2048	C	1674.06	363.72	12	1.79	-1.03	1.95	-4.48	0.31	43.28	1.79	-1.03	1.95
	4094	D	1653.53	371.39	12	0.13	0.02	3.37	1.26	2.37	-5.09	0.13	0.02	3.37
23	4085	A	1684.49	337.94	12	-1	-1.79	-3.25	-2.5	-4.48	-6.45	-1	-1.79	-3.25
	4089	B	1647.76	359.15	12	0.42	-0.21	3.81	25.41	-13.87	123.06	0.42	-0.21	3.81
22	13118	A	1700.77	296.15	12	-0.05	-0.04	16.77	-0.21	-0.11	108.06	-0.05	-0.04	16.77
	13107	B	1687.48	307.31	12	0.13	0.2	15.01	0.32	0.7	95.16	0.13	0.2	15.01
	4078	C	1669.53	322.36	12	0.07	-0.03	12.88	0.11	0.02	72.65	0.07	-0.03	12.88
	4079	D	1654.4	335.06	12	0.1	-0.06	5.38	-1.52	1.68	67.99	0.1	-0.06	5.38
	4081	E	1639.59	347.49	12	0.08	-0.09	1.21	-0.17	-1.93	-11.08	0.08	-0.09	1.21

STRUCTURAL SCHEMATIC REPORT (continued)

ST. PETERSBURG PIER COLUMN REACTIONS AS PER ROBOT MODEL C002-029

COLUMN DATA						DEAD LOADS						LIVE LOADS		
						DL REACTIONS			TOTAL DEAD LOAD REACTIONS			LLr REACTIONS		
RAKER LINE	COLUMN NODE	COLUMN TYPE	X (ft)	Y (ft)	Z (ft)	FX (kip)	FY (kip)	FZ (kip)	FX (kip)	FY (kip)	FZ (kip)	FX (kip)	FY (kip)	FZ (kip)
21	13116	A	1664.39	272.53	12	-0.09	-0.01	13.38	-0.34	0.01	96.12	-0.09	-0.01	13.38
	13109	B	1654.98	286.26	12	-0.04	-0.01	7.52	-0.28	0.06	67.46	-0.04	-0.01	7.52
	4074	C	1642.99	303.74	12	-0.06	-0.08	7.12	-0.38	-0.37	52.62	-0.06	-0.08	7.12
	2042	D	1632.82	318.59	12	1.05	-1.78	7.04	2.97	-5.87	64.54	1.05	-1.78	7.04
	4076	E	1623.2	332.61	12	0.02	-0.02	2.16	0.17	-1.38	30.65	0.02	-0.02	2.16
20	13120	A	1622.69	257.8	12	-0.05	0.01	10.79	-0.23	0.05	81.65	-0.05	0.01	10.79
	13111	B	1617.57	268.81	12	-0.04	0.03	8.88	-0.23	0.19	69.82	-0.04	0.03	8.88
	4069	C	1608.78	287.73	12	-0.09	-0.1	11.05	-0.38	-0.47	65.75	-0.09	-0.1	11.05
	4070	D	1601.72	302.92	12	0.01	-0.2	4.77	-0.75	0.09	56.17	0.01	-0.2	4.77
	4072	E	1594.94	317.5	12	0.03	-0.02	2.71	0.02	-1.86	30.45	0.03	-0.02	2.71
19	13113	A	1576.67	255.35	12	0.08	-0.26	22.33	0.2	-0.83	111.65	0.08	-0.26	22.33
	4063	B	1570.28	274.32	12	0.06	0.07	7.72	0.17	0.16	51.88	0.06	0.07	7.71
	4064	C	1565.08	289.72	12	-0.02	0.07	5.14	-0.6	0.2	54.5	-0.02	0.07	5.14
	2036	D	1561.86	299.27	12	0.3	-1.16	1.21	2.94	-9.81	10.78	0.3	-1.16	1.21
	4066	E	1560.37	303.69	12	-0.03	0	2.83	-0.67	-0.21	33.52	-0.03	0	2.83
18	2032	A	1533.07	250.25	12	0	-0.3	23.32	-0.22	-1.08	110.78	0	-0.3	23.31
	4059	B	1526.7	279.73	12	-5.17	0.53	3.06	-28.03	2.67	41.03	-5.17	0.53	3.06
	4061	C	1523.71	293.58	12	-0.03	0.27	2.64	-0.54	0.58	33.57	-0.03	0.27	2.64
17	2030	A	1488.74	246.6	12	-0.15	-0.11	15.69	-0.74	-0.43	85.37	-0.15	-0.11	15.68
	4055	B	1484.87	272.48	12	-1.06	-0.39	13.97	-4.41	-1.57	83.47	-1.06	-0.39	13.97
	4057	C	1482.84	286.08	12	-0.04	-0.2	3.24	-0.69	-0.99	36.54	-0.04	-0.2	3.24
16	2028	A	1443.98	246.06	12	-0.34	0.78	12.02	-1.16	2.76	68.3	-0.34	0.78	12.01
	4053	B	1441.13	281.28	12	0.17	0	3.06	-1.49	-0.47	21.64	0.17	0	3.06
15	4046	A	1398.73	249.21	12	0.4	1.13	9.68	1.25	4.56	55.74	0.4	1.13	9.67
	4050	B	1398.37	279.3	12	0.08	-1.01	11.39	-0.33	-4.04	55.05	0.08	-1.01	11.39
14	4001	A	1354.59	280.31	12	0.21	-0.29	4.68	-0.93	-1.23	28.59	0.21	-0.29	4.68

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ST. PETERSBURG PIER COLUMN REACTIONS AS PER ROBOT MODEL C002-029

COLUMN DATA						LIVE LOADS						TEMPERATURE LOADS		
						LLb REACTIONS			TOTAL LIVE LOAD REACTIONS			T1 REACTIONS		
RAKER LINE	COLUMN NODE	COLUMN TYPE	X (ft)	Y (ft)	Z (ft)	FX (kip)	FY (kip)	FZ (kip)	FX (kip)	FY (kip)	FZ (kip)	FX (kip)	FY (kip)	FZ (kip)
37	4003	A	1353.66	540.74	25.5	1.15	-1	30.72	0.38	5.01	33.31	106.85	-12.78	39.08
	4005	B	1354.34	529.09	25.5	0.37	0.93	10.66	1.03	-5.22	14.81	3.6	16.64	0.18
36	4009	A	1398.29	542.76	0	0.01	-1.45	35.73	-0.01	-1.48	47.51	0.3	-0.86	-32.36
	4011	B	1398.04	520.76	22.42	-0.06	1.46	4.28	-0.33	1.68	11.7	3.33	-6.66	-6.9
35	13211	A	1444.06	558	0	0.02	-0.17	-1.17	0.03	-0.24	4.02	0.88	-1.36	1.49
	4013	B	1442.7	541.23	0	-0.06	-0.81	37.64	-0.07	-1.07	47.09	0.24	-1.31	1.17
	4015	C	1440.89	518.72	19.42	0.06	1.1	4.6	0.13	1.46	11.14	1.97	-3.91	-5.68
34	13213	A	1488.87	556.58	0	0.02	0	-0.87	0.03	-0.02	8.62	0.6	-0.33	0.25
	4017	B	1485.93	536.87	0	-0.02	-0.25	35.41	-0.01	-0.3	45.39	0.23	-0.2	-8.55
	4019	C	1482.52	513.95	16.83	0.13	0.78	5.1	0.15	0.98	12.17	1.19	-0.59	-1.1
33	13201	A	1534.35	557.36	0	-1.39	-0.59	0.54	-1.71	-0.74	6.16	-14.45	-6.19	11.43
	2006	B	1532.79	550.14	0	0.01	-0.01	0.52	-0.06	-0.03	8.2	0.34	0.13	0.23
	2008	C	1528.33	529.36	0	0	-0.09	35.49	0.01	-0.1	49.01	0.2	0.25	3.62
	4021	D	1523.4	506.47	14	0.09	0.35	5.48	0.13	0.49	12.28	0.58	1.25	1.05
32	13208	A	1578.38	550.54	0	0.01	0	-0.41	-0.02	0.01	9.43	0.12	-0.07	1.78
	2010	B	1574.93	540.28	0	0.01	-0.01	0.36	0.1	-0.08	8.84	0.17	0.03	-2.87
	4024	C	1567.75	518.96	0	-0.01	-0.08	34.44	0	-0.09	51.25	0.11	0.09	-38.11
	4025	D	1560.16	496.37	12	0.11	0.29	5.37	0.16	0.44	12.36	-0.27	0.71	-0.55
31	13104	A	1623.61	544.53	0	-1.17	-0.54	0.65	-0.59	-0.31	9.84	-43.61	-20.13	29.61
	2012	B	1615.74	527.58	0	0.01	-0.01	-0.15	-0.05	0.01	13.55	-0.08	-0.27	-0.6
	2014	C	1605.21	504.91	0	-0.02	-0.1	36.06	-0.01	-0.11	52.23	-0.28	-0.28	3.67
	4027	D	1594.82	482.53	12	0.15	0.31	5.04	0.22	0.5	11.68	-1.71	-0.35	-1.7
30	13102	A	1666.19	530.14	0	0	0	-0.02	0	0	10.47	-0.07	-0.21	-0.25
	2016	B	1652.67	510.42	0	0.01	-0.02	-0.17	0.07	-0.04	16.05	-0.28	-0.35	0.79
	4030	C	1637.37	488.08	0	-0.04	-0.08	36.06	-0.03	-0.08	51.36	-0.55	-0.5	-36.19
	4031	D	1623.19	467.39	12	0.21	0.24	5.24	0.27	0.4	10.75	-3.45	-1.06	-6.4

STRUCTURAL SCHEMATIC REPORT (continued)

ST. PETERSBURG PIER COLUMN REACTIONS AS PER ROBOT MODEL C002-029

COLUMN DATA						LIVE LOADS						TEMPERATURE LOADS		
						LLb REACTIONS			TOTAL LIVE LOAD REACTIONS			T1 REACTIONS		
RAKER LINE	COLUMN NODE	COLUMN TYPE	X (ft)	Y (ft)	Z (ft)	FX (kip)	FY (kip)	FZ (kip)	FX (kip)	FY (kip)	FZ (kip)	FX (kip)	FY (kip)	FZ (kip)
29	13106	A	1703.94	506.5	12	0.05	-0.03	-0.17	-0.49	0.3	4.79	-0.65	0.32	3.54
	2018	B	1695.51	499.43	12	0.01	0	0.05	0.44	0.29	4.13	-0.28	-0.14	-1.15
	4033	C	1681.46	487.65	12	0.02	-0.01	-0.36	0.01	0.04	9.58	-0.26	-0.26	3.7
	2020	D	1659.12	468.9	12	0.02	-0.25	36.53	0.39	-2.35	39.46	-51.61	33.53	37.44
	4034	E	1639.59	452.51	12	0.25	0.19	4.54	0.2	0.24	6.39	-1.44	1.84	3.22
27	4036	A	1702.07	433.51	12	0.03	0.04	-5.16	0.25	0.04	4.6	-0.07	-0.49	9.74
	2024	B	1683.15	428.44	12	2.97	1.34	41.63	3.64	1.4	41.21	-5.57	-2.88	-6.39
	4038	C	1656.51	421.3	12	-0.03	2.42	-2.77	0.08	2.3	-1.11	1.05	-3.35	11
26	13011	A	1739.02	424.95	12	0	0	-0.26	-0.57	7.48	34.92	-0.1	-0.05	2.44
	4040	B	1705.19	419.74	12	0.01	0.05	-0.24	0.13	-0.02	10.64	-0.16	-0.48	-1.7
	4042	C	1685.42	416.7	12	-0.37	0.52	38.55	-0.34	0.37	44.14	-0.17	-1.33	-3.94
	4044	D	1657.75	412.43	12	0.03	2.61	8.12	0.31	2.5	11.43	0.71	-3.4	-7.67
25	13007	A	1740.05	382.98	12	0	0.01	0.35	0.03	0.01	22.41	-0.19	-0.15	0.42
	4096	B	1706	386.54	12	0.01	0.04	-1.57	0.27	0.01	15.36	-0.48	-0.25	-0.88
	4098	C	1686.11	388.61	12	-0.2	0.53	35.76	0.24	0.51	41.63	-1.56	-0.7	-1.13
	4100	D	1658.26	391.52	12	0.7	2.35	9.28	1.45	2.24	15.03	-1.18	-2.81	-0.92
24	13009	A	1739.04	339.42	12	-0.02	0.02	0.04	0.02	0.03	17.19	-0.11	-0.06	0.76
	4092	B	1694.59	356.04	12	-0.19	0.1	11.72	0.12	-0.25	42.27	-0.59	-0.54	62.67
	2048	C	1674.06	363.72	12	-18.62	7.03	13.01	-16.83	6	14.96	-16.45	4.13	-18.33
	4094	D	1653.53	371.39	12	0.87	3.26	-41.36	1	3.28	-37.99	-1.26	-2.22	-1.52
23	4085	A	1684.49	337.94	12	1.93	3.47	6.28	0.93	1.68	3.03	-14.93	-26.76	-48.48
	4089	B	1647.76	359.15	12	32.26	-17.65	129.96	32.68	-17.86	133.77	-1.4	-2.02	3
22	13118	A	1700.77	296.15	12	-0.03	0.03	0.01	-0.08	-0.01	16.78	-0.27	0.01	-0.08
	13107	B	1687.48	307.31	12	-0.07	0.09	-0.76	0.06	0.29	14.25	-0.46	0.14	0.57
	4078	C	1669.53	322.36	12	-0.2	0.15	0.99	-0.13	0.12	13.87	-0.87	0.15	10.31
	4079	D	1654.4	335.06	12	-1.95	2.1	42.72	-1.85	2.04	48.1	-3.02	0.13	2.94
	4081	E	1639.59	347.49	12	-1.04	-1.78	-39.75	-0.96	-1.87	-38.54	-2.4	-1.12	-5.07

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ST. PETERSBURG PIER COLUMN REACTIONS AS PER ROBOT MODEL C002-029

COLUMN DATA						LIVE LOADS						TEMPERATURE LOADS		
						LLb REACTIONS			TOTAL LIVE LOAD REACTIONS			T1 REACTIONS		
RAKER LINE	COLUMN NODE	COLUMN TYPE	X (ft)	Y (ft)	Z (ft)	FX (kip)	FY (kip)	FZ (kip)	FX (kip)	FY (kip)	FZ (kip)	FX (kip)	FY (kip)	FZ (kip)
21	13116	A	1664.39	272.53	12	0	0.01	0.07	-0.09	0	13.45	-0.26	0.11	-0.09
	13109	B	1654.98	286.26	12	-0.02	0	0.03	-0.06	-0.01	7.55	-0.49	0.23	2.06
	4074	C	1642.99	303.74	12	-0.1	0	1.05	-0.16	-0.08	8.17	-0.91	0.11	20.98
	2042	D	1632.82	318.59	12	-1.74	1.97	27.34	-0.69	0.19	34.38	-14.34	17.97	-28.84
	4076	E	1623.2	332.61	12	-0.2	-1.16	11.68	-0.18	-1.18	13.84	-1.83	-0.76	-2.54
20	13120	A	1622.69	257.8	12	-0.01	-0.02	0.02	-0.06	-0.01	10.81	-0.26	0.26	0.33
	13111	B	1617.57	268.81	12	-0.01	-0.04	-0.06	-0.05	-0.01	8.82	-0.36	0.42	0.51
	4069	C	1608.78	287.73	12	-0.06	-0.07	-0.18	-0.15	-0.17	10.87	-0.64	0.49	2.08
	4070	D	1601.72	302.92	12	-0.58	0.37	32	-0.57	0.17	36.77	-1.94	1.93	1.1
	4072	E	1594.94	317.5	12	-0.4	-1.53	7.96	-0.37	-1.55	10.67	-1.28	-0.1	-3.13
19	13113	A	1576.67	255.35	12	-0.01	-0.02	-0.09	0.07	-0.28	22.24	-0.13	0.42	1.02
	4063	B	1570.28	274.32	12	-0.05	-0.05	0.6	0.01	0.02	8.31	-0.25	0.58	-5.24
	4064	C	1565.08	289.72	12	-0.43	-0.08	27.7	-0.45	-0.01	32.84	-0.7	1.99	3.69
	2036	D	1561.86	299.27	12	1.37	-4.51	4.72	1.67	-5.67	5.93	-5.91	17.37	-18.48
	4066	E	1560.37	303.69	12	-0.76	-0.03	11.39	-0.79	-0.03	14.22	-0.14	-0.41	-3.08
18	2032	A	1533.07	250.25	12	-0.05	-0.02	-0.01	-0.05	-0.32	23.3	0.3	0.62	0.58
	4059	B	1526.7	279.73	12	-5.35	-0.25	26.25	-10.52	0.28	29.31	35.24	-0.29	22.3
	4061	C	1523.71	293.58	12	-0.6	-0.07	11.42	-0.63	0.2	14.06	0.75	-0.59	-3.24
17	2030	A	1488.74	246.6	12	-0.07	-0.01	0	-0.22	-0.12	15.68	1.16	0.8	0.63
	4055	B	1484.87	272.48	12	-0.41	-0.99	29.38	-1.47	-1.38	43.35	1.1	7.73	1
	4057	C	1482.84	286.08	12	-0.61	0.39	11.61	-0.65	0.19	14.85	2.55	-5.33	-3.19
16	2028	A	1443.98	246.06	12	-0.11	-0.01	0.02	-0.45	0.77	12.03	3.14	0.59	-0.93
	4053	B	1441.13	281.28	12	-2.73	-0.56	-0.24	-2.56	-0.56	2.82	9.2	2.16	0.69
15	4046	A	1398.73	249.21	12	-0.11	-0.02	-0.13	0.29	1.11	9.54	4.28	1.03	4.19
	4050	B	1398.37	279.3	12	-0.74	-0.03	0.25	-0.66	-1.04	11.64	3.82	0.46	-4.12
14	4001	A	1354.59	280.31	12	-2.26	-0.09	-0.53	-2.05	-0.38	4.15	15.66	-0.7	4.12

STRUCTURAL SCHEMATIC REPORT (continued)

ST. PETERSBURG PIER COLUMN REACTIONS AS PER ROBOT MODEL C002-029

COLUMN DATA						TEMPERATURE LOADS			WIND LOADS					
						T2 REACTIONS			WL1a REACTIONS			WL1b REACTIONS		
RAKER LINE	COLUMN NODE	COLUMN TYPE	X (ft)	Y (ft)	Z (ft)	FX (kip)	FY (kip)	FZ (kip)	FX (kip)	FY (kip)	FZ (kip)	FX (kip)	FY (kip)	FZ (kip)
37	4003	A	1353.66	540.74	25.5	-240.41	28.76	-87.93	85.31	-33.92	-2.35	57.01	-18.7	28.28
	4005	B	1354.34	529.09	25.5	-8.09	-37.45	-0.41	1.12	38.87	-2.24	-1.25	22.53	-35.61
36	4009	A	1398.29	542.76	0	-0.67	1.93	72.8	0.32	-2.66	-129.59	-0.02	2.72	-77.3
	4011	B	1398.04	520.76	22.42	-7.5	15	15.52	5.42	1.41	-15.35	4.74	-1.77	-54.68
35	13211	A	1444.06	558	0	-1.98	3.05	-3.35	-0.17	2.14	-58.05	-0.03	2.43	-36.82
	4013	B	1442.7	541.23	0	-0.53	2.94	-2.63	0.67	2.54	-68.64	0.52	4.25	-77.71
	4015	C	1440.89	518.72	19.42	-4.43	8.81	12.78	4.01	4.62	-14.24	2.17	3.08	-45.16
34	13213	A	1488.87	556.58	0	-1.34	0.75	-0.57	-0.22	0.1	-98.18	-0.09	0.29	-66.99
	4017	B	1485.93	536.87	0	-0.51	0.45	19.24	0.17	-0.22	-4.29	0.16	0.57	-32.75
	4019	C	1482.52	513.95	16.83	-2.67	1.32	2.48	3.03	-0.97	-20.9	1.54	-1.32	-55.47
33	13201	A	1534.35	557.36	0	32.5	13.93	-25.72	51.96	22.54	-107.81	49.98	21.93	-85.97
	2006	B	1532.79	550.14	0	-0.76	-0.3	-0.52	0.61	0.7	-75.62	0.53	1.04	-52.45
	2008	C	1528.33	529.36	0	-0.44	-0.56	-8.14	0.76	0.22	-57.66	0.66	0.99	-104.49
	4021	D	1523.4	506.47	14	-1.31	-2.82	-2.37	3.17	1.28	-14.94	2.03	2.38	-49.41
32	13208	A	1578.38	550.54	0	-0.27	0.16	-4	-0.05	1.01	-135.98	0.02	0.91	-95.28
	2010	B	1574.93	540.28	0	-0.37	-0.06	6.46	-0.52	1.56	-57.99	-0.34	1.37	-36.65
	4024	C	1567.75	518.96	0	-0.24	-0.21	85.75	0.27	1.23	219.46	0.21	1.57	119.32
	4025	D	1560.16	496.37	12	0.61	-1.6	1.23	4.09	5.28	-1.59	2.36	4.51	-42.24
31	13104	A	1623.61	544.53	0	98.12	45.3	-66.63	310.39	144.01	-341.35	263.83	122.3	-269.7
	2012	B	1615.74	527.58	0	0.18	0.61	1.36	1.26	3.61	-119.28	0.96	2.88	-78.95
	2014	C	1605.21	504.91	0	0.62	0.63	-8.25	2.75	4.95	-82.09	2.18	4.35	-133.01
	4027	D	1594.82	482.53	12	3.85	0.79	3.83	11.1	20.57	14.22	7.29	15.82	-30.67
30	13102	A	1666.19	530.14	0	0.16	0.47	0.56	1.02	1.76	-173.16	0.78	1.34	-121.42
	2016	B	1652.67	510.42	0	0.62	0.79	-1.78	1.28	5.73	-147.83	0.97	4.41	-101.63
	4030	C	1637.37	488.08	0	1.24	1.13	81.42	5.14	8.17	-346.01	4	6.57	-345.82
	4031	D	1623.19	467.39	12	7.75	2.38	14.39	19.29	37.81	17.61	12.99	28.95	-24.85

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ST. PETERSBURG PIER COLUMN REACTIONS AS PER ROBOT MODEL C002-029

COLUMN DATA						TEMPERATURE LOADS			WIND LOADS					
						T2 REACTIONS			WL1a REACTIONS			WL1b REACTIONS		
RAKER LINE	COLUMN NODE	COLUMN TYPE	X (ft)	Y (ft)	Z (ft)	FX (kip)	FY (kip)	FZ (kip)	FX (kip)	FY (kip)	FZ (kip)	FX (kip)	FY (kip)	FZ (kip)
29	13106	A	1703.94	506.5	12	1.46	-0.72	-7.98	-3.76	2.58	-105.19	-3.17	2.15	-74.74
	2018	B	1695.51	499.43	12	0.63	0.33	2.58	1.13	2.4	9.25	1.15	2.05	9.95
	4033	C	1681.46	487.65	12	0.58	0.58	-8.33	-1.74	3.85	-193.84	-1.36	2.95	-140.52
	2020	D	1659.12	468.9	12	116.11	-75.44	-84.23	-177.68	347.56	460.58	-160.07	284.61	348.61
	4034	E	1639.59	452.51	12	3.23	-4.14	-7.24	-2.23	12.66	20.91	-2.92	10.3	4.67
27	4036	A	1702.07	433.51	12	0.16	1.1	-21.92	4.33	-3.98	-340.05	3.6	-3.63	-264.78
	2024	B	1683.15	428.44	12	12.53	6.47	14.38	332.33	77.45	595.71	256.33	58.4	447.81
	4038	C	1656.51	421.3	12	-2.37	7.55	-24.75	20.13	-15.37	83.5	15.78	-13.51	65.33
26	13011	A	1739.02	424.95	12	0.22	0.1	-5.49	11.62	-123.57	-543.78	8.35	-86.63	-377.73
	4040	B	1705.19	419.74	12	0.35	1.08	3.83	7.92	-2.71	-28.41	6.61	-2.68	-34.49
	4042	C	1685.42	416.7	12	0.39	3	8.87	27.9	-6.57	-26.84	22.86	-6.18	-72.55
	4044	D	1657.75	412.43	12	-1.59	7.66	17.26	37.87	-14.25	-11.06	29.9	-12.67	-30.95
25	13007	A	1740.05	382.98	12	0.43	0.33	-0.94	1.76	-1.16	-306.28	1.51	-0.97	-210.22
	4096	B	1706	386.54	12	1.09	0.56	1.98	5.73	-2.3	-157.39	5.31	-2.34	-136.54
	4098	C	1686.11	388.61	12	3.51	1.58	2.54	32.96	-8.24	-12.86	28.87	-7.92	-72.69
	4100	D	1658.26	391.52	12	2.66	6.32	2.07	33.8	-13.7	31.53	28.37	-12.08	1.75
24	13009	A	1739.04	339.42	12	0.25	0.14	-1.71	0	-0.05	-240.62	0.04	-0.05	-165.99
	4092	B	1694.59	356.04	12	1.32	1.22	-141	-0.47	0.63	-313.28	0.48	0.55	-252.29
	2048	C	1674.06	363.72	12	37.01	-9.3	41.24	261.22	-100.81	429.05	211.43	-80.99	290.69
	4094	D	1653.53	371.39	12	2.83	4.98	3.42	8.36	-7.63	16.11	6.52	-6.78	4.35
23	4085	A	1684.49	337.94	12	33.59	60.21	109.08	-33.37	-59.83	-108.39	-32.96	-59.09	-107.06
	4089	B	1647.76	359.15	12	3.16	4.55	-6.75	-1.98	-1.84	-25.66	-4.14	-0.49	-43.99
22	13118	A	1700.77	296.15	12	0.6	-0.02	0.17	1.62	-0.09	-275.8	1.22	-0.13	-191.68
	13107	B	1687.48	307.31	12	1.04	-0.32	-1.28	0.63	-3.42	-55.86	0.68	-2.62	-36.01
	4078	C	1669.53	322.36	12	1.95	-0.33	-23.19	4.12	-3.46	-77.47	3.32	-3.34	-114.72
	4079	D	1654.4	335.06	12	6.81	-0.28	-6.63	13.7	-12.58	-3.29	10.62	-11.08	-39.96
	4081	E	1639.59	347.49	12	5.4	2.52	11.4	11.08	-9.6	23.83	9.09	-7.88	14.08

STRUCTURAL SCHEMATIC REPORT (continued)

ST. PETERSBURG PIER COLUMN REACTIONS AS PER ROBOT MODEL C002-029

COLUMN DATA						TEMPERATURE LOADS			WIND LOADS					
						T2 REACTIONS			WL1a REACTIONS			WL1b REACTIONS		
RAKER LINE	COLUMN NODE	COLUMN TYPE	X (ft)	Y (ft)	Z (ft)	FX (kip)	FY (kip)	FZ (kip)	FX (kip)	FY (kip)	FZ (kip)	FX (kip)	FY (kip)	FZ (kip)
21	13116	A	1664.39	272.53	12	0.6	-0.24	0.21	1.85	-0.41	-194.99	1.38	-0.37	-133.83
	13109	B	1654.98	286.26	12	1.1	-0.51	-4.64	1.4	-1.39	-47.01	1.27	-1.35	-39.96
	4074	C	1642.99	303.74	12	2.05	-0.25	-47.21	4.09	-1.65	-211.02	3.37	-1.64	-233.43
	2042	D	1632.82	318.59	12	32.26	-40.43	64.88	133.85	-189.25	336.07	113.59	-160.76	261.06
	4076	E	1623.2	332.61	12	4.11	1.71	5.72	5.84	-4.34	6.95	5.07	-3.96	-5.05
20	13120	A	1622.69	257.8	12	0.58	-0.59	-0.75	1.55	-0.99	-149.78	1.2	-0.87	-101.34
	13111	B	1617.57	268.81	12	0.8	-0.94	-1.16	1.79	-1.63	-54.38	1.57	-1.62	-45.45
	4069	C	1608.78	287.73	12	1.44	-1.1	-4.69	4.21	-2.07	-45.53	3.84	-2.02	-94.57
	4070	D	1601.72	302.92	12	4.36	-4.34	-2.49	9.45	-9.55	-3.16	7.98	-8.67	-30.54
	4072	E	1594.94	317.5	12	2.88	0.24	7.05	5.35	-3.97	5.74	4.74	-3.85	-7.96
19	13113	A	1576.67	255.35	12	0.3	-0.94	-2.28	-0.6	3.88	-250.92	-0.22	2.31	-177.78
	4063	B	1570.28	274.32	12	0.56	-1.3	11.79	2.72	-0.65	-96.29	1.66	-0.88	-144.65
	4064	C	1565.08	289.72	12	1.58	-4.47	-8.29	5.09	2.52	-21.99	4.08	2.26	-45.78
	2036	D	1561.86	299.27	12	13.29	-39.07	41.58	12.68	-36.99	39.27	14.32	-41.81	44.37
	4066	E	1560.37	303.69	12	0.32	0.93	6.93	3.94	-1.41	-6.28	3.47	-1.89	-19
18	2032	A	1533.07	250.25	12	-0.68	-1.4	-1.3	2.61	-0.16	-245.42	2.85	-4.38	-199.98
	4059	B	1526.7	279.73	12	-79.28	0.64	-50.17	293.16	-55.64	149.05	236.78	-44.49	71.51
	4061	C	1523.71	293.58	12	-1.7	1.32	7.29	17.17	-61.56	64.35	15.23	-55.88	43.64
17	2030	A	1488.74	246.6	12	-2.6	-1.79	-1.41	5.65	-6.47	-180.84	4.86	-7.24	-140.61
	4055	B	1484.87	272.48	12	-2.49	-17.39	-2.24	2.93	14.75	-18.46	7.74	14.51	-91.61
	4057	C	1482.84	286.08	12	-5.73	11.98	7.17	16.62	-80.17	43.45	14.66	-67.73	20.25
16	2028	A	1443.98	246.06	12	-7.07	-1.32	2.1	12.15	-25.51	-130.05	9.58	-28.11	-108.35
	4053	B	1441.13	281.28	12	-20.69	-4.85	-1.54	13.76	2.24	-7.96	11.57	1.78	-23.05
15	4046	A	1398.73	249.21	12	-9.64	-2.33	-9.43	9.35	-10.85	-50.03	6.48	-15.39	-67.71
	4050	B	1398.37	279.3	12	-8.59	-1.04	9.27	4.01	-2.42	-28.18	3.33	0.43	-74.62
14	4001	A	1354.59	280.31	12	-35.23	1.57	-9.27	14.18	-3.51	-21.83	11.07	-4.72	-34.08

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ST. PETERSBURG PIER COLUMN REACTIONS AS PER ROBOT MODEL C002-029

COLUMN DATA						WIND LOADS								
						WL2a REACTIONS			WL2b REACTIONS			WL3a REACTIONS		
RAKER LINE	COLUMN NODE	COLUMN TYPE	X (ft)	Y (ft)	Z (ft)	FX (kip)	FY (kip)	FZ (kip)	FX (kip)	FY (kip)	FZ (kip)	FX (kip)	FY (kip)	FZ (kip)
37	4003	A	1353.66	540.74	25.5	-97.09	44.38	0.21	-83.81	51.26	-5.24	47.45	30.64	32.51
	4005	B	1354.34	529.09	25.5	0.13	-50.52	14.82	3.22	-57.69	40.03	6.04	-30.85	18.6
36	4009	A	1398.29	542.76	0	-0.37	1.37	152.59	-0.33	-2.41	143.15	0.29	-1.12	44.31
	4011	B	1398.04	520.76	22.42	-6.54	-0.86	36.52	-6.48	0.87	73.24	2.78	-4.94	30.02
35	13211	A	1444.06	558	0	0.15	-2.85	63.92	0.04	-3.37	50.75	-0.62	-0.51	-13.32
	4013	B	1442.7	541.23	0	-0.74	-4.02	90.42	-0.6	-5.91	104.76	0.09	-0.7	7.87
	4015	C	1440.89	518.72	19.42	-4.23	-5.17	32.38	-2.9	-4.31	62.64	2.93	-1.81	-1.28
34	13213	A	1488.87	556.58	0	0.22	-0.22	110.26	0.12	-0.44	92.33	-0.57	-0.61	-37.14
	4017	B	1485.93	536.87	0	-0.22	-0.1	19.02	-0.23	-0.83	46.86	0.44	-0.66	-11.64
	4019	C	1482.52	513.95	16.83	-3.14	1.35	42.43	-2.05	1.68	76.79	2.78	-4.08	-30.69
33	13201	A	1534.35	557.36	0	-64.73	-28.2	126.56	-68.1	-29.94	117.99	27.14	10.77	-42.06
	2006	B	1532.79	550.14	0	-0.74	-1.06	85.28	-0.74	-1.49	72.13	-0.25	-1.14	-34.47
	2008	C	1528.33	529.36	0	-0.92	-0.65	94.75	-0.89	-1.44	144.67	0.56	-1.69	-44.99
	4021	D	1523.4	506.47	14	-3.49	-2.18	34.81	-2.76	-3.5	68.31	1.89	-6.62	-32.97
32	13208	A	1578.38	550.54	0	0.03	-1.23	153.83	-0.03	-1.26	131.25	-0.36	0.39	-54.11
	2010	B	1574.93	540.28	0	0.58	-1.9	63.79	0.47	-1.91	50.55	-0.44	0.44	-18.48
	4024	C	1567.75	518.96	0	-0.31	-1.73	-231.76	-0.27	-2.19	-161.64	0.51	0.17	133.49
	4025	D	1560.16	496.37	12	-4.37	-6.37	20.77	-3.17	-6.29	58.71	3.61	0.42	-17.85
31	13104	A	1623.61	544.53	0	-371.87	-172.49	399.7	-361.65	-167.64	369.68	204.68	95.31	-225.42
	2012	B	1615.74	527.58	0	-1.46	-4.24	132.76	-1.3	-3.94	108.44	0.84	3.06	-59.26
	2014	C	1605.21	504.91	0	-3.21	-6.01	127.67	-2.96	-5.98	183.94	2.73	4.18	-100.81
	4027	D	1594.82	482.53	12	-12.29	-23.9	2.73	-9.85	-21.69	43.06	10.51	15.49	-12.51
30	13102	A	1666.19	530.14	0	-1.18	-2.04	195.74	-1.06	-1.83	166.06	0.94	1.62	-135.81
	2016	B	1652.67	510.42	0	-1.48	-6.65	166.17	-1.31	-6.03	138.99	1.3	5.21	-111.47
	4030	C	1637.37	488.08	0	-5.98	-9.62	439.48	-5.44	-8.99	477.98	5.29	7.51	-299.52
	4031	D	1623.19	467.39	12	-21.51	-43.84	-2.6	-17.57	-39.57	35.29	19.62	33	-12.8

STRUCTURAL SCHEMATIC REPORT (continued)

ST. PETERSBURG PIER COLUMN REACTIONS AS PER ROBOT MODEL C002-029

COLUMN DATA						WIND LOADS								
						WL2a REACTIONS			WL2b REACTIONS			WL3a REACTIONS		
RAKER LINE	COLUMN NODE	COLUMN TYPE	X (ft)	Y (ft)	Z (ft)	FX (kip)	FY (kip)	FZ (kip)	FX (kip)	FY (kip)	FZ (kip)	FX (kip)	FY (kip)	FZ (kip)
29	13106	A	1703.94	506.5	12	4.5	-3.07	119.32	4.34	-2.95	102.11	-4.44	2.95	-84.35
	2018	B	1695.51	499.43	12	-1.44	-2.88	-12.01	-1.57	-2.79	-13.53	1.66	2.6	14.6
	4033	C	1681.46	487.65	12	2.04	-4.47	221.2	1.86	-4.04	192.2	-1.54	3.45	-157.59
	2020	D	1659.12	468.9	12	218.02	-412.37	-533.17	222.69	-392.5	-480.02	-90.8	245.66	307.77
	4034	E	1639.59	452.51	12	3.16	-14.97	-19.03	4.08	-14.16	-6.2	-1.01	9.37	4.1
27	4036	A	1702.07	433.51	12	-5.16	4.89	396.58	-4.94	4.99	362.89	3.84	-3.77	-287
	2024	B	1683.15	428.44	12	-386.44	-89.44	-687.31	-351.24	-79.98	-613.34	278.02	63.81	487.32
	4038	C	1656.51	421.3	12	-23.52	18.64	-97.53	-21.63	18.57	-89.57	16.92	-13.72	68.71
26	13011	A	1739.02	424.95	12	-13.23	139.67	613.02	-11.43	118.5	516.59	9.14	-95.29	-416.2
	4040	B	1705.19	419.74	12	-9.44	3.43	38.87	-9.07	3.69	47.59	7.05	-2.73	-34.4
	4042	C	1685.42	416.7	12	-33.07	8.16	55.22	-31.36	8.5	100.71	24.45	-6.28	-68.38
	4044	D	1657.75	412.43	12	-44.36	17.34	23.25	-41	17.41	42.99	32.14	-12.75	-27.98
25	13007	A	1740.05	382.98	12	-2.12	1.38	344.12	-2.07	1.33	287.46	1.61	-1.01	-231.84
	4096	B	1706	386.54	12	-7.08	2.94	190.04	-7.29	3.22	187.5	5.62	-2.37	-144.31
	4098	C	1686.11	388.61	12	-39.92	10.3	44.02	-39.64	10.89	101.16	30.73	-8.09	-66.72
	4100	D	1658.26	391.52	12	-40.36	16.63	-26.21	-38.93	16.6	-1.84	30.47	-12.15	6.14
24	13009	A	1739.04	339.42	12	-0.02	0.07	270.73	-0.05	0.07	227	0.04	-0.04	-182.94
	4092	B	1694.59	356.04	12	0.16	-0.76	369.19	-0.67	-0.76	345.67	0.52	0.86	-298.64
	2048	C	1674.06	363.72	12	-308.37	118.73	-480.28	-289.94	111.06	-397.31	230.89	-87.73	325.47
	4094	D	1653.53	371.39	12	-9.75	9.29	-15	-8.93	9.32	-5.76	7.53	-6.59	6.61
23	4085	A	1684.49	337.94	12	42.16	75.59	136.94	45.44	81.47	147.58	-26.54	-47.57	-86.18
	4089	B	1647.76	359.15	12	3.51	1.71	41.05	5.75	0.66	60.88	-3.57	-0.04	-43.13
22	13118	A	1700.77	296.15	12	-1.87	0.13	310.97	-1.68	0.18	262.18	1.33	-0.09	-210.53
	13107	B	1687.48	307.31	12	-0.82	3.97	61.68	-0.93	3.59	49.17	0.68	-2.76	-40.03
	4078	C	1669.53	322.36	12	-4.86	4.34	115.54	-4.56	4.6	158.53	3.57	-3.24	-117.54
	4079	D	1654.4	335.06	12	-15.96	15.27	21.15	-14.56	15.23	55.66	11.72	-10.77	-38.29
	4081	E	1639.59	347.49	12	-13.14	11.39	-25.72	-12.47	10.83	-19.19	9.97	-7.58	15.24

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ST. PETERSBURG PIER COLUMN REACTIONS AS PER ROBOT MODEL C002-029

COLUMN DATA						WIND LOADS								
						WL2a REACTIONS			WL2b REACTIONS			WL3a REACTIONS		
RAKER LINE	COLUMN NODE	COLUMN TYPE	X (ft)	Y (ft)	Z (ft)	FX (kip)	FY (kip)	FZ (kip)	FX (kip)	FY (kip)	FZ (kip)	FX (kip)	FY (kip)	FZ (kip)
21	13116	A	1664.39	272.53	12	-2.13	0.5	219.15	-1.89	0.51	183.44	1.54	-0.09	-125.02
	13109	B	1654.98	286.26	12	-1.72	1.75	56.44	-1.74	1.86	55.26	1.02	-1.09	-18.3
	4074	C	1642.99	303.74	12	-4.86	2.09	278.16	-4.63	2.26	322.16	3.49	-0.89	-178.32
	2042	D	1632.82	318.59	12	-160.49	227	-391.81	-156.25	221.18	-358.73	95.9	-133.61	225.39
	4076	E	1623.2	332.61	12	-7.06	5.34	-3.27	-6.96	5.46	7.14	4.89	-2.76	-1.49
20	13120	A	1622.69	257.8	12	-1.81	1.2	167.8	-1.66	1.2	139.63	0.97	-0.27	-56.12
	13111	B	1617.57	268.81	12	-2.17	2.07	64.92	-2.16	2.25	62.74	1.22	-0.57	-23.47
	4069	C	1608.78	287.73	12	-5.17	2.61	80.44	-5.29	2.81	131.18	3.19	-0.36	-40.73
	4070	D	1601.72	302.92	12	-11.32	11.72	16.65	-10.99	12	42.45	6.03	-2.81	-12.45
	4072	E	1594.94	317.5	12	-6.51	4.99	-0.97	-6.52	5.33	11.1	3.89	-1.14	-3.62
19	13113	A	1576.67	255.35	12	0.59	-4.2	284.8	0.31	-3.17	245.06	0.13	1.58	-97.29
	4063	B	1570.28	274.32	12	-2.96	0.93	144.52	-2.27	1.24	200.1	1.87	0.37	-84.66
	4064	C	1565.08	289.72	12	-5.99	-3.07	38.9	-5.6	-3.11	63.53	4.51	2.21	-17.71
	2036	D	1561.86	299.27	12	-16.88	49.28	-52.3	-20	58.42	-62	-5.9	18.22	-19.02
	4066	E	1560.37	303.69	12	-4.78	2.02	13.83	-4.77	2.64	26.31	2.96	0.63	-12.07
18	2032	A	1533.07	250.25	12	-3.42	2.15	290.6	-3.93	6.09	275.97	2.47	-1.62	-106.78
	4059	B	1526.7	279.73	12	-345.92	65.47	-153.3	-325.19	61.23	-97.24	225.39	-34.21	101.81
	4061	C	1523.71	293.58	12	-20.9	75.53	-72.14	-21.01	77.19	-60.16	9.38	-28.3	22.46
17	2030	A	1488.74	246.6	12	-6.8	8.57	211.01	-6.69	10.01	193.97	4.1	-3.44	-75.44
	4055	B	1484.87	272.48	12	-5.94	-18.61	57.19	-10.71	-20.04	127.23	5.62	8.87	-40.62
	4057	C	1482.84	286.08	12	-20.2	96.04	-44.46	-20.22	93.49	-27.81	9.3	-35.81	10.69
16	2028	A	1443.98	246.06	12	-14.23	33.58	155.09	-13.18	38.87	149.54	7.57	-14.09	-57.85
	4053	B	1441.13	281.28	12	-16.45	-2.63	17.07	-15.9	-2.44	31.98	10.92	1.76	-10.48
15	4046	A	1398.73	249.21	12	-10.54	15.87	71.68	-8.9	21.31	93.75	6.04	-7.44	-31.43
	4050	B	1398.37	279.3	12	-4.78	1.76	57.19	-4.58	-0.62	103.5	3.07	0.26	-36.11
14	4001	A	1354.59	280.31	12	-16.56	5.02	33.37	-15.21	6.53	47.22	9.96	-2.73	-15.64

STRUCTURAL SCHEMATIC REPORT (continued)

ST. PETERSBURG PIER COLUMN REACTIONS AS PER ROBOT MODEL C002-029

COLUMN DATA						WIND LOADS								
						WL3b REACTIONS			WL3b-1 REACTIONS			WL3c REACTIONS		
RAKER LINE	COLUMN NODE	COLUMN TYPE	X (ft)	Y (ft)	Z (ft)	FX (kip)	FY (kip)	FZ (kip)	FX (kip)	FY (kip)	FZ (kip)	FX (kip)	FY (kip)	FZ (kip)
37	4003	A	1353.66	540.74	25.5	31.42	58.4	41.42	54.96	-17.98	9.58	-36.72	55.04	16.14
	4005	B	1354.34	529.09	25.5	8.58	-60.81	36.97	0.26	21.07	-13.02	5.12	-59.73	36.51
36	4009	A	1398.29	542.76	0	0.26	-2.28	108.75	0.26	0.53	-59.96	-0.1	-1.94	129.65
	4011	B	1398.04	520.76	22.42	0.15	-7.29	58.87	4.34	-1.32	-23.66	-4.29	-3.1	61.48
35	13211	A	1444.06	558	0	-1.34	-3.83	33.2	-0.07	1.97	-38.01	-0.7	-4.22	56.75
	4013	B	1442.7	541.23	0	-0.08	-5.7	78.23	0.32	3.2	-55.18	-0.38	-6.57	102.42
	4015	C	1440.89	518.72	19.42	2.36	-8.7	33.07	2.42	2.95	-30.76	-1	-8.01	50.76
34	13213	A	1488.87	556.58	0	-1.17	-1.71	50.86	-0.11	0.23	-74.01	-0.56	-1.24	101.53
	4017	B	1485.93	536.87	0	0.52	-2.18	27.27	0.22	0.43	-30.06	0.09	-1.69	45.23
	4019	C	1482.52	513.95	16.83	2.43	-6.19	28.3	1.99	-1.49	-53.04	-0.51	-2.2	67.9
33	13201	A	1534.35	557.36	0	-38.59	-19.39	77.39	53	23.2	-93	-73.65	-33.69	135.12
	2006	B	1532.79	550.14	0	-1.69	-4.54	27.11	0.57	1.02	-57.82	-1.52	-3.62	72.02
	2008	C	1528.33	529.36	0	-0.07	-5.59	84.59	0.71	0.9	-101.6	-0.72	-4.12	147.89
	4021	D	1523.4	506.47	14	-0.33	-19.49	8.92	2.39	2.23	-46.15	-2.5	-13.45	50.12
32	13208	A	1578.38	550.54	0	-0.91	-0.83	68.86	0.02	0.95	-104.81	-0.53	-1.42	141.9
	2010	B	1574.93	540.28	0	-0.39	-1.62	32.98	-0.37	1.44	-41.08	0.15	-2.35	59.13
	4024	C	1567.75	518.96	0	0.69	-2.47	46.91	0.24	1.57	139.48	0.17	-2.96	-107.83
	4025	D	1560.16	496.37	12	2.91	-7.63	29.03	2.82	4.73	-37.89	-1.05	-9.04	53.69
31	13104	A	1623.61	544.53	0	-52.63	-23.35	16.95	281.75	130.61	-290.92	-303.88	-140.28	292.97
	2012	B	1615.74	527.58	0	-0.01	1.45	24.09	1.04	3.08	-87.94	-1	-2.17	99.95
	2014	C	1605.21	504.91	0	1.97	1.3	6.37	2.35	4.59	-130.74	-1.13	-3.73	131.45
	4027	D	1594.82	482.53	12	8.88	4.86	17.48	8.25	17	-25.33	-2.87	-13.78	34.9
30	13102	A	1666.19	530.14	0	0.64	1.1	-73.36	0.84	1.45	-133.24	-0.45	-0.77	88.22
	2016	B	1652.67	510.42	0	1.04	3.4	-53.53	1.05	4.75	-113.89	-0.42	-2.67	81.98
	4030	C	1637.37	488.08	0	4.32	4.57	-51.04	4.31	7.02	-356.76	-1.69	-4.21	320.68
	4031	D	1623.19	467.39	12	18.52	19.69	4.87	14.51	31.12	-19.58	-3.39	-18.95	22.24

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ST. PETERSBURG PIER COLUMN REACTIONS AS PER ROBOT MODEL C002-029

COLUMN DATA						WIND LOADS								
						WL3b REACTIONS			WL3b-1 REACTIONS			WL3c REACTIONS		
RAKER LINE	COLUMN NODE	COLUMN TYPE	X (ft)	Y (ft)	Z (ft)	FX (kip)	FY (kip)	FZ (kip)	FX (kip)	FY (kip)	FZ (kip)	FX (kip)	FY (kip)	FZ (kip)
29	13106	A	1703.94	506.5	12	-4.29	2.74	-42.85	-3.38	2.32	-85.3	0.85	-0.73	60.92
	2018	B	1695.51	499.43	12	1.35	1.87	12.62	1.44	2.33	12.2	-0.76	-1.29	-5.73
	4033	C	1681.46	487.65	12	-0.96	2.14	-86.01	-1.45	3.27	-153.94	0.86	-2.02	101.43
	2020	D	1659.12	468.9	12	82.8	21.88	31.36	-163.11	304.81	380.33	206.42	-288.15	-358.38
	4034	E	1639.59	452.51	12	2.43	2.02	-3.09	-2.67	10.98	7.19	3.94	-9.66	-9
27	4036	A	1702.07	433.51	12	2.85	-4.27	-148.7	2.94	-1.37	-285.13	-0.51	-3.04	188.61
	2024	B	1683.15	428.44	12	156.64	31.41	285.68	263.22	65.18	449.68	-153.46	-46	-242.49
	4038	C	1656.51	421.3	12	10.69	-12.55	55.3	14.68	-7.44	46.16	-6.61	-3.73	1.02
26	13011	A	1739.02	424.95	12	5.01	-50.87	-208.19	8.76	-92.7	-418.98	-5.4	59.66	293.07
	4040	B	1705.19	419.74	12	4.58	-3.87	-15.51	6.04	-0.18	-35.89	-2.43	-4.07	27.94
	4042	C	1685.42	416.7	12	15.1	-8.19	-46.24	21.73	-1.06	-56.36	-10.31	-7.57	19.28
	4044	D	1657.75	412.43	12	19.79	-12.34	-23.57	28.54	-6.14	-17.1	-13.69	-5.04	-2.75
25	13007	A	1740.05	382.98	12	1.22	-1.01	-183.58	1.22	-0.49	-165.56	-0.12	-0.48	-0.42
	4096	B	1706	386.54	12	4.2	-3.27	-109.56	4.3	-0.25	-107.64	-0.55	-3.31	11.04
	4098	C	1686.11	388.61	12	23.26	-8.61	-51.78	23.19	-3.41	-48.59	-2.39	-5.15	2.6
	4100	D	1658.26	391.52	12	23.17	-11.62	6.2	22.96	-5.94	3.02	-2.08	-4.47	3.2
24	13009	A	1739.04	339.42	12	-0.02	-0.16	-188.56	0.09	0.1	-87	-0.11	-0.28	-105.97
	4092	B	1694.59	356.04	12	0.16	0.49	-251.76	0.76	1.02	-221.83	-0.45	-0.17	-66.37
	2048	C	1674.06	363.72	12	240.31	-92.48	350.72	111.23	-40.46	143	142.88	-56.26	227.78
	4094	D	1653.53	371.39	12	7.16	-7.9	5.71	4.68	-1.35	4.53	3.3	-6.15	1.63
23	4085	A	1684.49	337.94	12	-47.19	-84.6	-153.26	13.72	24.59	44.55	-55.01	-98.61	-178.65
	4089	B	1647.76	359.15	12	-4.16	-1.18	-44.37	-0.74	1.86	-20.95	-2.97	-2.33	-24.61
22	13118	A	1700.77	296.15	12	1.24	-0.24	-210.3	0.75	0.13	-106.52	0.48	-0.36	-105.73
	13107	B	1687.48	307.31	12	0.47	-3.21	-51.44	0.53	-0.89	-8.61	-0.16	-2.39	-47.09
	4078	C	1669.53	322.36	12	3.3	-3.82	-115.71	2.08	-0.85	-64.51	1.19	-2.8	-58.81
	4079	D	1654.4	335.06	12	11.33	-12.39	-36.48	6.53	-3.06	-23.05	5.27	-8.39	-16.96
	4081	E	1639.59	347.49	12	9.6	-8.81	16.66	5.77	-1.68	5.8	4.24	-6.21	10.24

STRUCTURAL SCHEMATIC REPORT (continued)

ST. PETERSBURG PIER COLUMN REACTIONS AS PER ROBOT MODEL C002-029

COLUMN DATA						WIND LOADS								
						WL3b REACTIONS			WL3b-1 REACTIONS			WL3c REACTIONS		
RAKER LINE	COLUMN NODE	COLUMN TYPE	X (ft)	Y (ft)	Z (ft)	FX (kip)	FY (kip)	FZ (kip)	FX (kip)	FY (kip)	FZ (kip)	FX (kip)	FY (kip)	FZ (kip)
21	13116	A	1664.39	272.53	12	1.4	-0.48	-147.43	0.96	0.6	-20.71	0.48	-0.7	-96.6
	13109	B	1654.98	286.26	12	1.24	-1.54	-44.87	0	0.17	38.91	0.79	-1.34	-51.02
	4074	C	1642.99	303.74	12	3.31	-1.99	-244.84	1.82	1.37	30.25	1.28	-2.34	-194.95
	2042	D	1632.82	318.59	12	123.47	-175.78	289.16	-1.16	7.59	0.01	92.12	-134.79	216.1
	4076	E	1623.2	332.61	12	5.2	-4.48	-3.23	1.9	1.69	2.85	2.6	-4.37	-3.2
20	13120	A	1622.69	257.8	12	1.16	-1.04	-112.17	0	1.21	77.68	0.67	-1.38	-112.13
	13111	B	1617.57	268.81	12	1.5	-1.87	-49.74	-0.05	2.01	36.69	0.9	-2.39	-52.27
	4069	C	1608.78	287.73	12	3.71	-2.44	-92.51	0.31	3.45	75.96	2.13	-3.57	-99.55
	4070	D	1601.72	302.92	12	8.33	-10.03	-27.63	-1.48	11.3	22.38	6.39	-12.87	-28.95
	4072	E	1594.94	317.5	12	4.89	-4.34	-5.43	0.17	5.28	2.45	3.15	-5.75	-3.98
19	13113	A	1576.67	255.35	12	-0.4	2.55	-195.07	0.94	-1.11	135.85	-0.8	2.19	-195.37
	4063	B	1570.28	274.32	12	1.6	-1.09	-137.32	1.19	2.75	62.33	0.32	-2.17	-117.48
	4064	C	1565.08	289.72	12	3.91	2.12	-45.26	2.97	0.98	41.16	1	0.84	-50.35
	2036	D	1561.86	299.27	12	17.89	-52.32	55.46	-44.88	133.61	-140.99	35.18	-103.99	109.91
	4066	E	1560.37	303.69	12	3.51	-2.16	-17.01	0.43	5.51	4.11	2.06	-4.25	-12.95
18	2032	A	1533.07	250.25	12	2.51	-4.02	-214.01	0.77	3.64	149.01	1.01	-4.51	-214.41
	4059	B	1526.7	279.73	12	222.92	-44.52	67.9	89.42	5.02	100.5	85.99	-29.88	-14.84
	4061	C	1523.71	293.58	12	15.84	-58.86	48.71	-7.66	43.79	-37.99	14.15	-60.45	51.01
17	2030	A	1488.74	246.6	12	4.55	-7.41	-151.52	0.63	5.9	106.59	2.3	-7.84	-152.39
	4055	B	1484.87	272.48	12	7.51	14.46	-86.72	0.63	-7.28	59.72	4.53	12.98	-86.55
	4057	C	1482.84	286.08	12	15.19	-71.43	24.76	-6.73	51.2	-20.93	13.25	-72.29	26.77
16	2028	A	1443.98	246.06	12	9.35	-29.1	-115.85	-0.5	20.38	79.42	5.79	-29.23	-115.4
	4053	B	1441.13	281.28	12	12.24	1.64	-22.73	4.77	0.69	14.95	5.43	0.68	-22.38
15	4046	A	1398.73	249.21	12	5.81	-11.37	-57.38	1.43	14.98	64.53	2.51	-14.73	-69.95
	4050	B	1398.37	279.3	12	2.91	0.3	-49.55	0.52	0.84	67.97	1.58	-0.15	-65.91
14	4001	A	1354.59	280.31	12	11.52	-3.23	-10.71	2.54	3.7	49.72	6.09	-3.9	-31.38

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ST. PETERSBURG PIER COLUMN REACTIONS AS PER ROBOT MODEL C002-029

COLUMN DATA						WIND LOADS					
						WL3c-1 REACTIONS			WL3d REACTIONS		
RAKER LINE	COLUMN NODE	COLUMN TYPE	X (ft)	Y (ft)	Z (ft)	FX (kip)	FY (kip)	FZ (kip)	FX (kip)	FY (kip)	FZ (kip)
37	4003	A	1353.66	540.74	25.5	26.29	-40.06	-11.89	-75.71	24.72	-13.22
	4005	B	1354.34	529.09	25.5	-3.74	43.45	-26.55	-0.37	-28.97	17.9
36	4009	A	1398.29	542.76	0	0.07	1.42	-94.16	-0.36	-0.73	82.48
	4011	B	1398.04	520.76	22.42	3.12	2.28	-44.69	-5.98	1.83	32.54
35	13211	A	1444.06	558	0	0.5	3.07	-41.28	0.09	-2.7	52.27
	4013	B	1442.7	541.23	0	0.27	4.78	-74.5	-0.44	-4.39	75.87
	4015	C	1440.89	518.72	19.42	0.73	5.84	-36.9	-3.34	-4.05	42.31
34	13213	A	1488.87	556.58	0	0.4	0.91	-73.85	0.15	-0.32	101.76
	4017	B	1485.93	536.87	0	-0.07	1.24	-32.95	-0.31	-0.58	41.33
	4019	C	1482.52	513.95	16.83	0.37	1.62	-49.36	-2.74	2.06	72.94
33	13201	A	1534.35	557.36	0	53.52	24.49	-98.23	-72.87	-31.89	127.86
	2006	B	1532.79	550.14	0	1.1	2.63	-52.4	-0.78	-1.4	79.52
	2008	C	1528.33	529.36	0	0.52	2.99	-107.59	-0.98	-1.23	139.68
	4021	D	1523.4	506.47	14	1.81	9.77	-36.47	-3.29	-3.05	63.49
32	13208	A	1578.38	550.54	0	0.38	1.03	-103.2	-0.02	-1.31	144.12
	2010	B	1574.93	540.28	0	-0.11	1.71	-43.03	0.51	-1.98	56.47
	4024	C	1567.75	518.96	0	-0.12	2.16	78.03	-0.33	-2.15	-191.98
	4025	D	1560.16	496.37	12	0.77	6.58	-39.05	-3.89	-6.49	52.09
31	13104	A	1623.61	544.53	0	220.59	101.83	-213.15	-387.6	-179.69	400.25
	2012	B	1615.74	527.58	0	0.72	1.58	-72.98	-1.43	-4.24	120.95
	2014	C	1605.21	504.91	0	0.82	2.72	-95.95	-3.23	-6.32	179.86
	4027	D	1594.82	482.53	12	2.09	10.03	-25.48	-11.36	-23.4	34.82
30	13102	A	1666.19	530.14	0	0.32	0.56	-64.82	-1.15	-1.99	183.39
	2016	B	1652.67	510.42	0	0.3	1.95	-61.36	-1.45	-6.54	156.69
	4030	C	1637.37	488.08	0	1.22	3.07	-234.95	-5.93	-9.67	490.86
	4031	D	1623.19	467.39	12	2.47	13.79	-16.4	-19.99	-42.84	26.92

STRUCTURAL SCHEMATIC REPORT (continued)

ST. PETERSBURG PIER COLUMN REACTIONS AS PER ROBOT MODEL C002-029

COLUMN DATA						WIND LOADS					
						WL3c-1 REACTIONS			WL3d REACTIONS		
RAKER LINE	COLUMN NODE	COLUMN TYPE	X (ft)	Y (ft)	Z (ft)	FX (kip)	FY (kip)	FZ (kip)	FX (kip)	FY (kip)	FZ (kip)
29	13106	A	1703.94	506.5	12	-0.66	0.57	-46.67	4.65	-3.2	117.32
	2018	B	1695.51	499.43	12	0.69	1.03	5.27	-1.97	-3.2	-16.75
	4033	C	1681.46	487.65	12	-0.63	1.53	-74.78	1.99	-4.49	211.88
	2020	D	1659.12	468.9	12	-149.11	212.46	265.37	224.37	-419.29	-523.13
	4034	E	1639.59	452.51	12	-2.79	7.11	6.69	3.67	-15.11	-9.89
27	4036	A	1702.07	433.51	12	-0.19	3.75	-137.15	-4.04	1.89	390.57
	2024	B	1683.15	428.44	12	103.42	34.64	154.48	-360.89	-89.19	-617.02
	4038	C	1656.51	421.3	12	3.49	6.55	-14.48	-20.32	11.01	-65.82
26	13011	A	1739.02	424.95	12	3.74	-42.35	-217.5	-12.05	127.6	576.58
	4040	B	1705.19	419.74	12	1.15	4.6	-21.41	-8.3	0.27	49.71
	4042	C	1685.42	416.7	12	5.86	8.82	-6.61	-29.88	1.64	77.84
	4044	D	1657.75	412.43	12	7.81	7.71	8.57	-39.33	9.29	25.21
25	13007	A	1740.05	382.98	12	-0.17	0.68	42.67	-1.66	0.68	226.91
	4096	B	1706	386.54	12	-0.45	3.77	15.43	-5.86	0.36	147.51
	4098	C	1686.11	388.61	12	-3.1	6.72	9.65	-31.64	4.84	66.69
	4100	D	1658.26	391.52	12	-3.32	7.03	-4.28	-31.24	9.02	-4.23
24	13009	A	1739.04	339.42	12	0.11	0.3	139.27	-0.12	-0.13	118.23
	4092	B	1694.59	356.04	12	0.44	0.17	104.72	-0.91	-1.19	279.95
	2048	C	1674.06	363.72	12	-182.46	71.77	-284.79	-147.4	54.07	-190.49
	4094	D	1653.53	371.39	12	-4.39	7.67	-2.6	-5.81	2.65	-5.98
23	4085	A	1684.49	337.94	12	64.26	115.2	208.69	-12.91	-23.15	-41.94
	4089	B	1647.76	359.15	12	3.85	2.71	32.42	1.58	-1.65	27.85
22	13118	A	1700.77	296.15	12	-0.72	0.4	144.29	-1.03	-0.15	145.17
	13107	B	1687.48	307.31	12	0.03	2.94	54.5	-0.75	1.26	11.76
	4078	C	1669.53	322.36	12	-1.83	3.53	78.04	-2.85	1.35	84.79
	4079	D	1654.4	335.06	12	-7.26	10.89	22.76	-8.71	4.83	29.5
	4081	E	1639.59	347.49	12	-5.92	8.06	-13.44	-7.38	3.35	-8.22

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ST. PETERSBURG PIER COLUMN REACTIONS AS PER ROBOT MODEL C002-029

COLUMN DATA						WIND LOADS					
						WL3c-1 REACTIONS			WL3d REACTIONS		
RAKER LINE	COLUMN NODE	COLUMN TYPE	X (ft)	Y (ft)	Z (ft)	FX (kip)	FY (kip)	FZ (kip)	FX (kip)	FY (kip)	FZ (kip)
21	13116	A	1664.39	272.53	12	-0.74	0.88	132.22	-1.27	-0.56	48.18
	13109	B	1654.98	286.26	12	-1.15	1.72	68.09	-0.29	0.03	-31.52
	4074	C	1642.99	303.74	12	-1.98	2.96	261.78	-2.62	-1.17	12.32
	2042	D	1632.82	318.59	12	-123.69	180.27	-289.09	-20.32	22.19	-49.89
	4076	E	1623.2	332.61	12	-3.77	5.67	4.61	-2.69	-0.83	-1.96
20	13120	A	1622.69	257.8	12	-1.03	1.8	154.18	-0.31	-1.08	-56.01
	13111	B	1617.57	268.81	12	-1.37	3.13	70.72	-0.33	-1.76	-27.77
	4069	C	1608.78	287.73	12	-3.19	4.63	135.4	-1.23	-3.17	-58.81
	4070	D	1601.72	302.92	12	-8.88	16.96	39.84	-0.24	-10.05	-17.06
	4072	E	1594.94	317.5	12	-4.49	7.58	6.12	-0.84	-4.45	-0.74
19	13113	A	1576.67	255.35	12	1.01	-3.07	268.61	-0.94	0.57	-98.07
	4063	B	1570.28	274.32	12	-0.67	2.81	165.89	-1.67	-2.66	-31.93
	4064	C	1565.08	289.72	12	-1.75	-1.33	68.51	-3.97	-1.64	-34.45
	2036	D	1561.86	299.27	12	-45.76	135.26	-142.97	43.35	-129	136.08
	4066	E	1560.37	303.69	12	-3	5.56	18.4	-1.01	-4.97	-0.19
18	2032	A	1533.07	250.25	12	-1.71	6.1	294.73	-1.53	-2.88	-107.47
	4059	B	1526.7	279.73	12	-143.01	43.8	5.55	-151.17	5.14	-121.7
	4061	C	1523.71	293.58	12	-19.66	82.89	-69.77	4.53	-31.86	28.7
17	2030	A	1488.74	246.6	12	-3.64	10.71	209.41	-1.92	-4.25	-76.19
	4055	B	1484.87	272.48	12	-6.56	-18.1	118.83	-0.01	3.16	-51.88
	4057	C	1482.84	286.08	12	-18.46	99.34	-36.51	3.63	-34.88	16.26
16	2028	A	1443.98	246.06	12	-8.72	40.14	158.7	-1.98	-15.87	-58.44
	4053	B	1441.13	281.28	12	-8.27	-1.08	30.7	-4.2	-1.45	-14.35
15	4046	A	1398.73	249.21	12	-4.21	20.3	95.52	-4.64	1.95	-12.12
	4050	B	1398.37	279.3	12	-2.39	0.22	90.72	-2.63	0.11	20.78
14	4001	A	1354.59	280.31	12	-9.05	5.43	42.94	-3.6	2.26	39.79

STRUCTURAL SCHEMATIC REPORT (continued)

ST. PETERSBURG PIER COLUMN REACTIONS AS PER ROBOT MODEL C002-029

COLUMN DATA						WIND LOADS					
						WL3d-1 REACTIONS			WL3e REACTIONS		
RAKER LINE	COLUMN NODE	COLUMN TYPE	X (ft)	Y (ft)	Z (ft)	FX (kip)	FY (kip)	FZ (kip)	FX (kip)	FY (kip)	FZ (kip)
37	4003	A	1353.66	540.74	25.5	-47.16	-43.73	-39.13	-73.52	-24.22	-38.12
	4005	B	1354.34	529.09	25.5	-7.4	44.64	-27.07	-6.35	23.06	-13.79
36	4009	A	1398.29	542.76	0	-0.32	1.86	-71.78	-0.42	1.02	-20.3
	4011	B	1398.04	520.76	22.42	-1.35	7.08	-41.08	-4.46	6.06	-20.13
35	13211	A	1444.06	558	0	1.34	3.2	-24.31	0.84	0.29	20.99
	4013	B	1442.7	541.23	0	-0.05	4.62	-57.29	-0.23	0.21	5.83
	4015	C	1440.89	518.72	19.42	-2.79	7.85	-22.1	-4.01	2.03	9.94
34	13213	A	1488.87	556.58	0	1.18	1.63	-36.55	0.78	0.77	51.52
	4017	B	1485.93	536.87	0	-0.53	2.05	-21.12	-0.56	0.83	16.77
	4019	C	1482.52	513.95	16.83	-2.69	6.31	-18.4	-3.65	5.35	41.95
33	13201	A	1534.35	557.36	0	29.06	15.18	-59.85	-36.42	-14.47	57.57
	2006	B	1532.79	550.14	0	1.57	4.29	-16.1	0.34	1.51	47.57
	2008	C	1528.33	529.36	0	-0.05	5.36	-65	-0.75	2.25	62.36
	4021	D	1523.4	506.47	14	-0.05	18.84	-0.26	-2.49	8.84	45.32
32	13208	A	1578.38	550.54	0	0.9	0.64	-48.69	0.5	-0.56	74.89
	2010	B	1574.93	540.28	0	0.46	1.32	-24.96	0.62	-0.63	25.79
	4024	C	1567.75	518.96	0	-0.71	2.15	-71.71	-0.67	-0.27	-181.02
	4025	D	1560.16	496.37	12	-3.34	6.64	-21.74	-4.82	-0.72	24.71
31	13104	A	1623.61	544.53	0	0.55	-0.79	36.9	-279.35	-130.09	308.79
	2012	B	1615.74	527.58	0	-0.19	-2.02	-7.54	-1.14	-4.2	81.85
	2014	C	1605.21	504.91	0	-2.39	-2.15	17.98	-3.72	-5.75	138.79
	4027	D	1594.82	482.53	12	-10.26	-8.04	-12.6	-14.22	-21.33	17.46
30	13102	A	1666.19	530.14	0	-0.79	-1.36	97.65	-1.29	-2.22	186.85
	2016	B	1652.67	510.42	0	-1.22	-4.26	73.34	-1.76	-7.14	153.42
	4030	C	1637.37	488.08	0	-5.09	-5.85	118.55	-7.21	-10.29	415.38
	4031	D	1623.19	467.39	12	-20.97	-25.41	-1.07	-26.63	-45.29	18.11

ST. PETERSBURG PIER COLUMN REACTIONS AS PER ROBOT MODEL C002-029

COLUMN DATA						WIND LOADS					
						WL3d-1 REACTIONS			WL3e REACTIONS		
RAKER LINE	COLUMN NODE	COLUMN TYPE	X (ft)	Y (ft)	Z (ft)	FX (kip)	FY (kip)	FZ (kip)	FX (kip)	FY (kip)	FZ (kip)
29	13106	A	1703.94	506.5	12	4.88	-3.13	56.56	6.11	-4.06	115.77
	2018	B	1695.51	499.43	12	-1.47	-2.21	-13.72	-2.24	-3.55	-19.76
	4033	C	1681.46	487.65	12	1.23	-2.69	113.68	2.13	-4.74	216.55
	2020	D	1659.12	468.9	12	-48.36	-78.56	-100.98	129.22	-341.09	-427.07
	4034	E	1639.59	452.51	12	-1.77	-4.07	1.73	1.52	-13	-5.84
27	4036	A	1702.07	433.51	12	-3.89	5.88	202.22	-5.3	5.19	395.25
	2024	B	1683.15	428.44	12	-213.13	-42.61	-389.05	-382.82	-87.9	-670.93
	4038	C	1656.51	421.3	12	-14.59	17.23	-75.76	-23.25	18.72	-94.06
26	13011	A	1739.02	424.95	12	-6.82	69.1	282.71	-12.58	131.13	572.74
	4040	B	1705.19	419.74	12	-6.25	5.34	21.26	-9.7	3.76	47.33
	4042	C	1685.42	416.7	12	-20.6	11.27	63.24	-33.65	8.61	94.05
	4044	D	1657.75	412.43	12	-27	16.95	32.37	-44.2	17.37	38.18
25	13007	A	1740.05	382.98	12	-1.68	1.39	251.78	-2.22	1.39	319.04
	4096	B	1706	386.54	12	-5.75	4.51	150.32	-7.73	3.26	198.73
	4098	C	1686.11	388.61	12	-31.87	11.83	70.99	-42.29	11.11	91.84
	4100	D	1658.26	391.52	12	-31.75	15.97	-8.48	-41.94	16.54	-8.38
24	13009	A	1739.04	339.42	12	0.03	0.22	259.52	-0.06	0.06	251.75
	4092	B	1694.59	356.04	12	-0.21	-0.67	346.55	-0.7	-1.15	409.22
	2048	C	1674.06	363.72	12	-330.69	127.27	-482.63	-317.62	120.79	-447.85
	4094	D	1653.53	371.39	12	-9.85	10.88	-7.84	-10.41	8.89	-9
23	4085	A	1684.49	337.94	12	64.92	116.38	210.84	37.07	66.45	120.38
	4089	B	1647.76	359.15	12	5.73	1.63	61.08	4.81	-0.1	59.63
22	13118	A	1700.77	296.15	12	-1.71	0.33	289.44	-1.82	0.13	289.77
	13107	B	1687.48	307.31	12	-0.65	4.42	70.79	-0.93	3.8	55.05
	4078	C	1669.53	322.36	12	-4.54	5.26	159.27	-4.91	4.47	161.47
	4079	D	1654.4	335.06	12	-15.6	17.05	50.23	-16.1	14.91	52.67
	4081	E	1639.59	347.49	12	-13.21	12.13	-22.92	-13.85	10.26	-21.16

STRUCTURAL SCHEMATIC REPORT (continued)

ST. PETERSBURG PIER COLUMN REACTIONS AS PER ROBOT MODEL C002-029

COLUMN DATA						WIND LOADS					
						WL3d-1 REACTIONS			WL3e REACTIONS		
RAKER LINE	COLUMN NODE	COLUMN TYPE	X (ft)	Y (ft)	Z (ft)	FX (kip)	FY (kip)	FZ (kip)	FX (kip)	FY (kip)	FZ (kip)
21	13116	A	1664.39	272.53	12	-1.92	0.66	202.86	-2.11	0.13	172.3
	13109	B	1654.98	286.26	12	-1.71	2.12	61.69	-1.4	1.51	25.42
	4074	C	1642.99	303.74	12	-4.56	2.74	336.83	-4.78	1.24	246.02
	2042	D	1632.82	318.59	12	-169.87	241.84	-397.83	-132.25	184.45	-310.63
	4076	E	1623.2	332.61	12	-7.15	6.16	4.44	-6.91	3.69	1.99
20	13120	A	1622.69	257.8	12	-1.6	1.42	154.24	-1.33	0.38	77.81
	13111	B	1617.57	268.81	12	-2.06	2.57	68.39	-1.68	0.8	32.53
	4069	C	1608.78	287.73	12	-5.1	3.36	127.19	-4.37	0.53	56.47
	4070	D	1601.72	302.92	12	-11.46	13.79	37.99	-8.28	4.07	17.32
	4072	E	1594.94	317.5	12	-6.72	5.96	7.47	-5.56	1.5	4.87
19	13113	A	1576.67	255.35	12	0.54	-3.51	268.22	-0.16	-2.18	134.83
	4063	B	1570.28	274.32	12	-2.2	1.5	188.85	-2.55	-0.48	116.43
	4064	C	1565.08	289.72	12	-5.39	-2.92	62.23	-6.18	-2.97	25.53
	2036	D	1561.86	299.27	12	-24.57	71.85	-76.17	7.69	-23.92	24.97
	4066	E	1560.37	303.69	12	-4.83	2.97	23.39	-4.2	-1	16.51
18	2032	A	1533.07	250.25	12	-3.46	5.52	294.27	-3.37	2.23	147.9
	4059	B	1526.7	279.73	12	-306.76	61.24	-93.51	-308.36	47.26	-140.4
	4061	C	1523.71	293.58	12	-21.78	80.92	-66.98	-13	38.87	-31.12
17	2030	A	1488.74	246.6	12	-6.26	10.19	208.33	-5.59	4.62	103.92
	4055	B	1484.87	272.48	12	-10.33	-19.88	119.24	-9	-11.61	61.23
	4057	C	1482.84	286.08	12	-20.89	98.22	-34.04	-12.84	48.23	-14.82
16	2028	A	1443.98	246.06	12	-12.87	40.01	159.29	-10.33	20.14	80.98
	4053	B	1441.13	281.28	12	-16.83	-2.26	31.26	-16.92	-2.23	16.61
15	4046	A	1398.73	249.21	12	-8	15.63	78.9	-7.42	2.18	20.5
	4050	B	1398.37	279.3	12	-4.01	-0.41	68.13	-3.44	-0.91	6.2
14	4001	A	1354.59	280.31	12	-15.84	4.44	14.72	-14.59	0.85	-26.82

B-26

PRECAST BEAM OPTIONS:
MATRIX

St. Petersburg Pier
Precast Beam Options
2/28/2013

Section Properties from PCI Bridge Design Manual Appendix B (except for beams designated as "Florida")

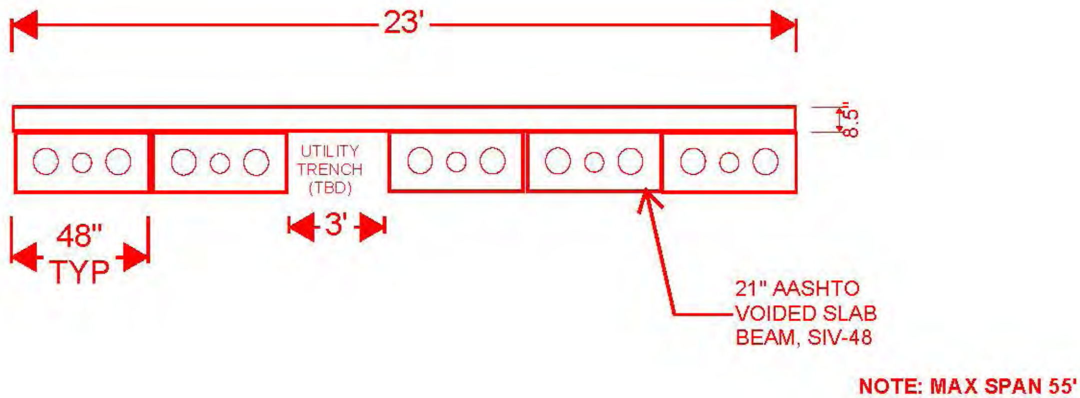
OVER WATER DRIVE (VEHICULAR BRIDGE STRUCTURE 20' WIDE +/- with 60' span)

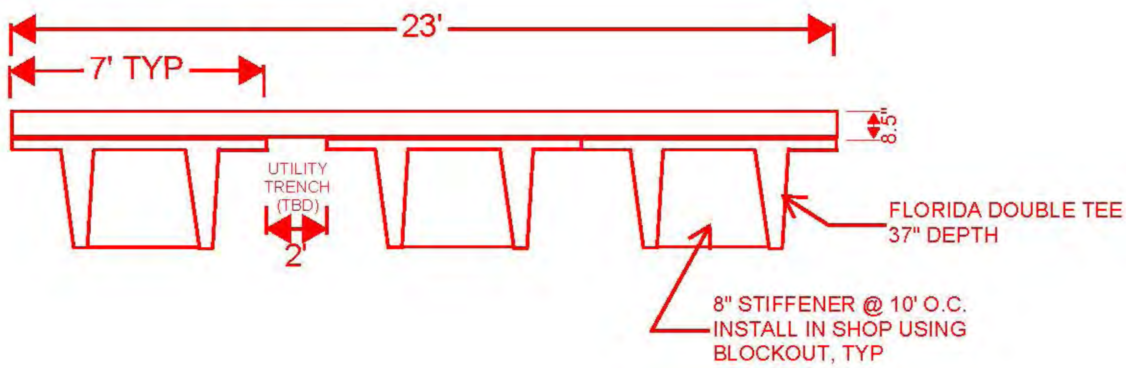
Beam Family	Type	Max Span	Depth	# of Beams	Comments
Voided Slab	SIV-48	57'	21"	continuous	Would require slight adjustment in pile cap spacing.
Box Beam	BI-36	92'	27"	3	Requires deck form
AASHTO I-Beam	IB-II	60'+	36"	4	Requires extensive deck form
Bulb Tee	Not considered		54" min		Too deep
Deck Bulb Tee	96" wide	65'	35"	2 or 3	with 2 beams, requires concrete form for deck
Heavy Section Double Tee	7' wide	62'	35"	3	Concerns about lateral strength/stability. May need thicker stems and additional reinforcing.
Florida I-Beam	FI-36	80'	36"	3 - 4	Requires extensive deck form
Florida Double Tee	7' wide	61'	37"	3	Concerns about lateral strength/stability. May need thicker stems and additional reinforcing.

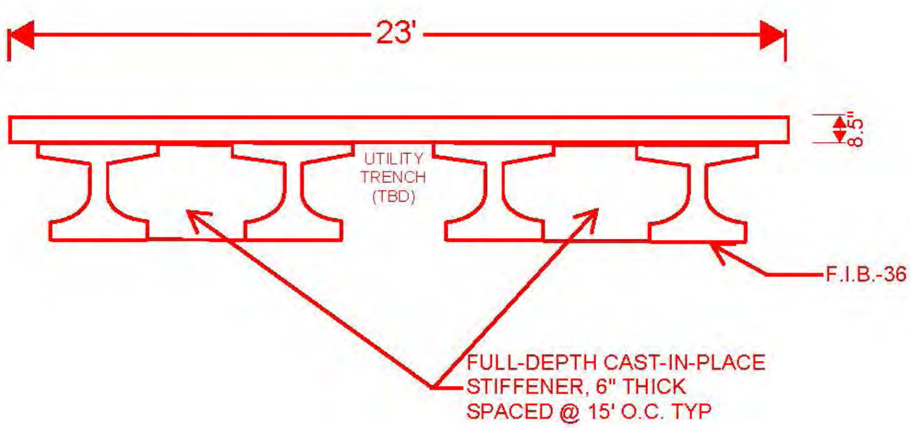
OVER WATER BRIDGE (PEDESTRIAN/BIKE STRUCTURE 10' WIDE +/- with 100' span)

Beam Family	Type	Max Span	Depth	# of Beams	Comments
Box Beam	BII-36	107'	33"	2	Requires concrete form for deck
	BI-36	92'	27"	2	Requires concrete form for deck. Would require 10' span reduction
AASHTO I-Beam	IB-III	100'	45"	3	Requires extensive deck form
Bulb Tee	BT-54	114'	54"	2	Very deep member
Deck Bulb Tee	96" wide	105'	53"	1	Possible stability issue, only 1 beam
	48" wide	145'	53"	2	Inefficient - oversized for vertical load
Heavy Section Double Tee	Not considered - cannot span over 87'				
Florida I-Beam	FI-36	95'	36"	2	Requires concrete form for deck. Would require slight span reduction. May be used if cladding does not extend total depth of structure.
Florida I-Beam	FI-45	115' +	45"	2	Requires concrete form for deck
Florida Double Tee	Not considered - cannot span over 61'				

PRECAST BEAM OPTIONS: SECTIONS







PROJECT SUMMARY
ESTUARY HABITAT RESTORATION PROGRAM PROJECT SOLICITATION

PROJECT NAME: Restoration of Coastal Estuarine Habitat Along St. Petersburg's Downtown Waterfront

NON-FEDERAL SPONSER: City of St. Petersburg (Applicant)

SITE LOCATION: Downtown waterfront, City of St. Petersburg, Pinellas County, Florida

AGENCY CONTACT: Mike Connors, PE, Public Works Administrator

PROJECT TIMELINE: Project commencement – Baseline monitoring, August 2013; Construction commencement – January 2014 completed in late 2015. Post-construction monitoring commencement – Upon construction completion through 2020 (5 year minimum).

PROJECT COSTS: $1,463,757 (federal share $950,000/non-federal share $513,757)

ACRES TO BE RESTORED: approximately 3-5 acres

KEY HABITAT TYPES: Seagrass habitat, bay bottom

PROJECT DESCRIPTION: The new St. Petersburg pier will replace an existing structure over 80 years old that emanates from the heart of the city along the 2nd Avenue North approach. Currently, the 100 foot wide by 1400 foot long approach covers the seabed with 260,000 feet of structure, diminishing light penetration and introducing undue pollution from automobiles and heavy duty delivery trucks that presently can drive the entire length. This project will improve habitat in the immediate vicinity of the new pier by reducing shading by approximately 60 percent, reducing pollutant loading, restoring seagrass habitat, and providing a high profile and unique opportunity for educating the public about Tampa Bay, its estuaries, innovations in marine science, and sustainable ecotourism. Incorporating modest habitat units will enhance the structural complexity of the habitat in the area of the pier, preserving and enhancing ecological function of existing piles. The project explicitly incorporates considerations of climate change into the design and provides critical habitat for important estuarine species with significant socioeconomic and economic value including many species of recreational and commercial importance, and specifically addresses activities identified in the Estuary Habitat Restoration Strategy, such as attaining a self-sustaining system integrated into the surrounding landscape while providing improved surface water quality and nutrient cycling, clearly defined performance measures, and identifying management and restoration priorities. Lastly, this project will lead to new public-private partnerships bringing together the local government, our local university, and other local non-profit organizations with missions to protect Tampa Bay. The Environmental Resource Permit has been noticed and we assure the Estuary Habitat Restoration Council that this project meets all National Environmental Policy Act guidelines.

PERMITS: An Environmental Resources permit application was submitted August 2012 to the Southwest Florida Water Management District and is expected to be approved by August 2013.

UNDERWATER FEATURE GRANT APPLICATION (continued)

ESTUARY HABITAT RESTORATION PROGRAM PROJECT

Background:

The municipal pier located in downtown St. Petersburg (Figure 1) is beyond its serviceable life and will be demolished in the summer of 2013. Built before predominant environmental regulations were in place to guard against habitat degradation, the ecological function of the immediate area underneath the existing pier has been compromised relative to what would be allowed under today's current environmental permitting requirements. This pier currently shades approximately 230,000 square feet of bay bottom, has approximately 1500 piles, and contributes pollutant loadings from vehicular traffic with direct discharge to Tampa Bay. The City of St. Petersburg is currently in the schematic design phase for a new pier for its downtown waterfront which will restore habitat, reduce shading, reduce pollutant loading and incorporate low impact design elements into its construction.

Striking, unique, and contemporary, the new St. Petersburg Pier will be a structural icon built towards the future of St. Petersburg. http://www.thenewstpetepier.com/. Named, "The Lens", the new pier is the result of an international design competition and aims specifically to restore estuarine habitat, reduce shading and pollutant loading, and provide a unique opportunity for environmental awareness and education. The design also specifically considers implications of climate change. These objectives of the Lens design fit well within the goals of the Tampa Bay Estuary Programs Comprehensive Conservation and Management Plan (TBEP 2006) and Habitat Master Plan Update (TBEP 2010), with specific goals to restore seagrasses, increase public education and investigate the efficacy of artificial structural habitats. With construction to begin in 2014 and scheduled for completion in 2015, this project compliments the anticipated timeline for implementing the Estuary Habitat Restoration grant.

Figure 1. Location of the St. Petersburg Pier in downtown St. Petersburg, Florida.

PN1

Designed specifically to enhance the interaction between visitors and the Tampa Bay estuary, the Lens is, in part, a natural open water and open air marine exhibit and is expected to attract one million visitors a year. A central construct of the design is the Underwater Feature that is intended to enhance ecological function compromised by the old pier design and serve as an innovative platform for environmental education and marine research.

There is simply no better location to implement this iconic and innovative design. A recent Bay Soundings article, http://www.baysoundings.com/Stories/feature.asp described St. Petersburg as a new epicenter of marine research and innovation unrivaled in the southeastern United States if not the world. The Lens, and specifically its Underwater Feature, is the subject of this proposal and, as this proposal will demonstrate, the unique and innovative features associated with this design make it an excellent candidate for the Estuary Habitat Restoration grant opportunity. We have reviewed the National Environmental Policy Act (NEPA) and compliance checklist and can assure the grantors that this project is in complete compliance with NEPA guidelines.

Our Team:
Our team has the expert qualifications necessary to successfully complete this project. While this is wholly a City of St. Petersburg project, our project partners include Michael Maltzan Architecture, Tampa Bay Watch, and Janicki Environmental. Mike Connors is the City of St. Petersburg public works administrator, has overseen extensive public works projects involving multiple agencies, and will maintain oversight of every aspect of this project. Michael Maltzan Architecture (MMA) is the Architect of Record for the project. MMA is an internationally recognized design firm committed to the creation of progressive, transformative designs that incorporate natural landscape features into the experience of the architectural design. Tampa Bay Watch is a nonprofit dedicated exclusively to the protection and restoration of marine and wetland environments of the Tampa Bay estuary through scientific and educational programs. Janicki Environmental brings expertise in estuarine ecology and the implementation of statistically rigorous monitoring designs.

Existing Conditions:
The St. Petersburg Pier is located within Pinellas County's Aquatic Preserve a designated Outstanding Florida Waterbody. However, these waters are also subject to the United States Environmental Protection Agency's (US EPA) Total Maximum Daily Load program and currently have adopted Reasonable Assurance agreements and a Nitrogen Management Consortium implemented to guide water quality management and restoration efforts aimed to achieve compliance with established water quality standards for these estuarine waters. Therefore, this project area meets a priority consideration for funding through the Estuary Habitat Restoration grant opportunity.

Currently, the Pier shades approximately 230,000 sq. ft. of bay bottom. The existing structure is a minimum of 100 ft. wide up to 300 ft. wide with a structure bottom elevation of approximately 5 ft. above MSL. The Lens reduces overwater shading by 50%, shading approximately 121,000 sq. ft. of bay bottom. A comparative image of the old and new pier design is provided in Figure 2. The existing pier has approximately 1,500 piles supporting the pier approach, pier head, and boat docks. The Lens will utilize approximately 610 new piles or approximately 40% of the current number.

UNDERWATER FEATURE GRANT APPLICATION (continued)

Submergent habitat features associated with the pier include modest seagrasses located just seaward of generally hardened shorelines in depths less than 8 feet of water, sand and sand/shell bottom types, seawall and riprap used for shoreline protection, existing piles and some isolated construction materials associated with current and past pier construction and maintenance. The waters of the Tampa Bay estuary are utilized by a number of protected species including the West Indian Manatee (*Trichechus manatus latirostris*), Bottlenose Dolphin (*Tursiops tuncatus*), and Loggerhead Sea Turtle (*Caretta caretta*). The Tampa Bay estuary is also designated as essential fish habitat for Shrimp (*Farfantepenaeus duodarum*), Red Drum (*Sciaenops ocellatus*), Stone Crab (*Menippe mercenaria*), Mangrove Snapper (*Lutjanus griseus*), Gag Grouper (*Mycteroperca microlepis*) and Smalltooth Sawfish (*Pristis pectinata*). The area is also part of the Atlantic Flyway and therefore an important stopover for migratory waterfowl and water dependent birds.

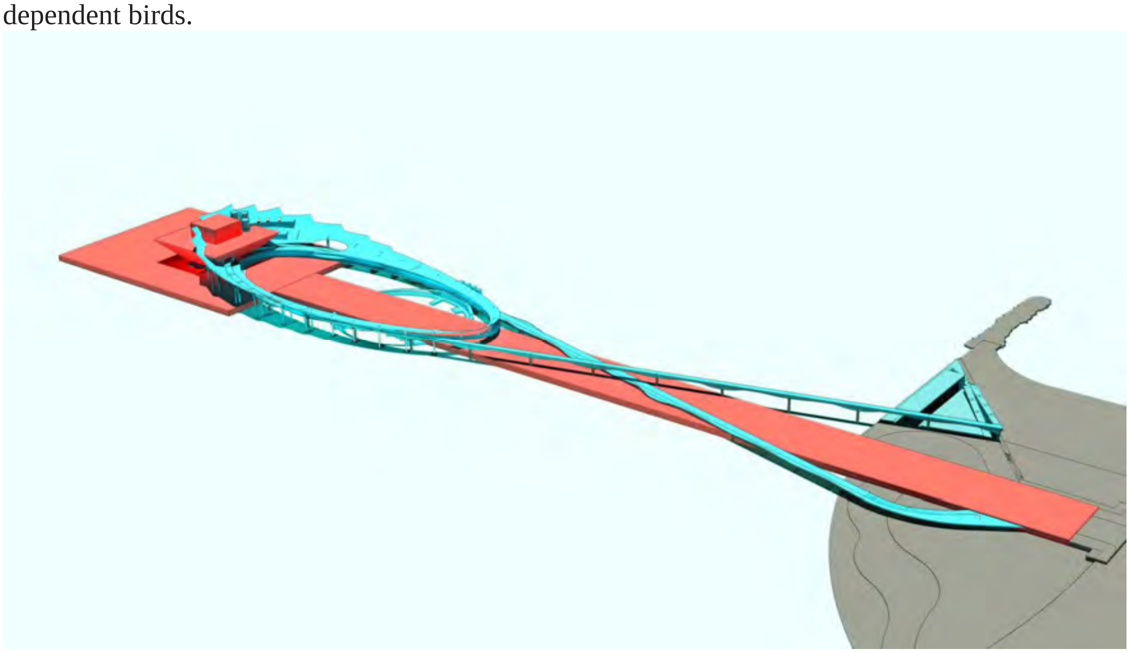


Figure 2. Existing pier approach and head (red) with overlay of the new St. Pete Pier design (cyan).

Downtown St. Petersburg is also part of the Pinellas County's Blueways paddling trail system http://www.pinellascounty.org/Plan/blueways/map-index.htm. Specific design objectives of the Lens include the incorporation of a day use marina facility with a kayak rental and access to the Underwater Feature (Figure 3) which will be incorporated as a Blueways destination and a central feature of the Blueways paddling trail.

PN3

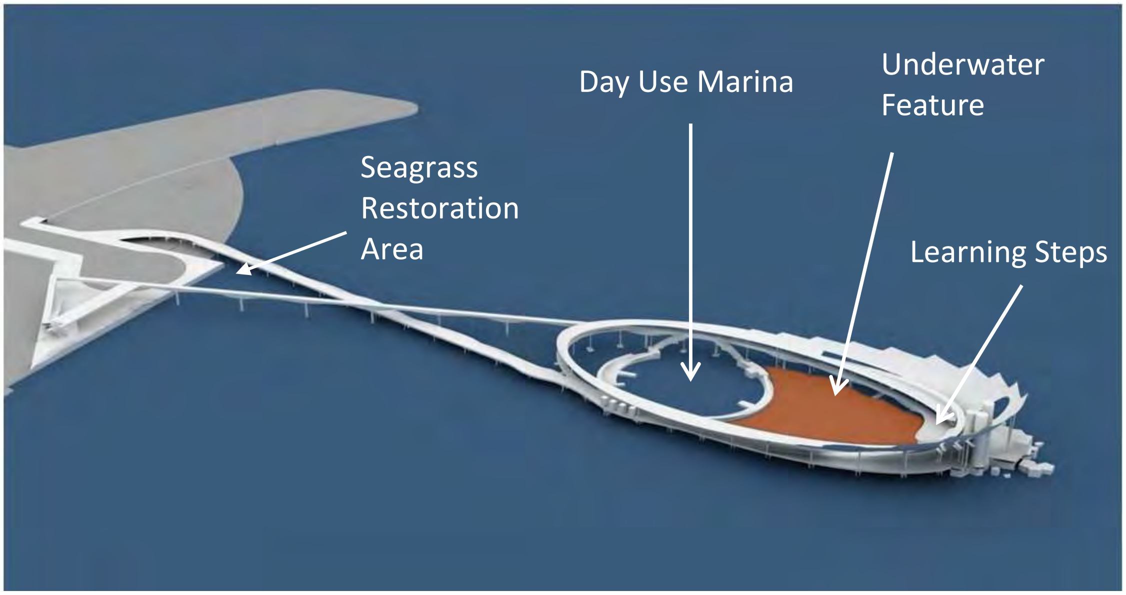


Figure 3. Depiction of new St. Pete Pier with day use marina, underwater feature and learning steps.

Restoration Goals:
The restoration goals associated with this project are to revitalize the local ecological function of an area that has been historically altered due to legacy construction and to provide a platform for educating the public about the Tampa Bay estuary, local habitat restoration efforts, the impacts of climate change, and the future of marine science. Seagrass plantings along the seawall in areas previously shaded by the old pier will increase connectivity with adjacent existing seagrass beds along the shoreline. By maintaining and repurposing a subset of the existing piles, the Underwater Feature will preserve existing habitat that would otherwise be removed by the demolition and enhance habitat by providing additional substrate for recruitment of local bivalves, tunicates, sponges, and associated macroinvertebrate taxa that occupy these biological niches.

The goals of the Underwater Feature were developed following an initial outreach effort to local marine science experts from the Florida Fish and Wildlife Research Institute, University of South Florida College of Marine Science, Stanford Research Institute, Tampa Bay Estuary Program, and Southwest Florida Regional Planning Council's Agency on Bay Management as well as others in the local marine science community. These initial interviews highlighted both the potential for the feature as well as limitations associated with constructing an exhibit in an estuarine environment. While concepts for the feature discussed during these interviews ranged from nothing more than some underwater lighting to a bird rookery and diving trail, there was consensus that this feature had incredible potential as a platform for environmental education and research. Given current funding constraints, the project team decided that a prudent course of development for the Underwater Feature would be to provide modest structural habitat enhancement to attract native biota towards the feature where it can be observed in a natural setting and use technology to the greatest extent practical to allow visitors to experience the local

UNDERWATER FEATURE GRANT APPLICATION (continued)

ecology in a passive setting. The Underwater Feature would then grow over time as more funding became available and partners with research and education needs availed themselves of the opportunity to use the feature as a platform for their own needs. The Lens design provides the infrastructure necessary to allow for this growth including the Learning Steps, a small amphitheater that can be used to allow schoolchildren as well as other groups close proximity to the water, free Wi-Fi access, a web portal for information about the Underwater Feature, and a dedicated boat slip in the marina for a research vessel that can be used for research and education needs.

What follows is a detailed description of how these restoration activities will restore habitat, enhance existing ecology, restore ecological function, enhance species diversity, and promote environmental education and awareness using a unique and innovative approach.

Approach and Rationale:
The foundational restoration concepts for the Underwater Feature are to integrate structural and functional elements to increase native species diversity and highlight the natural beauty of the Tampa Bay estuary as an educational platform for visitors to the new pier. The design is intended to add intrinsic value to the local ecology by providing structural habitat for recruitment of native species. However, the design is not proposing an artificial reef and does not intend to impose an unattainable ecological paradigm on the local area. Rather, the design intends to maintain existing piles within the underwater feature as seen in Figure 4 and augment these piles with modest structural enhancements to attract local biota. This figure is one of several potential configurations currently under consideration.

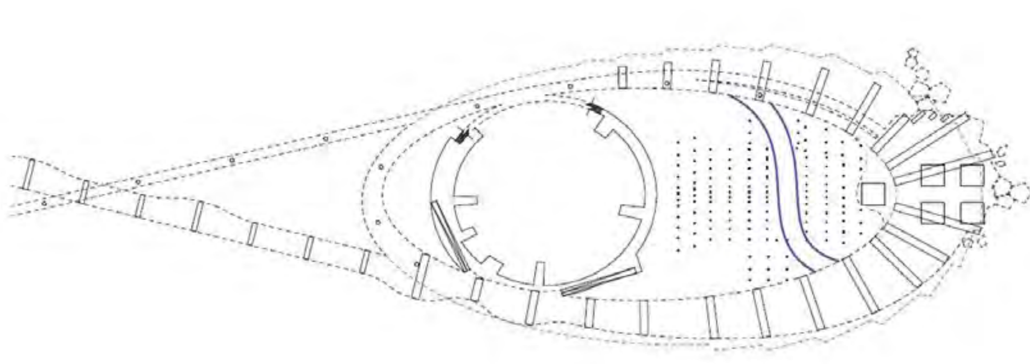


Figure 4. Schematic of the existing piles located within the Underwater Feature.

All piles will be cut off and capped at various depths below the water with the majority of piles capped at least 3’ below mean lower low water. Piles located closer to the Learning Steps and the day use marina may be left higher towards the surface to attract biota towards the surface where they can be more easily observed. Consideration is being given to including a “corridor”

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within the design. This corridor will serve to allow for larger animals such as dolphins to traverse and explore the feature and also allow for maintenance vessels to access to the feature.

To enhance species diversity within the feature, the existing piles will be augmented with naturally occurring Florida limestone rock suspended on the piles using custom made habitat structures. An example of the type of reef structures being considered is the Ecosystem reef design built by Reefmaker (Figure 5)(http://www.reefmaker.com/marine-ecosystems). These reef structures are built as disks that can be stacked on pilings with spacers in between each disk to provide habitat and shelter for a myriad of estuarine taxa. A short video of the installation and post install observations of this system in the nearshore waters of Pensacola can be viewed on the Reefmaker website http://www.reefmaker.com/videos/cwnqrkvgvQU

Figure 5. Example type of habitat structure being considered for Underwater Feature.

We feel that there is a potential opportunity to leverage resources of the USACE to assist in the creation of this feature by providing the source material of natural limestone rubble from the USACE Tampa Harbor port expansion project which will excavate natural limestone rock along Cut A and Cut B channels in lower Tampa Bay. Utilizing this source material will result in the highest level of assurance that biota native to Tampa Bay will recruit to the habitat and may even provide some compensatory mitigation credit for the USACE project, if necessary.

The project team has developed a list of realistic expectations for the occurrence and utilization of the feature by local, native, estuarine flora and fauna. For example, we have developed a list of surface oriented taxa (Table 1) that may be observed within the feature without any

UNDERWATER FEATURE GRANT APPLICATION (continued)

technological aid and identified the seasonally dependent probabilities of occurrence of these taxa.

Table 1. List of taxa that are surface oriented and may utilize the Tampa Bay Estuary during a portion of their life history.

Scientific Name	Common Name	Season	Hyperlink
Tursiops truncatus	Bottlenose Dolphin	Year Round	http://fieldnotes-steve.blogspot.com/2011/09/dolphins-of-tampa-bay.html
Caretta caretta	Loggerhead Sea Turtle	May -Oct	http://www.flickriver.com/photos/tags/loggerheadseaturtle/interesting
Melalops atlanticus	Tarpon	May-Oct	http://www.rogergibson.org/wp-content/uploads/2010/04/tarpon-water-boca-grande.jpg
Rhinoptera bonasus	Cownose Ray	Year Round	http://lh6.ggpht.com/bX3Ye4oEXBhJgCWSo_YkTwcO_nJXRHZ1dXhmSFPVARUoDh4ObrPovLS_r4mnVxkFgDn6plhkuHfjJliJC8RI=s1200
Aetobatus narinari	Spotted Eagle Ray	Mar-May	http://www.wtsp.com/slideshows/2011/Spotted-Eagle-Ray-Lands-in-Boat/02%20Spotted-Eagle-Ray-leaping-in-water-(detail).jpg
Caranx hippos	Crevalle Jack	Mar-June	http://distractioncharters.com/images/light-tackle-jack-fishing.JPG
Mugil cephalus	Mullet	Year Round	http://www.islander.org/6-3-09/mullet-jbystrom.jpg
Rachycentron canadum	Cobia	Mar-May	http://blog.downeastguideservice.com/2010_05_01_archive.html
**Archosargus probatocephalus*	Sheepshead	Nov-May	http://www.google.com/imgres?imgurl=http://www.cyberangler.com/photos/watermark.php%3Ffile%3D18624%26size%3D1&imgrefurl=http://www.cyberangler.com/fishing-reports/florida/tampa-bay/sheepshead-drift-fishing-20847.htm&h=300&w=400&sz=25&tbnid=ExJ4ufsBQuHTSM:&tbnh=104&tbnw=138&prev=/search%3Fq%3Dtampa%2Bbay%2Bsheepshead%2Bimage%26tbm%3Disch%26tbo%3Du&zoom=1&q=tampa+bay+sheepshead+image&usg=__YCaBDeqqE_6mzhQPv8zwLwZjaKc=&docid=SwGxr43pxj2weM&hl=en&sa=X&ei=ZrITUeO_B4m09QTSqIHgBw&ved=0CEgQ9QEwCA&dur=549
**Lutjanus griseus*	Mangrove Snapper	Year Round	http://www.google.com/search?q=mangrove+snapper+image+tampa+bay&hl=en&tbo=u&qscrl=1&rlz=1T4ADRA_enUS448US482&tbm=isch&source=univ&sa=X&ei=1rITUc3TFJCC9gTb4YHYBg&ved=0CC0QsAQ&biw=1638&bih=758#imgrc=uUNjGo2TdX4jtM%3A%3BIZUhVMo4yxcA7M%3Bhttp%253A%252F%252Fwww.thebradentontimes.com%252Fclientuploads%252Ffishing%252FMangrove-Snappers-300x225.jpg%3Bhttp%253A%252F%252Fwww.thebradentontimes.com%252Fnews%252F2012%252F12%252F27%252Ffishing%252Fstay_legal_between_the_lines_with_mangrove_snapper%252F%3B300%3B225
**Chaetodipterus faber*	Atlantic Spadefish	Year Round	http://www.tampabaywildimages.com/keyword/atlantic%20spadefish#!i=2203256957&k=Lmzf4LM

*** = Oriented towards surface structure**

The project team also acknowledges water clarity will limit the ability of visitors to be able to view all the biota that will utilize the area without some type of technological aid. Therefore, programmatic criteria are being established to enhance the interaction and the viewing experience for visitors to the Lens and aid in monitoring the success of the Underwater Feature using technology. This technology includes:

- synoptic video and camera monitoring of structural features;
- passive hydroacoustics (hydrophones);
- biotelemetry;
- active acoustics to monitor nighttime activity;
- real time monitoring of physical parameters,
- Internet portals to data and information collected at the Underwater Feature.

Utilizing technology will not only increase awareness of the utilization of the Underwater Feature by local fauna but aid in monitoring trends over time in the utilization of the feature as further described in the attached monitoring plan. A brief discussion of each of these techniques is provided in the paragraphs below.

Synoptic camera monitoring is now commonly being employed as a monitoring tool for evaluating changes in hard bottom structure such as coral reefs**.** We intend to use cameras to

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the greatest extent possible to document occurrence and utilization of species associated with the structural habitat feature as further described in the attached monitoring plan. Camera "traps" are a relatively novel technique utilized to obtain information on cryptic or nocturnal predators and their prey in remote areas that are elusive to other types of monitoring efforts. Cameras are typically deployed in arrays across areas thought to be primary, transitory feeding areas for species of interest and consideration will be given to employing this methodology to assist in documenting utilization of the habitat structures within the feature.

Passive acoustics are simply specialized microphones that have been adapted to record sounds in water. Despite their simplicity, hydrophones are used in cutting edge marine research to identify species-specific vocalizations associated spawning activity.

Biotelemetry involves establishing an array of listening devices that can be used to track fish and invertebrate species that have been tagged with specialized sound emitting devices. Biotelemetry has been widely used in estuarine waters to track movements and spawning aggregations of gamefish (Barbieri et al 2008), sharks (Heupel et al. 2004) and Snook (Bennett 2006). Biotelemetry is now being used to monitor site fidelity, home range, habitat use and even mortality.

Active acoustics can be as simplistic as fish finders used on typical recreational and commercial boats. However, active acoustics techniques are also increasingly being used to estimate fish biomass over large areas of estuarine, nearshore and offshore waters. Using a sound transmitting and receiving device active acoustic devices can record shapes and images that can be translated into biomass estimates within a given area.

Real time continuous monitoring of physical chemistry parameters provide high frequency measurements of the physical chemistry of the surrounding waters including temperature, salinity, turbidity, and dissolved oxygen concentrations.

As described in the monitoring plan, a baseline assessment will be conducted once the pier closes on Memorial Day 2013 but before demolition begins in August 2013. This survey will map bay bottom sediment characteristics and conduct species inventories for biota attached to existing piles directly in the area that will become the Underwater Feature. The baseline assessment will map, geo-reference, and video document physical features including bottom sediment characteristics and any bay bottom structural features such as hard bottom habitat as well as provide a biological inventory documenting the occurrence of species inhabiting the existing piles and surficial sediments, including invasive species. It is anticipated that the dive team will require significant artificial lighting to conduct the baseline survey given the lack of ambient light available in the area of the Underwater Feature.

To define a reference condition, consideration is being given to dedicating some of the existing piles within the Underwater Feature as reference piles to compare the effects of the habitat units against. These reference piles would be considered as control units in the monitoring design. Monitoring the control sites as well as the structural habitat or "treatment" units will allow for evaluation of the success of the treatment on ecological function.

UNDERWATER FEATURE GRANT APPLICATION (continued)

A second monitoring assessment will be conducted once the pier deck and piles have been removed but before construction begins on the new pier. This survey will allow for a pre-intervention estimate of changes in species composition and sediment characterization once the pier deck is removed and light has become available to previously shaded areas of the bay bottom. The monitoring will follow the same methods used in the baseline survey.

Project construction for the Underwater Feature is expected to occur simultaneously with construction of the larger Lens design but should be completed prior to completing construction of the pier itself. Post construction monitoring will take place initially on a quarterly basis for the first year and then every six months to document the recruitment of species to the habitat units. Post-construction monitoring will quantify changes to both structural characteristics measured as the occurrence and taxa richness of sessile epifauna recruiting to the feature as well as functional parameters measured as the complexity of trophic structure of the habitat units as defined by the taxa richness of larger macroinvertebrate and ichthyofauna utilizing the habitat units relative to the reference piles. This is further described in the attached monitoring plan.

Budget:
The following highlights the major contributions to the overall budget for the Underwater Feature. Details of the budget are provided in the attached budget documents.

- Stabilization and preparation of existing piles
  $ 150,000
- Schematic design of feature
  $ 50,000
- Fabrication, installation, and post-construction monitoring of the structural habitat units
  $ 800,000
- Construction of the Learning Steps
  $ 140,000
- Underwater Lighting
  $ 80,000
- UACE administrative oversight
  $ 100,000
- Soft costs (in-kind services)
  $ 143,757

Summary:
This project meets all of the qualifications necessary to fulfill the requirements of the Estuarine Habitat Restoration grant opportunity and will contribute significantly the NOAA's Estuary Habitat Restoration Strategy. This project contributes significantly to the long term conservation of estuarine habitat by improving historically degraded habitat due to legacy pier construction activities, employing innovative habitat enhancement features and most importantly, providing environmental education and awareness on the importance of conservation and planning to reduce the need for future habitat restoration. The project explicitly incorporates considerations of climate change into the design and provides critical habitat for important estuarine species with significant socioeconomic and economic value including many species of recreational and commercial importance. The project compliments other restoration activities in Tampa Bay by

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improving historically degraded habitat, reducing shading and pollutant loading to Tampa Bay and educating the public on local ongoing restoration and protection efforts. The project will also highlight novel marine science initiatives by local cooperators aimed at improving our understanding of estuarine, coastal and marine systems. Due to its proximity to the Florida Fish and Wildlife Conservation Commission, the University of South Florida, the National Oceanic and Atmospheric Administration and the United States Geological Survey, this site is centrally located to leverage local expertise in marine research and education. Due to its high profile, the new pier will also be an attractive venue to create public private partnerships and provide a myriad of opportunities for future collaborations for research and education. The project combines sophisticated structural habitat enhancement components with the simplistic appeal of observing nature undisturbed and has the potential to educate up to a million visitors a year. This project will create important habitat for juvenile stone crab, blue crab, and provide a complex biological community of macroinvertebrate species that provide habitat, refugia, and a prey base for higher trophic levels. The design is sustainable, can be easily maintained and can also be removed if necessary without impact to the ecosystem. The permitting application has been submitted and all indications are that the project is on track for approval. A monitoring plan has been developed that includes a defined baseline assessment, interim construction monitoring and specific post construction plans designed to provide concrete measures of success of the project in restoring habitat and ecological function to the new pier. The project team has the expert qualifications to successfully complete this project and the budget is reasonable, cost effective and provides direct resource benefit.

References:

Bennett, J.P. 2006. Using acoustic telemetry to estimate natural and fishing mortality of common snook in Sarasota Bay, Florida. Master thesis, University of Florida.
http://ufdc.ufl.edu/UFE0016067/00001

Heupel, M.R., C.A. Simpendorfer and R. E. Hueter 2004. Estimation of home ranges using passive monitoring techniques. Environmental Biology of Fishes 71. p135-142.

Lowerre-Barbieri, S., S. Walters, and J. Bickford. 2008. Spatial and temporal reproductive dynamics of spotted seatrout in Tampa Bay and adjacent waters. Page 135-151 in Investigations into Nearshore and Estuarine Gamefish Behavior, ecology, and life history in Florida. Sport Fish Restoration Act Report.

NOAA 2007. National Artificial Reef Plan: Guidelines for siting, construction, development, and assessment of artificial reefs.
http://www.nmfs.noaa.gov/sfa/PartnershipsCommunications/NARPwCover3.pdf

TBEP 2006. Charting the Course: The Comprehensive Conservation and Management Plan for Tampa Bay. Tampa Bay Estuary Program, St. Petersburg Fl.
http://www.tbep.org/tbep/charting_the_course.html

TBEP 2010. Tampa Bay Estuary Program Habitat Master Plan Update. Technical Report #06-09 of the Tampa Bay Estuary Program. Prepared by PBS&J (D. Robison).

UNDERWATER FEATURE GRANT APPLICATION (continued)

Monitoring Plan:

The design of the Underwater Feature is based on the conceptual model that increasing the structural complexity of habitat within the center of the Lens will provide for increased biological diversity, ecosystem function, and an increased opportunity for visitors to become informed about the Tampa Bay estuary. The design includes structural habitat enhancement units that will be attached to existing piles remaining from the legacy pier (Figure 1). Some piles will be left as reference piles or controls to compare against the success of the habitat units in increasing ecological diversity and ecosystem function. Technology will be used to the greatest extent possible to monitor and document the success of these treatment units.

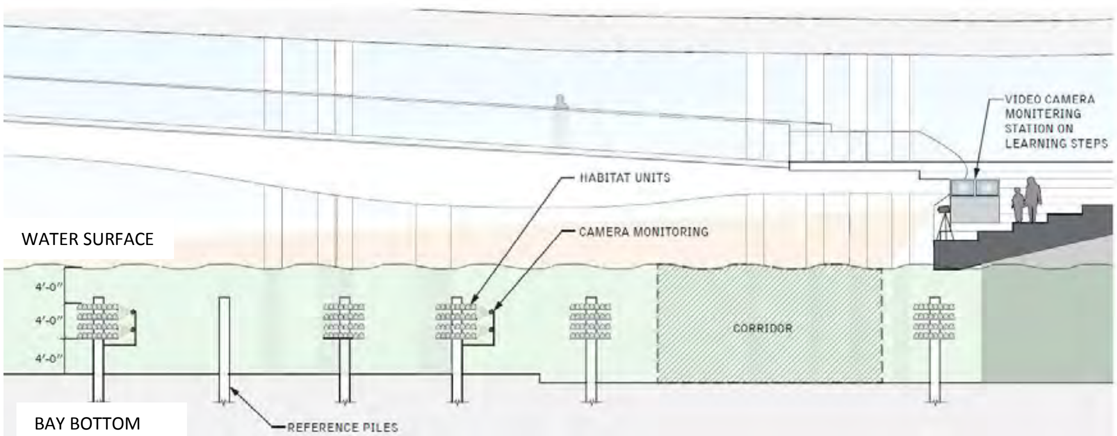

Figure 1. Conceptual design of Underwater Feature.

To quantify the success of the Underwater Feature in providing enhanced ecological function, specific hypotheses will be evaluated within the context of the conceptual model. These hypotheses include testing elements of structural and functional characteristics of the biota inhabiting the feature.

A hypothesis related to the **structural** elements of the design is that the habitat enhancement units will recruit a greater diversity and abundance of flora and epifauna than the existing piles without structural enhancement. The increased structural complexity provided by the sessile flora and fauna will increase biological diversity and serve as a base for trophic transfer to higher trophic levels. A hypothesis related to the **functional** elements of the design is that the habitat enhancement units will recruit a greater diversity and abundance of trophic guilds as measured by larger macroinvertebrate and fish species than the existing piles without structural enhancement. This increased biological diversity and complexity of the ecosystem will be the primary measure of the functional success of the Underwater Feature. A hypothesis related to the **socioeconomic** success of the Underwater Feature will be that visitors to the new pier will come away with a greater understanding of the Tampa Bay ecosystem and will have learned something new about the Tampa Bay estuary.

We expect the community structure of local fauna to include members of the following phylogenetic divisions: Porifera (Sponges), Ascidiacae (Tunicates), Actiniaria (Anemones), Mollusca (Oysters), Cirripedia (Barnacles), Polycheata (Worms), Arthropoda (Crustaceans),

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Echinodermata (Brittle stars), and Octocorallia (Sea Whips). We intend to document the diversity of these taxa to assess the structural characteristic of success of the habitat enhancement units relative to the reference units. Likewise, we intend to document secondary consumers, macroinvertebrates, and fish taxa including enumerating the number of trophic guilds as a measure of the functional success of the units relative to the reference piles. Despite the close proximity of the reference piles to the treatment units, we feel that the reference piles are a valid means of testing success of the treatment units.

The monitoring plan will consist of a baseline survey, a pre-construction survey and a series of post-construction monitoring events designed to evaluate trends over time. A baseline assessment will be conducted once the pier closes on Memorial Day 2013 but before demolition begins in August 2013. This will be considered a pre-construction survey. This survey will map bay bottom sediment characteristics and conduct species inventories for biota attached to existing piles directly in the area that will become the Underwater Feature. The baseline assessment will geo-reference, map, and video document physical features including bottom sediment characteristics and any bay bottom structural features such as hard bottom habitat as well as provide a biological inventory documenting the occurrence of species inhabiting the existing piles and surficial sediments, including invasive species. It is anticipated that the dive team will require significant artificial lighting to conduct the baseline survey given the lack of ambient light available in the area of the Underwater Feature.

A second monitoring assessment will be conducted once the pier deck and piles have been removed but before construction begins on the new pier. This survey will allow for a pre-intervention estimate of changes in species composition and sediment characterization once the pier deck is removed and light has become available to previously shaded areas of the bay bottom. The monitoring will follow the same methods used in the baseline survey.

Post-construction monitoring will take place quarterly for the first year and biannually for the next 4 years post-construction the habitat units and quantify changes in both structural and functional parameters. Monitoring will consist of evaluating a subset of reference piles and habitat enhancement units. Methods will include diver surveys, photographic documentation and analysis and synoptic video assessments. Analysis of the data collected through these efforts will include multivariate analytical techniques to assess differences in community structure and identify species contributing most to observed differences in community structure both between the reference and habitat enhancement units as well as changes within a unit over time. These analyses will serve to evaluate the structural and functional success of the habitat units. The socioeconomic impact of the feature will be assessed using statistically valid survey methods to evaluate the impact of providing this feature as an educational tool for environmental awareness to visitors of the pier.

The monitoring plan intends to include novel technologies to both monitor success of the habitat features and also to increase the interaction between the visitors and the estuary as further described in the project narrative.

UNDERWATER FEATURE GRANT APPLICATION (continued)

BUDGET NARRATIVE - ESTUARY HABITAT RESTORATION PROGRAM PROJECT

Estimated total project cost: $1,463,757
ERA funding request: $950,000
Non-federal share from all non-federal sources (state, local, non-profit, in-kind and volunteer contributions): $513,757

City Personnel: Total workforce labor costs $25,594
City Architect – 100 hours x $55.77 p/hr. City architect will work closely with pier design team Michael Maltzan Architecture to complete design components of the project, providing day to day project communication and general oversight of project activities and general implementation; ensure project objectives are met, and all necessary approvals and permits are secured.

Engineer – 75 hours x $42 p/hr. The Project Engineer will work closely with design team on the technical design aspects of the structure. This includes the design of the foundation, bridge superstructure, structural support members, and the detailed technical studies required to design and construct the new pier.

Project Coordinator – 200 hours x $37.91 p/hr. The project coordinator will be responsible for daily management of both the demolition project and the new pier design to ensure that the documents are coordinated, permit issues are resolved and the project is progressing. The project coordinator will also work with the Construction Manager to perform constructability reviews and obtain cost estimates during the pre-construction phase of the work.

Inspector – 300 hours x $28.95 p/hr. Once the project goes into construction, the Inspector will have daily inspection duties to make sure that the Construction Manager's work is progressing incompliance with the construction documents.

Grant Coordinator – 17 hours x $35.27 p/hr. Grant coordinator will oversee administrative and technical post-award reporting to ensure all documents are filed on time, and that overall project financial management is coordinated and managed correctly.

Fringe benefits included in indirect cost total.

Travel: Travel costs cover the transport of key personnel representing the architecture consultant to provide site visits during key project milestones. Estimate based on 2 persons traveling for 3 trips at $750 each for a total cost of $4,500.

Related Materials & Supplies: Costs are requested for both pre- and post-construction monitoring, and includes monitoring devices and sampling gear, and other miscellaneous monitoring related items. Estimate a total of $5,290 in materials and supplies.

Contractual: $100,000 - consultant services for the preliminary and detailed design ($50,000) with the city matching ($50,000).

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Construction: Total construction costs estimated at $1,180,000.
$339,790 – Skansa USA for construction of the piling stabilization support system, installation of underwater lighting system; and construction of Learning steps.
$30,000 - Sonny Glassbrenner Inc, to salvage the pilings.
$800,000 - purchase and install limestone rock reef structures to be determined through competitive bid process ($800,000).

Other Costs: $100,000 – requested for USACE activities and requirements.
$50,000 – covers 5-year post-construction monitoring.

Indirect Costs: St. Petersburg will not charge indirect costs on this proposal, but is including unrecovered overhead as a cost share; equals $48,373 at a rate of 1.89 per labor hours (see attached IDCR agreement).

Cost Share: Cost share will be covered through city labor costs from department operating budgets and through unrecovered overhead, and other in-kind services and materials brought to the project through partners Tampa Bay Watch and the University of South Florida. All participating stakeholders will be providing the services of their respective professional staffs to assist in this project, and their time and services will be documented per federal effort certification requirements.

Overview of Larger Project Budget: St. Petersburg has budgeted funds in the capital improvements budget for the replacement of its municipal pier, budgeted for $50 million dollars, which includes some of the costs we will commit as cost share.

UNDERWATER FEATURE GRANT APPLICATION (continued)

U.S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
WASHINGTON, D.C. 20410-7000

OFFICE OF THE ASSISTANT SECRETARY
FOR COMMUNITY PLANNING AND DEVELOPMENT

November 5, 2009

M. Wayne Finley, M.B.A
Contracts and Grants Officer
Budget & Management Division
City of St.Petersburg.

Dear Mr.Finley,

Attached is an original and one copy of the indirect cost Rate Agreement for your signature. This agreement reflects an understanding reached between your organization and this Department concerning the rate(s) that may be used to support your claim for indirect costs on grants and contracts with the Federal Government.

Please have the original copy of the agreement signed by an authorized representative of you organization and return it to me, retaining a copy for your files. The agreement will become effective upon signature. We will reproduce and distribute the Agreement to the appropriate awarding organizations of the Federal Government for their use.

An indirect cost proposal, together with the supporting information, is required to substantiate you claim for indirect costs under grants and contracts awarded by the Federal Government. Thus, your next proposal based on actual costs for the fiscal year ending September 30, 2009, and budgeted cost for the fiscal year ending September 30, 2009 is due in our office by March 31, 2010.

Sincerely,

Lisa Abell
Lisa Abell
Assistant Comptroller

Enclosure

STATE AND LOCAL
INDIRECT COST RATE NEGOTIATION AGREEMENT

ORGANIZATION **Date:** NOVEMBER 19, 2009

Name City of St. Petersburg
Engineering Department
Address Post Office Box 2842
St. Petersburg, Fl 33731-2842

Filing Reference: This replaces the Agreement Dated:

The rate(s) approved in this Agreement are for use on grants, contracts and other agreements with the Federal Government to which MB Circular A-87 applies, subject to the conditions in Section II, A below. The rate(s) were negotiated by the above named organization and the U.S. Department of Housing and Urban Development in accordance with the authority contained in Attachment A, Section E of the Circular.

SECTION I: INDIRECT COST RATES

TYPE	EFFECTIVE PERIOD FROM	TO	RATE(%) *1	LOCATION	APPLICABLE TO
Provisional	10/01/07	09/30/08	188.00	All	All Programs
Provisional	10/01/08	Until Amended	189.00	All	All Programs

***1 BASE:**

Direct salaries and wages excluding all fringe benefits

UNDERWATER FEATURE GRANT APPLICATION (continued)

DEPARTMENT/AGENCY
City of St. Petersburg Engineering Department

AGREEMENT DATE:

SECTION II: SPECIAL REMARKS

TREATMENT OF FRINGE BENEFITS:
Fringe Benefits are tracked and charged directly or indirectly in the same manner as salary and wages cost.

TREATMENT OF PAID ABSENCES:
Vacation, holiday, sick leave pay and other paid absences are included in salaries and wages and are claimed on grants, contracts and other agreements as part of the normal cost for salaries and wages. Separate claims for the costs of these paid absences are not made.

FRINGE BENEFITS:
FICA
Retirement
Worker's Compensation
Unemployment Insurance
Health Insurance

EQUIPMENT DEFINITION:
Equipment means an article of nonexpendable, tangible personal property having a useful life of more than one year and an acquisition cost of $5,000 or more per unit.

DEPARTMENT/AGENCY
City of St. Petersburg Engineering Department

AGREEMENT DATE:

SECTION III: GENERAL

A. LIMITATIONS:

The rates in this Agreement are subject to any statutory or administrative limitations and apply to a given grant, contract or other agreement only to the extent that funds are available. Acceptance of the rate(s) is subject to the following conditions: (1) Only costs incurred by the governmental unit and are allowable under the governing cost principles; (2) The same costs that have been treated as indirect costs are not claimed as direct costs; (3) Similar types of costs have been accorded consistent accounting treatment; and (4) The information provided by the governmental unit which was used to establish the rate(s) is not later found to be materially incomplete or inaccurate by the Federal Government. In such situations the rate(s) would be subject to renegotiation at this discretion of the Federal Government. Also, the rate(s) cited in this Agreement may be subject to audit.

B. ACCOUNTING CHANGES

This Agreement is based on the accounting system purported by the government unit to be in affect during the Agreement period. Changes to the method of accounting for costs which affect the amount of reimbursement resulting from the use of this Agreement require prior approval of the authorized representative of the cognizant agency. Such changes include, but are not limited to, changes in the charging of a particular type of cost from indirect to direct. Failure to obtain approval may result in cost disallowances.

C. NOTIFICATION TO FEDERAL AGENCIES

The rate(s) cited in this Agreement were approved in accordance with the authority in Office of Management and Budget Circular A-87, and should be applied to all grants, contracts and other agreements covered by this Circular, subject to any limitations in A above. The governmental unit may provide copies of this Agreement to other Federal Agencies as a means of notifying them of the Agreement contained herein.

D. RATES

Fixed Rates: If a fixed rate is included in this Agreement, it is based on an estimate of the costs for the period covered by this rate. When the actual costs for this period are determined, an adjustment will be made to a rate of a future year(s) to compensate for the difference between the costs used to establish the fixed rate and actual costs.

Provision-Final Rates: If a provisional rate is included in this Agreement, the governmental unit must submit a proposal to establish a final rate within six-months after their fiscal year end. Billings and charges to Federal awards must be adjusted if the final rate varies from the provisional rate. If the final rate is greater than the provisional rate and there are no funds available to cover the additional indirect costs, the governmental unit may not recover all indirect costs. Conversely, if the final rate is less than the provisional rate, the governmental unit will be required to pay back the difference to the funding agency.

**UNDERWATER FEATURE
GRANT APPLICATION
(continued)**

DEPARTMENT/AGENCY
City of St. Petersburg Engineering Department

AGREEMENT DATE:

D. OTHER:

If any Federal contract, grant or other agreement is reimbursing indirect costs by a means other than the approved rate(s) cited in this Agreement, the governmental unit should (1) credit such costs to the affected programs and (2) apply the approved rate(s) to the appropriate base to identify the proper amount of indirect costs allocable to these programs.

BY THE GOVERNMENTAL UNIT

City of St. Petersburg Engineering Department

Thomas B. Gibson
(Signature)

Thomas B. Gibson
(Name)

Engineering Director
(Title)

12-10-2009
(Date)

BY THE COGNIZANT AGENCY ON BEHALF OF THE FEDERAL GOVERNMENT

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT

Lisa Abell
(Signature)

Lisa Abell
(Name)

Budget Director
(Title)

11-19-09
(Date)

HUD Representative:

Telephone: 202-402-8130

APPLIED TECHNOLOGY & MANAGEMENT
5550 NW 111th BLVD.
GAINESVILLE, FLORIDA 32653
TEL: 386-418-6400
FAX: 386-418-6401

www.appliedtm.com

April 17, 2013

Tim Williams
Michael Maltzan Architecture
2801 Hyperion Avenue, Studio 107
Los Angeles, California 90027

Re: The New St Petersburg Pier – The Lens – Marina Design

Dear Tim:

As requested, I have prepared a letter on the marina design process and ATM's role and effort to date. ATM has been advancing the marina conceptual design presented in the Basis of Design document for the Lens Marina.

- The marina will be circular in shape and consist of floating dock components
- The dock design ensures that the components are able to survive a design storm condition and attenuate expected waves and boat wakes under typical operational conditions.
- The portion of the marina subject to the longest fetches and therefore largest storm waves and the docks on the north and south, which are subject to boat wakes will be constructed of heavy-duty deep-draft wide components.
- The western portion of the marina is designed for heavy pedestrian activity, concessions and the launching of kayaks and other people-powered vessels. The dock platform in this area is therefore wide and designed to carry the dead loads of the expected buildings and other furniture.
- The eastern portion of the marina is subject to the largest expected storm waves and is designed to accommodate fishing.
- The inner portion of the circular marina is accessed via a 50ft wide opening in the docks under the overwater bridge in the marina's northern portion and is designed to accommodate small powerboats with limited air draft. Mooring furniture will be provided for side-tying vessels along the interior docks and on provided finger piers.
- Utilities provided are limited to electricity and water for the concession areas, light bollards, and 20amp GFI sockets for maintenance along the docks. No shore utilities are provided for the visiting boaters.
- SOS pedestals and safety ladders are also provided throughout the marina. The SOS pedestals are lighted and are equipped with life rings and fire extinguishers.
- Access to the marina is provided from both the overwater drive and the overwater bridge fixed piers. At least one ADA-compliant access gangway will be provided.

Coastal, Environmental, Marine, and Water Resources Engineering

SCHEMATIC DESIGN REPORT: MARINA (continued)

Typically, the primary factors that determine the docking system of any marina facility include: environmental exposure to wind, waves, and currents, the owner/architect's preference of decking material and aesthetics, and economics.

Most floating dock systems are designed to be constructed of modular components that are capable of performing for over 20 years with minor, yet regular, maintenance needs. The owner has the option of selecting specific materials for the dock redevelopment. ATM typically recommends a competitive bid process by which performance specifications are prepared that detail minimum standards for system performance. Bidders then provide their best price for their particular product that will meet or exceed the specification. This method can typically save money while allowing the owner/architect to select from a range of floating dock system options.

Performance specifications were developed during schematic design that are incorporated in the bidding documents and must be adhered to by the supplier. These performance specifications are adapted from guidance described in PIANC (1997), Hunt (1996), ASCE (1994), and related publications. Several materials are available for the three basic floating dock system components, which include deck, frame, and floats. Brief descriptions of typical materials follow.

<u>Decking</u>
All-concrete docks are widely used and incorporate flotation, framing, and decking in one monolithic unit.

<u>Frame</u>
Structural framing for floating docks may be wood, metal, or concrete. Wood frames may be native structural lumber or glued-laminated beams for additional strength. Galvanized steel and aluminum are also widely used framing materials, with aluminum preferred in the saltwater environment when the strength of steel is not required. Corrosion potential is generally the concern for metal frames, although proper coatings can reduce corrosion.

<u>Floats</u>
The all concrete floating dock is typically concrete encased polystyrene and is cast in monolithic units. If a concrete flotation system is selected, the flotation modules should consist of a reinforced, unitized shell of special lightweight concrete completely encapsulating a solid polystyrene foam core.

<u>Accessories</u>
Dock accessories (cleats, ladders, etc.) and utility services are available for all types of floating docks. The all-concrete docks typically include utility access via PVC raceways that are formed and extend through the floats with conduit stub-ups at predetermined locations on the deck.

<u>Anchorage</u>
Floating docks must be "anchored" in-place. The wind, current and especially wave loads are transferred from the docks to the anchoring system, which must be engineered to accept these loads. Docks are typically anchored with either piling (usually concrete or

steel) or chains or elastic rodes secured to the seabed with mass anchors, helical anchors, or stub piling. The final design of the anchoring system is based upon computed wind, wave, and current forces acting on the docks and vessels, anticipated extreme water levels, site soil characteristics, the supplier's dock system structural requirements, and aesthetics. Marina depths, anticipated design loads, and materials availability/cost all factor in to the selection of the anchorage system.

The design team is currently considering the relative advantages and trade-offs of specifying a pile-anchored marina versus one moored entirely on elastic rodes (SeaFlex) or some mixture of these components. Both have advantages for accomplishing project design intent, but neither completely meets all of the design goals.

Perimeter Protection Options

As discussed above, the facility is not naturally protected from prevailing and design level waves, so artificial protection must be included to provide harbor tranquility. Because traditional fixed breakwater options were not selected in the design basis phase, floating wave attenuators are the only possible method for providing the necessary perimeter protection. The performance specification developed for the project specify the condition under which the docks must perform and survive.

Specifications

ATM developed performance specifications for the project including:

- Marine Piles (general)
- Prestressed Concrete Piles
- Steel Pipe Piles
- Dock Utility General Requirements
- Floating Docks and Wave Attenuators
- Aluminum Gangways, and
- Flexible Mooring Systems

References

American Society of Civil Engineers, 1994. Planning and Design Guidelines for Small Craft Harbors, ASCE Manual on Engineering Practice No. 50. New York: American Society of Civil Engineers, 291 p.

Batts, M.E., M.R. Cordes, L.R. Russell, J.R. Shaver, and E. Simiu, 1980. "Hurricane Wind Speeds in the United States." NBS Building Science Series 124, US Department of Commerce, May 1980.

Cox, J.C., 1989. "Breakwater Attenuation Criteria and Specification for Marina Basins." In Marinas: Design and Operation, Proc. International Conference on Marinas. Southampton, UK, p. 139-155.

Gaythwaite, J., 1987. "Floating Breakwaters for Small Craft Facilities." Civil Engineering Practice, J. of the Boston Society of Civil Engineers, Section ASCE, Vol. 2 No. 1.

SCHEMATIC DESIGN REPORT: MARINA (continued)

Neumann, C.J., and Pryslak, M.J., 1981. NOAA Technical Report NWS 26. Frequency and Motion of Atlantic Tropical Cyclones. National Hurricane Center, Coral Gables, Florida.

PIANC, 1994. “Floating Breakwaters, A Practical Guide for Design and Construction.” PTC II, Report of Working Group No. 13, Supplement to Bulletin 85. Brussels, 1994.

PIANC, 1997. “Review of Selected Standards for Floating Dock Designs.” PIANC Sport & Pleasure Navigation Commission, Supplement to Bulletin 93, January 1997.

Sorensen, R.M., 1973. “Ship-Generated Waves.” Advances in Hydroscience, Academic Press, New York, Volume 9, pp 49-83.

Thom, H.C.S., 1968. “New Distributions of Extreme Winds in the United States.” Journal of the Structural Division, ASCE, July 1968, #6038, pp. 1787-1801.

Tobiasson, Bruce O. and Ronald C. Kollmeyer, 2000. Marinas and Small Craft Harbors. Second Edition. Medfield: Westviking Press, 659 p.

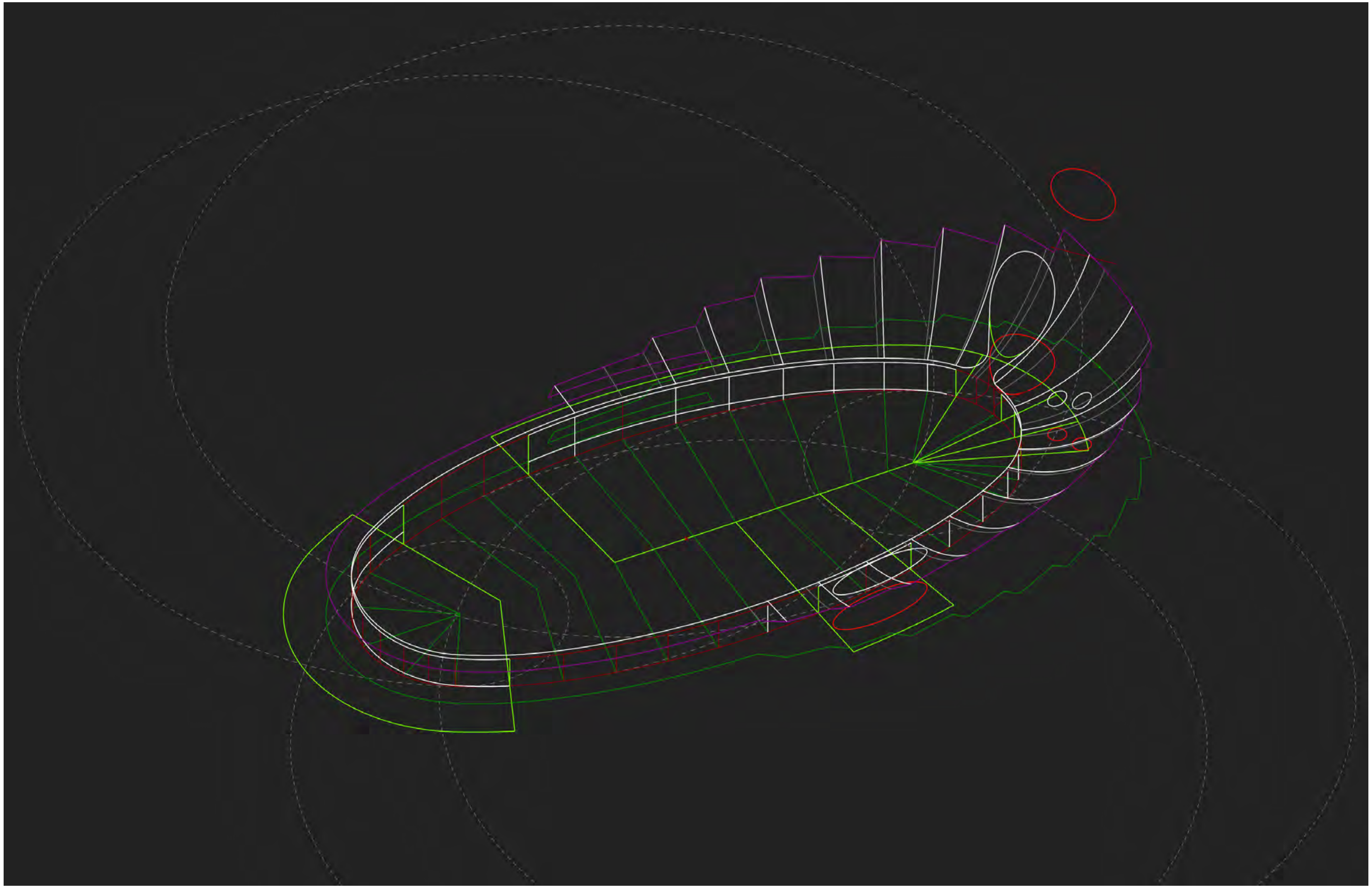
US Army Corps of Engineers, 1984. Shore Protection Manual. Waterways Experiment Station, Vicksburg, Mississippi.

Sincerely,

Robert H Semmes
Vice President

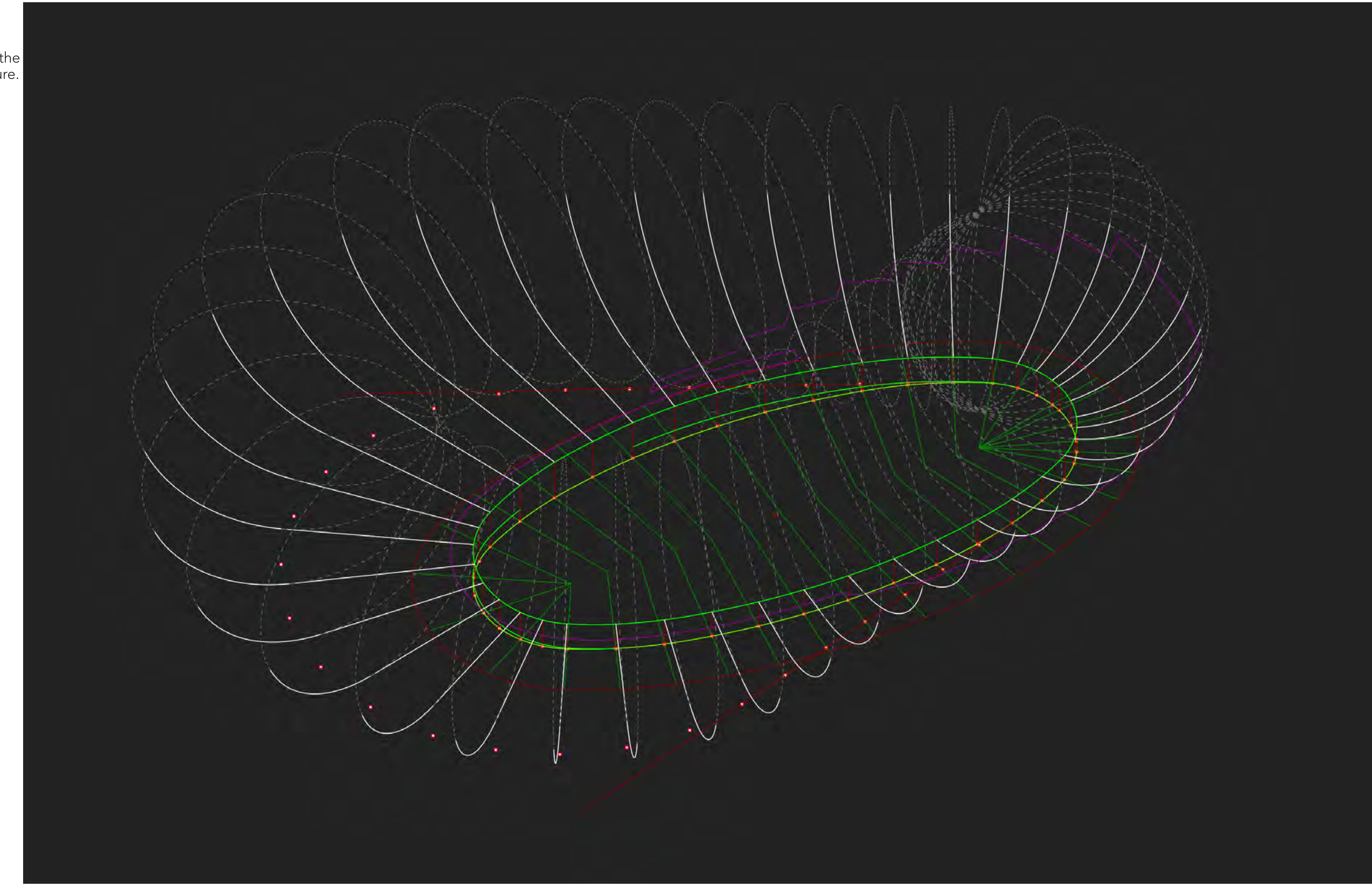
CANOPY DESIGN ANALYSIS:
3D IMAGES

The plan of the entire project has been rationalized into a series of semi-circular arcs to optimize construction.



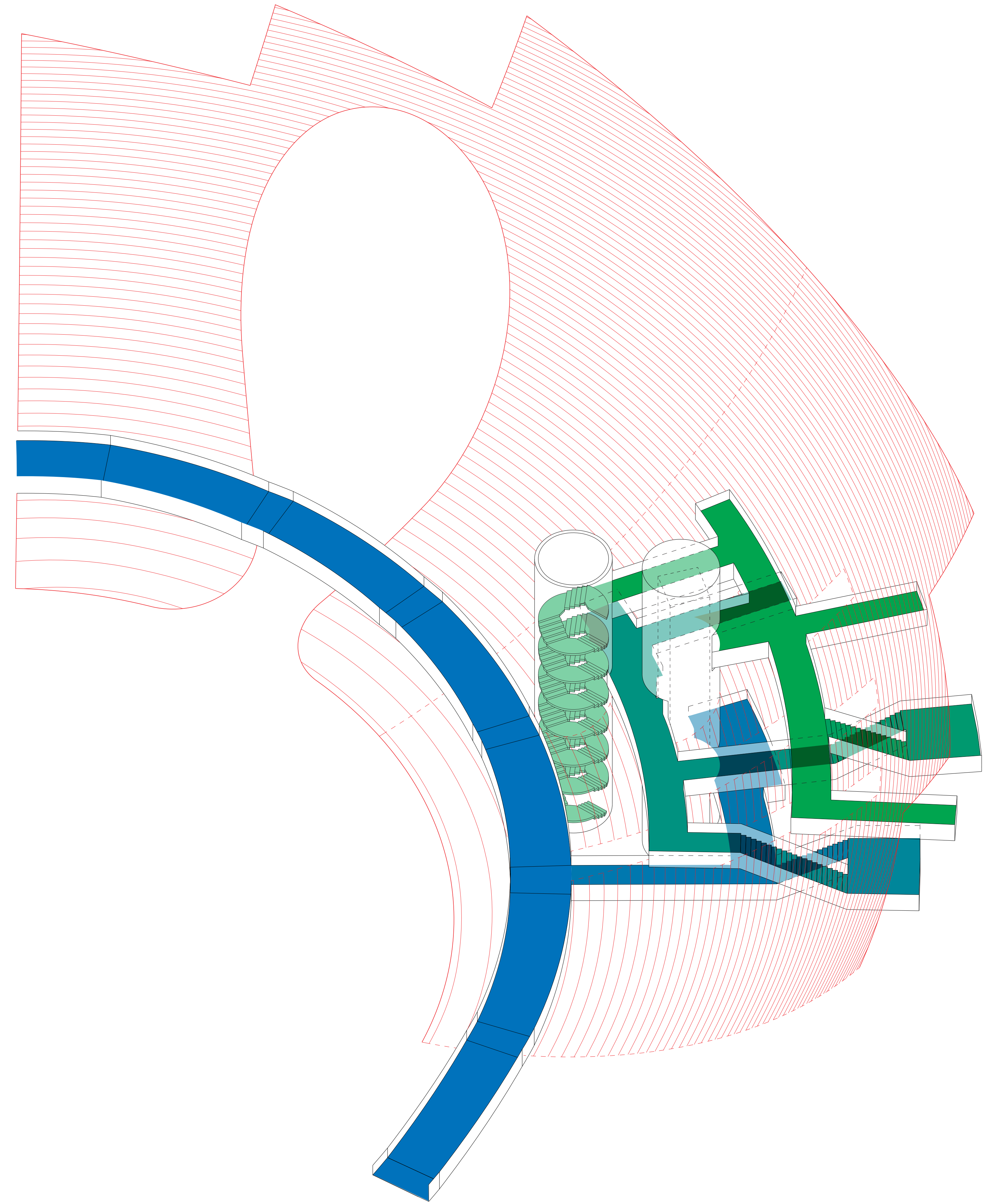
CANOPY DESIGN ANALYSIS: 3D IMAGES (continued)

The canopy design is generated from a series of semi-circular sections with uniform radii. This rationalized form will economize the fabrication of the steel substructure.



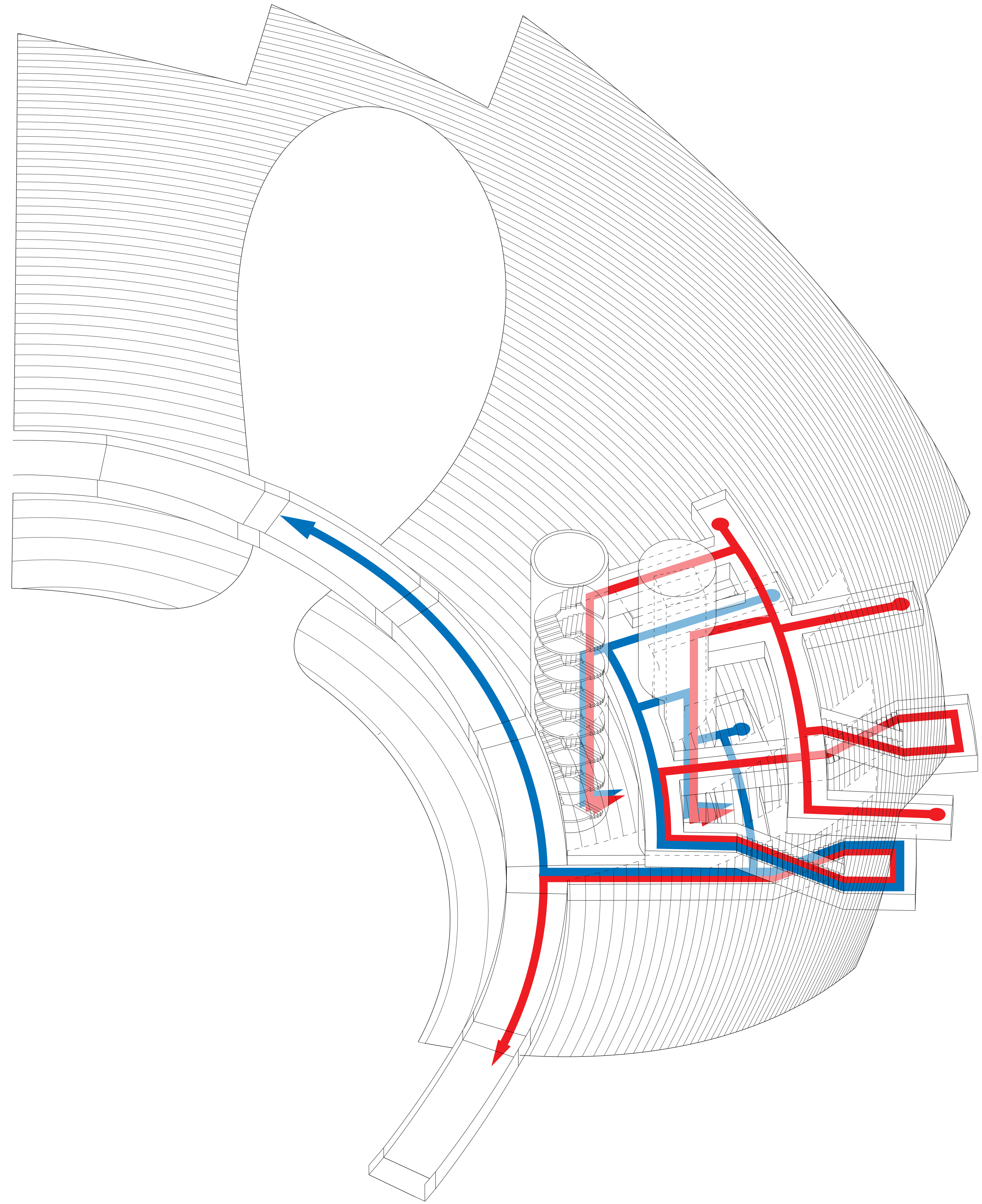
BALCONY DESIGN ANALYSIS: 3D IMAGES

The balconies form a continuous circulation network that links the bike path (blue) to the highest balcony (green).



BALCONY DESIGN ANALYSIS: 3D IMAGES (continued)

Each bancony has three (3) means of egress; the stair core, the elevator and the Bike Path.



4

SCHEMATIC DESIGN ANALYSIS

INTRODUCTION

The drawings in this section are exerpts from the full Schematic Design drawing set that will be submitted to the City of St. Petersburg. The drawings are intended to provide an overall understanding of the development of the Project and its Components during Schematic Design and to supplement the narrative and reports included in this document.

LIST OF DRAWINGS

- ARCHITECTURAL DRAWINGS
  - 1 / A0-01 Sheet Index
  - 2 / A1-02 Drive Plan
  - 3 / A1-05 Canopy Plan
  - 4 / A2-01 Elevations
  - 5 / A3-01 Sections
  - 6 / A6-01 Enlarged Promontory Plan
  - 7 / A6-11 Bridge & Drive Sections
- 3D VIEWS
  - 1 / A0-03 Overall View
  - 2 / A5-00 Canopy
  - 3 / A7-34 Balconies
- CANOPY PANELIZATION
  - 1 / Control Geometry
  - 2 / Overall Panelization
- STRUCTURAL DRAWINGS
  - 1 / S0-21 Site Structural Plan
  - 2 / S1-00 Pile Plan
  - 3 / S1-03 Enlarged Pile Plan
  - 4 / S5-11 Framing Plan
  - 5 / S5-23 Enlarged Framing Plan
  - 6 / S5-41 Framing Axonometric
- MARINA DRAWINGS
  - 1 / A8-01 Enlarged Marina Plan
- HUB/RESTAURANT
  - 1 / A4-01 Enlarged Hub Plan
- LIGHTING
  - 1 / Schematic Design Report

1 / A0-01 Sheet Index

ST PETERSBURG PIER SHEET INDEX

SHEET	SHEET DESCRIPTION	SCALE	100% SCHEMATIC DESIGN MAY 2, 2013	100% DESIGN DEVELOPMENT	50% CONSTRUCTION DOCUMENTS	RESPONSIBLE PARTY
A8 FLOATING MARINA						
A8-01	ENLARGED MARINA PLAN	1" = 20'	•			MMA
A9 PATTERN AND SCHEDULES						
A9-01	PROMONTORY CONCRETE PATTERN	1" = 15'	•			MMA
STRUCTURAL						
SITE PLAN						
S-021	SITE STRUCTURAL PLAN	1" = 60'	•			BHNY
FOUNDATION PLANS						
S1-00	FOUNDATION PLAN OVERALL	1" = 60'	•			BHNY
S1-01	PARTIAL FOUNDATION PLAN- OVERWATER DRIVE	1" = 30'	•			BHNY
S1-01A	PARTIAL GENERAL PLAN- OVERWATER DRIVE	1" = 40'	•			BHNY
S1-02	PARTIAL FOUNDATION PLAN- OVERWATER BRIDGE	1" = 30'	•			BHNY
S1-03	PARTIAL FOUNDATION PLAN- PROMONTORY	1" = 30'	•			BHNY
STRUCTURE- PILE CAP PLANS/SECTIONS/DETAILS						
S1-10	PILE FOUNDATION DETAILS AND SCHEDULE	NONE	•			BHNY
S1-11	PILE CAP PLAN, ELEVATION & SECTION AND SCHEDULES	NONE	•			BHNY
S1-11A	OVERWATER DRIVE SPAN PLANS	1/4" = 1'	•			BHNY
S1-12	STANDARD DETAILS	NONE	•			BHNY
S1-31	OVERWATER DRIVE SECTIONS	3/4" = 1'	•			BHNY
STRUCTURE- OVERWATER BRIDGE						
S2-01	OVERWATER BRIDGE GENERAL PLAN	1" = 40'	•			BHNY
S2-11	OVERWATER BRIDGE SPAN PLANS (BEAM/DECK)	1/4" = 1'	•			BHNY
S2-31	OVERWATER BRIDGE SECTIONS	3/4" = 1'	•			BHNY
STRUCTURE- PROMONTORY						
S4-21	PROMONTORY BEAM LAYOUT PLAN	1" = 30'	•			BHNY
S4-31	PROMONTORY DECK PLANS	3/16" = 1'	•			BHNY
S4-41	PROMONTORY SECTIONS	1/4" = 1'	•			BHNY
STRUCTURE- CANOPY						
S5-11	CANOPY GENERAL PLAN	1" = 30'	•			BHLA
S5-21	CANOPY PLAN AREA A	1" = 10'	•			BHLA
S5-22	CANOPY PLAN AREA B	1" = 10'	•			BHLA
S5-23	CANOPY PLAN AREA C	1" = 10'	•			BHLA
S5-24	CANOPY PLAN AREA D	1" = 10'	•			BHLA
S5-25	CANOPY PLAN AREA E	1" = 10'	•			BHLA
S5-26	CANOPY PLAN AREA F	1" = 10'	•			BHLA
S5-31	TYPICAL CANOPY SECTIONS 1	1/8" = 1'	•			BHLA
S5-32	TYPICAL CANOPY SECTIONS 2	1/8" = 1'	•			BHLA
S5-33	TYPICAL CANOPY SECTIONS 3	1/8" = 1'	•			BHLA
S5-41	CANOPY ELEVATIONS	NTS	•			BHLA
S5-51	CANOPY FRAMING DETAILS	VARIES	•			BHLA
ELECTRICAL						
E1-01	ELECTRICAL PLAN	NTS	•			BHNY
E1-02	ELECTRICAL PLAN	NTS	•			BHNY
E6-00	ELECTRICAL PANELS	NONE	•			BHNY
E7-00	ELECTRICAL SCHEDULE	NONE	•			BHNY
PLUMBING						
P1-01	WATER AND SANITARY SERVICE	NTS	•			BHNY
P1-02	WATER AND SANITARY SERVICE	NTS	•			BHNY
P5-00	WATER AND SANITARY SECTION	NTS	•			BHNY
CIVIL						
C5-01	GENERAL CONSTRUCTION NOTES	NONE	•			BHNY
C5-11	EXISTING CONDITIONS PLAN AND LEGEND	1" = 30'	•			BHNY
C5-21	DEMOLITION PLAN	1" = 30'	•			BHNY
C5-31	UPLAND GENERAL PLAN AND SITE PLAN	1" = 30'	•			BHNY
C6-01	CONSTRUCTION SURFACE WATER PROTECTION PLAN	1" = 30'	•			BHNY
C6-11	BEST MANAGEMENT PRACTICE DETAILS	NONE	•			BHNY
C6-21	STORM WATER POLLUTION PREVENTION PLAN	NONE	•			BHNY
DEMOLITION						
D1-01	UPLAND GRADING AND DRAINAGE PLAN	1" = 30'	•			BHNY
D1-11	GRADING AND DRAINAGE DETAILS	NONE	•			BHNY
D1-12	GRADING AND DRAINAGE DETAILS	NONE	•			BHNY
U1-01	UPLAND UTILITY PLAN	1" = 30'	•			BHNY

ST PETERSBURG PIER SHEET INDEX

SHEET	SHEET DESCRIPTION	SCALE	100% SCHEMATIC DESIGN MAY 2, 2013	100% DESIGN DEVELOPMENT	50% CONSTRUCTION DOCUMENTS	RESPONSIBLE PARTY
GENERAL INFORMATION						
A0-00	COVER SHEET	NONE	•			MMA
A0-01	SHEET INDEX	NONE	•			
A0-02	PROJECT DATA	NONE	•			WJA/MMA
A0-03	PROJECT AXONOMETRICS	NONE	•			WJA/MMA
A0-06	3D DATABASE INFORMATION	NONE	•			MMA
LS1-01	LIFE SAFETY PLAN	1" = 60'	•			WJA
ARCHITECTURAL GEOMETRY PLANS						
A0 SITE INFORMATION						
A0-10	SITE PLAN	1" = 120'	•			MMA
1	TOPOGRAPHIC SURVEY - FOR REFERENCE ONLY	NONE	•			BHNY/MMA
2	TOPOGRAPHIC SURVEY - FOR REFERENCE ONLY	1" = 30'	•			BHNY/MMA
3	TOPOGRAPHIC SURVEY - FOR REFERENCE ONLY	1" = 30'	•			BHNY/MMA
4	TOPOGRAPHIC SURVEY - FOR REFERENCE ONLY	1" = 60'	•			BHNY/MMA
1	3D SONAR MAPPING OF EXISTING PILINGS - FOR REFERENCE ONLY	1" = 30'	•			BHNY/MMA
2	3D SONAR MAPPING OF EXISTING PILINGS - FOR REFERENCE ONLY	1" = 30'	•			BHNY/MMA
1	HYDROGRAPHIC SURVEY - FOR REFERENCE ONLY	1" = 100'	•			BHNY/MMA
A1 PLANS						
A1-00	GRID PLAN	1" = 60'	•			
A1-01	MARINA LEVEL PLAN	1" = 60'	•			MMA
A1-02	OVERWATER DRIVE LEVEL PLAN	1" = 60'	•			MMA
A1-03	OVERWATER BRIDGE LEVEL PLAN	1" = 60'	•			MMA
A1-04	BALCONY LEVEL PLAN	1" = 60'	•			MMA
A1-05	CANOPY PLAN	1" = 60'	•			MMA
A2 ELEVATIONS						
A2-01	EXTERIOR ELEVATIONS	1" = 60'	•			MMA
A3 SECTIONS						
A3-01	OVERALL SECTIONS	1" = 30'	•			MMA
A4 UPLANDS						
A4-01	ENLARGED UPLANDS PLAN	1" = 30'	•			MMA
A4-02	UPLANDS SECTIONS	1" = 20'	•			MMA
A5 METAL CANOPY						
A5-00	ENLARGED CANOPY AXONOMENTRIC- ABOVE	NONE	•			
A5-01	ENLARGED CANOPY AXONOMENTRIC- BELOW	NONE	•			MMA
A5-02	ENLARGED CANOPY PLAN	1" = 30'	•			MMA
A5-03	ENLARGED CANOPY REFLECTED CEILING PLAN	1" = 30'	•			MMA
A5-04	CANOPY SECTIONS	1" = 5'	•			MMA
A5-05	CANOPY SECTIONS	1" = 5'	•			MMA
A5-06	CANOPY SECTIONS	1" = 5'	•			MMA
A5-10	CANOPY DETAILS	VARIES	•			MMA
A6 CONCRETE						
A6-01	ENLARGED PROMONTORY PLAN	1" = 15'	•			MMA
A6-02	ENLARGED MARINA OVERLOOK PLANS AND SECTIONS	1" = 15'	•			MMA
A6-03	ENLARGED RIALTO STAIR	1" = 10'	•			MMA
A6-04	ENLARGED BIKE PATH PLAN	1" = 60'	•			MMA
A6-11	OVERWATER DRIVE/ OVERWATER BRIDGE SECTIONS	1" = 5'	•			MMA
A6-20	RAILING KEY PLAN	VARIES	•			MMA
A6-21	RAILING DETAILS	1 1/2"= 1'	•			MMA
A6-22	BENCH DETAILS	1 1/2"= 1'	•			MMA
A6-23	OVERWATER DRIVE CANOPIES	VARIES	•			MMA
A7 ELEMENTS						
A7-11	PROMONTORY CONCESSIONS PLAN, RCP, ELEVATIONS, DETAILS	VARIES	•			MMA
A7-12	PROMONTORY GRILL CAFÉ PLAN	1" = 10'	•			MMA
A7-21	PROMONTORY RESTROOMS PLAN & RCP	1/4"=1'-0"	•			MMA
A7-22	PROMONTORY RESTROOMS ELEVATIONS & SECTION	1/4"=1'-0"	•			MMA
A7-23	PROMONTORY RESTROOMS INTERIOR ELEVATIONS	1/4"=1'-0"	•			MMA
A7-24	MARINA RESTROOMS PLAN, RCP, INTERIOR ELEVATIONS	1/4"=1'-0"	•			MMA
A7-25	HUB RESTROOMS PLAN, RCP, INTERIOR ELEVATIONS	VARIES	•			MMA
A7-30	OVERLOOK BALCONY AXONOMETRICS	VARIES	•			MMA
A7-31	OVERLOOK BALCONY PLANS	1" = 5'	•			MMA
A7-32	OVERLOOK BALCONY PLANS	1" = 5'	•			MMA
A7-33	OVERLOOK BALCONY LEVEL 2	1" = 5'	•			MMA
A7-41	ELEVATOR PLANS, SECTION, CAB INT. ELEVATIONS, AND DETAILS	1" = 5'	•			MMA
A7-51	LEARNING STEPS AXONOMETRIC AND PLANS	1" = 10'	•			MMA

FOR PERMITTING PURPOSES ONLY

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Associate Architect:
WANNEMACHER JENSEN ARCHITECTS, INC.
180 Mirror Lake Drive N., St. Petersburg, FL 33701
T (727) 822-5566

Structure/Civil/MEP/Code/Fire Engineer:
BURO HAPPOLD CONSULTING ENGINEERS INC.
100 Broadway - 23rd Floor, New York, NY 10005
T (212) 334-2025

Marine Structure Engineer:
McLAREN ENGINEERING GROUP
5728 Major Blvd., Suite 603, Orlando, FL 32819
T (407) 354-5411

Marina:
APPLIED TECHNOLOGY & MANAGEMENT, INC.
5550 N.W. 111th Blvd., Gainesville, FL 32653
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Lighting Designer:
L'OBSERVATOIRE INTERNATIONAL
120 Walker St., 7th Floor East, New York, NY 10013
T (212) 255-4463

REVISIONS	BY	DATE

NEW ST. PETERSBURG PIER
CITY OF ST. PETERSBURG

SCHEMATIC DESIGN DOCUMENTS
CITY PROJECT NO. 10864
MICHAEL MALTZAN ARCHITECTURE PROJECT NO. 1202

ENGINEERING and CAPITAL IMPROVEMENTS DEPARTMENT
CITY of ST. PETERSBURG

APPROVED BY:

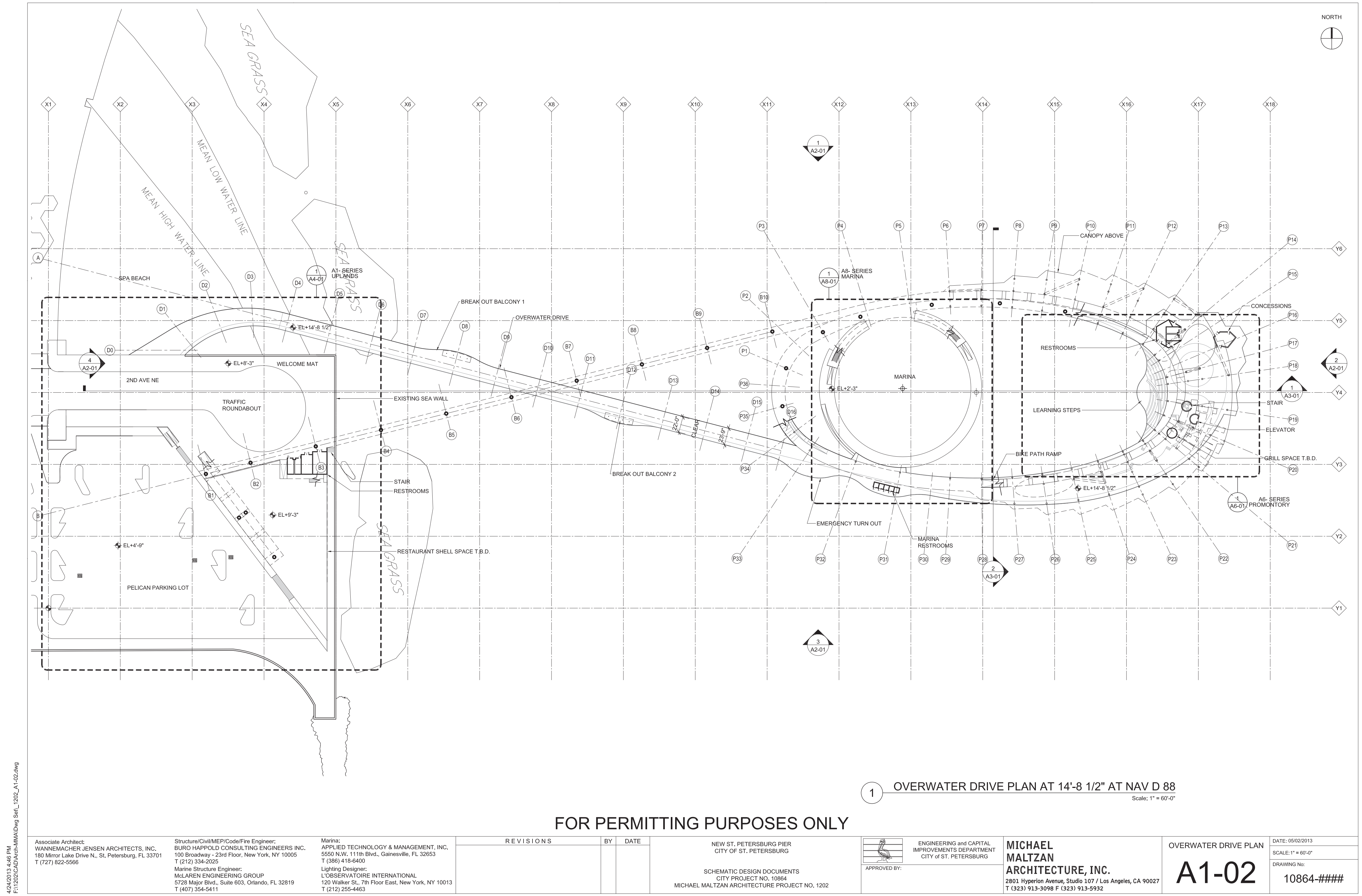
MICHAEL MALTZAN ARCHITECTURE, INC.
2801 Hyperion Avenue, Studio 107 / Los Angeles, CA 90027
T (323) 913-3098 F (323) 913-5932

SHEET INDEX
A0-01

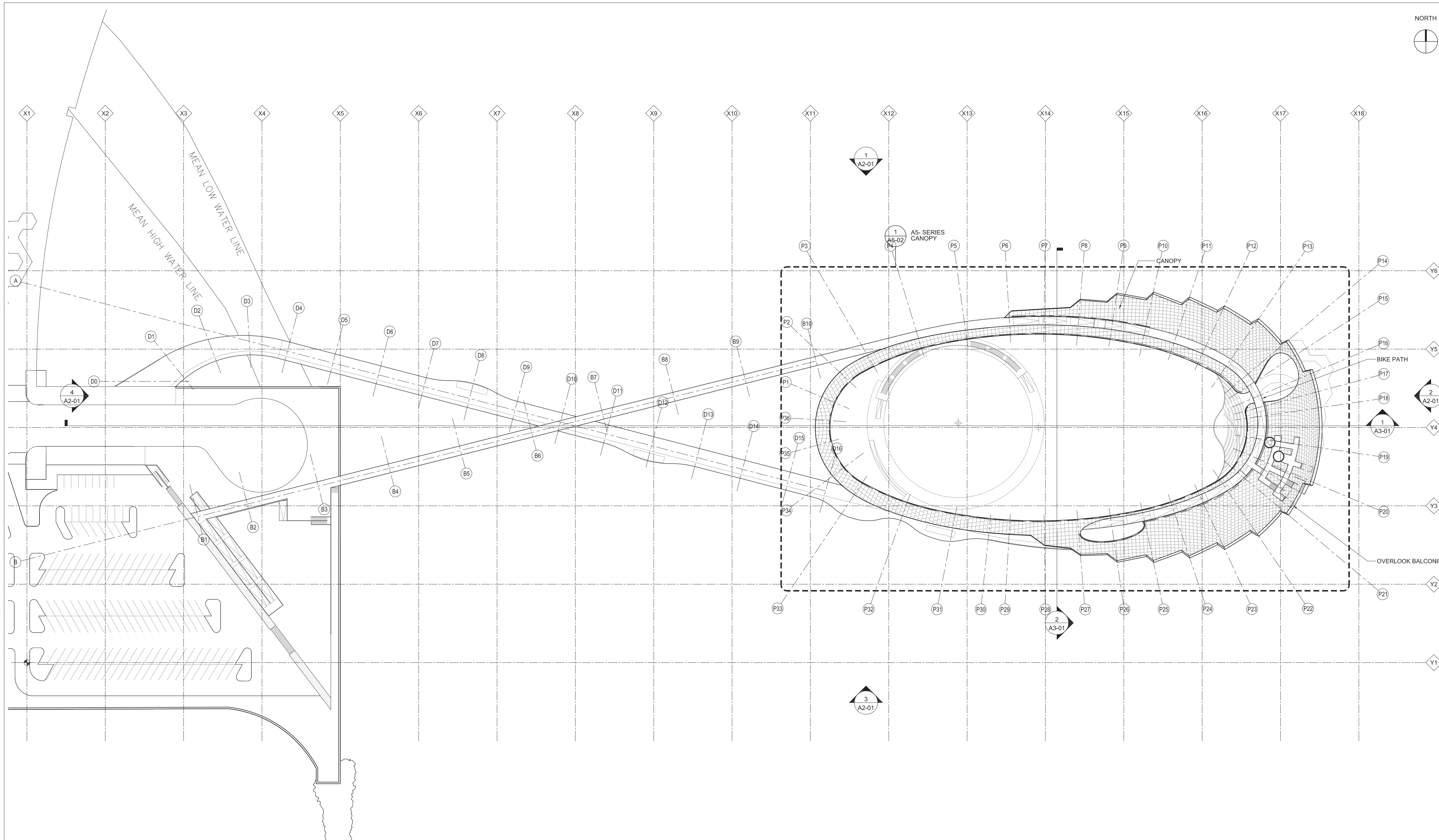
DATE: 05/02/2013
SCALE: NONE
DRAWING No:
10864-####

ARCHITECTURAL DRAWINGS

2 / A1-02 Drive Plan



3 /
A1-05 Canopy Plan



1 CANOPY PLAN AT 110'-4" AT NAV D 88
Scale: 1" = 60'-0"

FOR PERMITTING PURPOSES ONLY

4/24/2013 4:47 PM
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Associate Architect:
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Lighting Designer:
L'OBSERVATOIRE INTERNATIONAL
120 Walker St., 7th Floor East, New York, NY 10013
T (212) 255-4463

REVISIONS	BY	DATE

NEW ST. PETERSBURG PIER
CITY OF ST. PETERSBURG

SCHEMATIC DESIGN DOCUMENTS
CITY PROJECT NO. 10864
MICHAEL MALTZAN ARCHITECTURE PROJECT NO. 1202

ENGINEERING and CAPITAL IMPROVEMENTS DEPARTMENT
CITY of ST. PETERSBURG

APPROVED BY:

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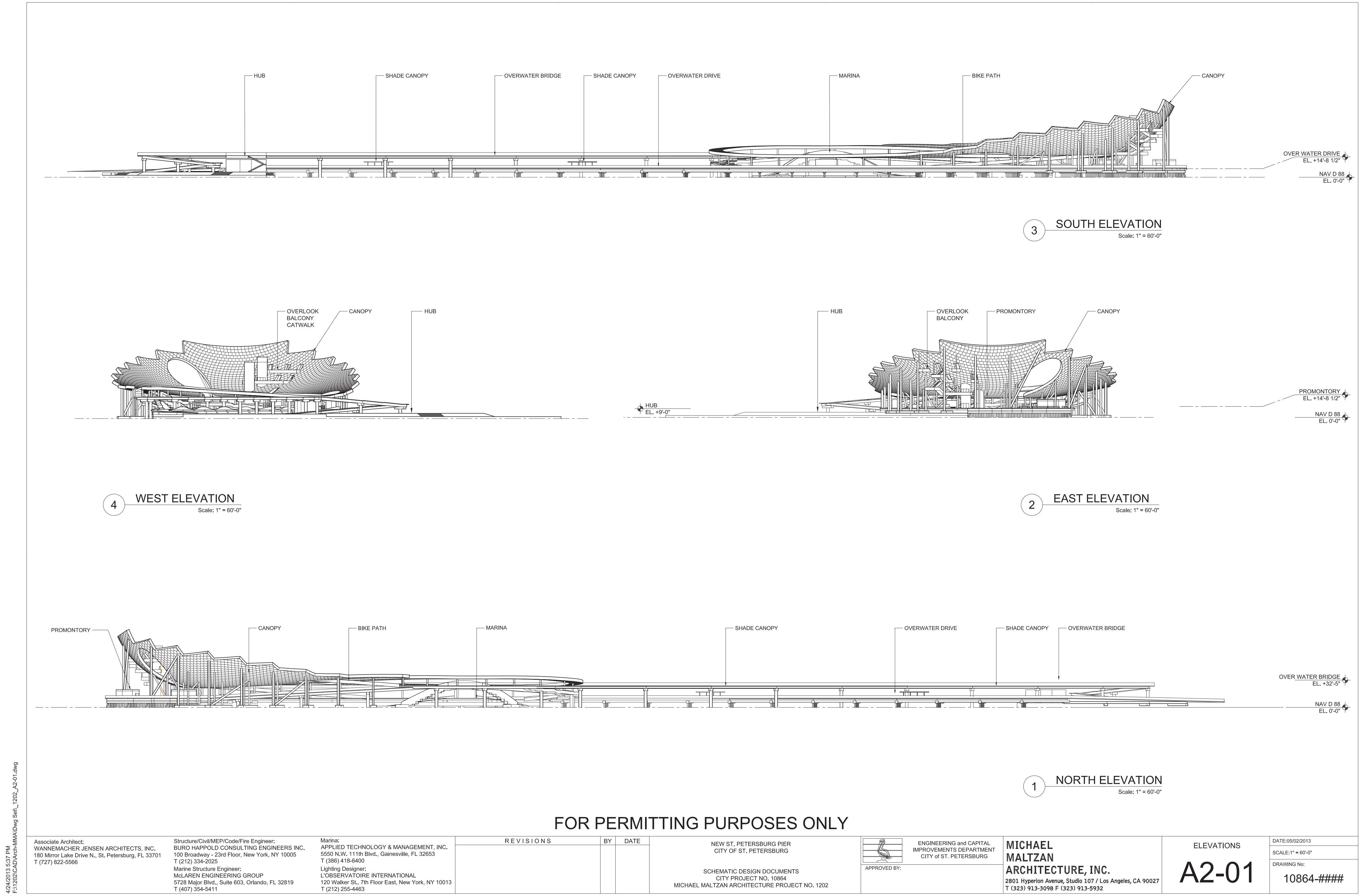
CANOPY PLAN
A1-05

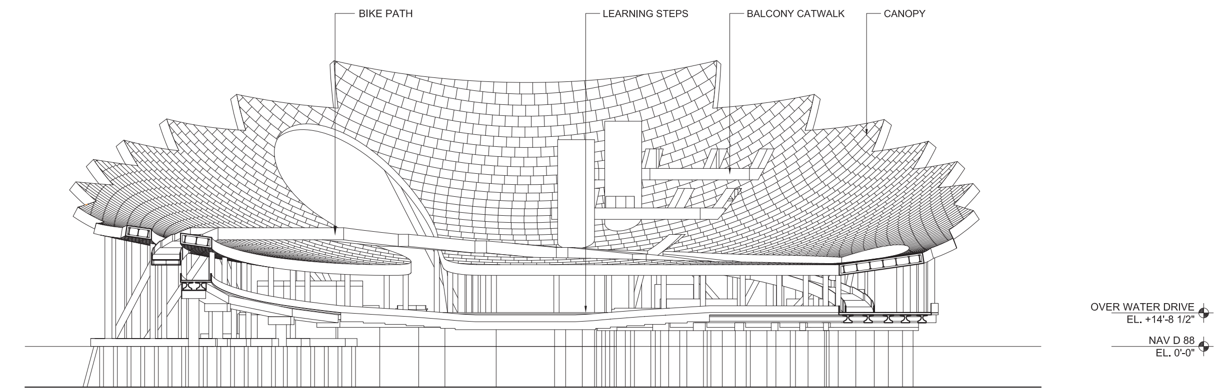
DATE: 05/02/2013
SCALE: 1" = 60'-0"
DRAWING No:
10864-####

ARCHITECTURAL DRAWINGS
(continued)

4 /
A2-01 Elevations



5 / A3-01 Sections



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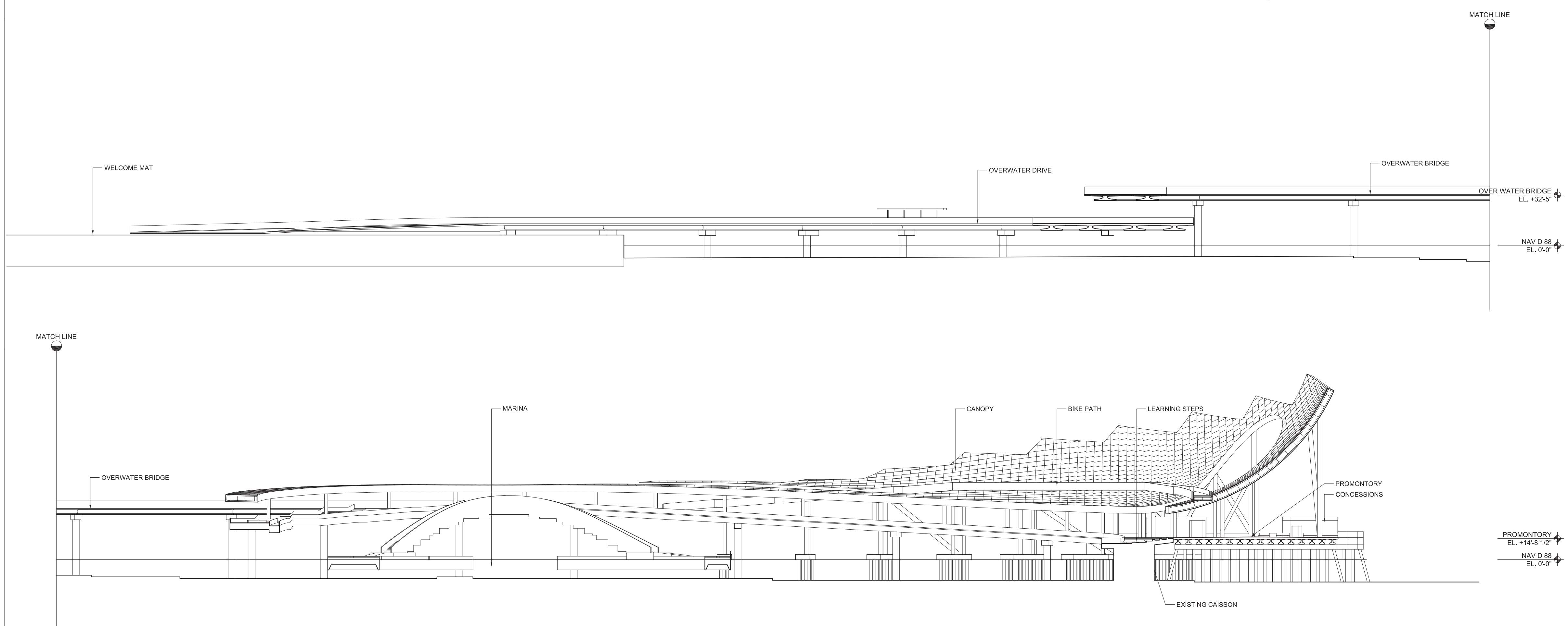

1 LONGITUDINAL SECTION
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Associate Architect:
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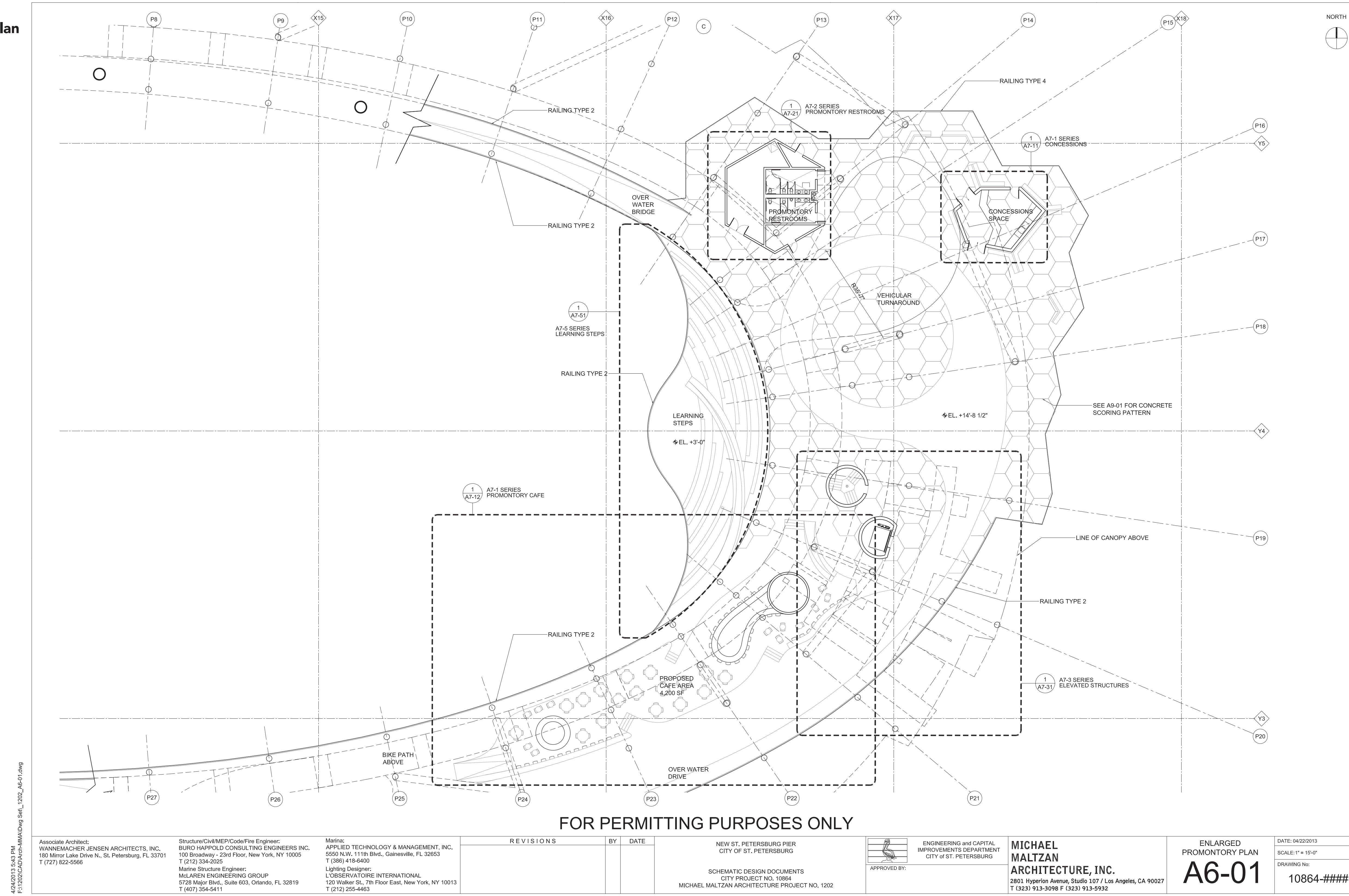
SECTIONS
A3-01

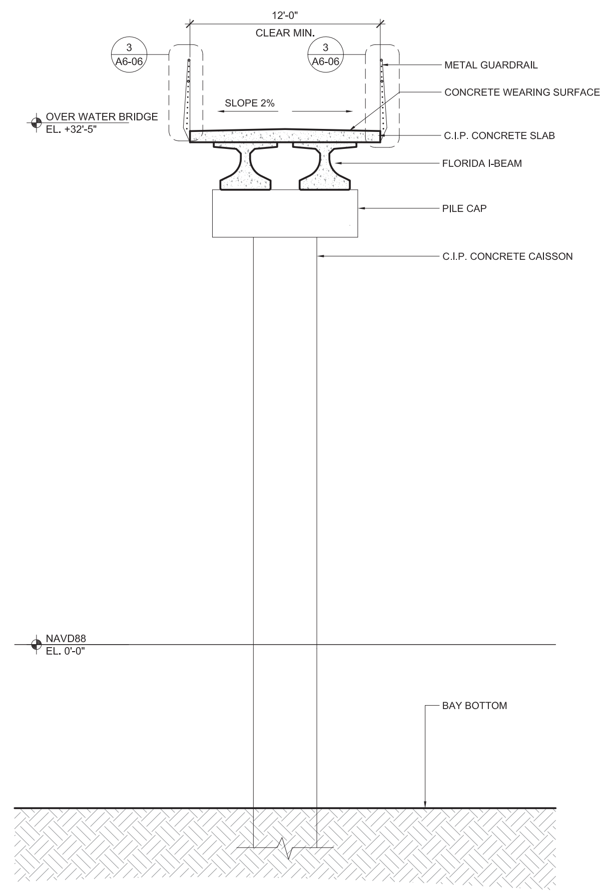
DATE:05/02/2013
SCALE:1" = 30'-0"
DRAWING No:
10864-####

ARCHITECTURAL DRAWINGS (continued)

6 / A6-01 Enlarged Promontory Plan



7 / A6-11 Bridge & Drive Sections



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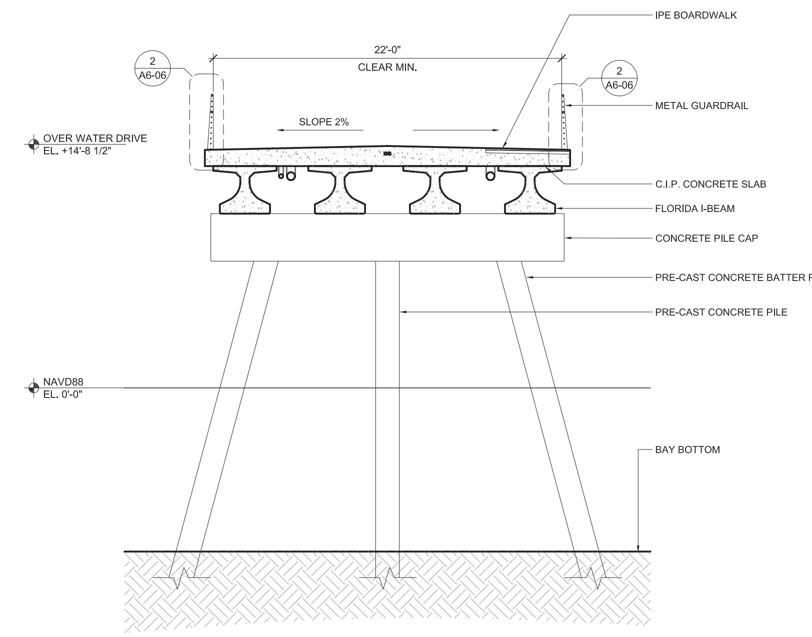

1 OVER WATER DRIVE
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SECTIONS
A6-11

DATE: 05/02/2013
SCALE: 1" = 5'-0"
DRAWING No:
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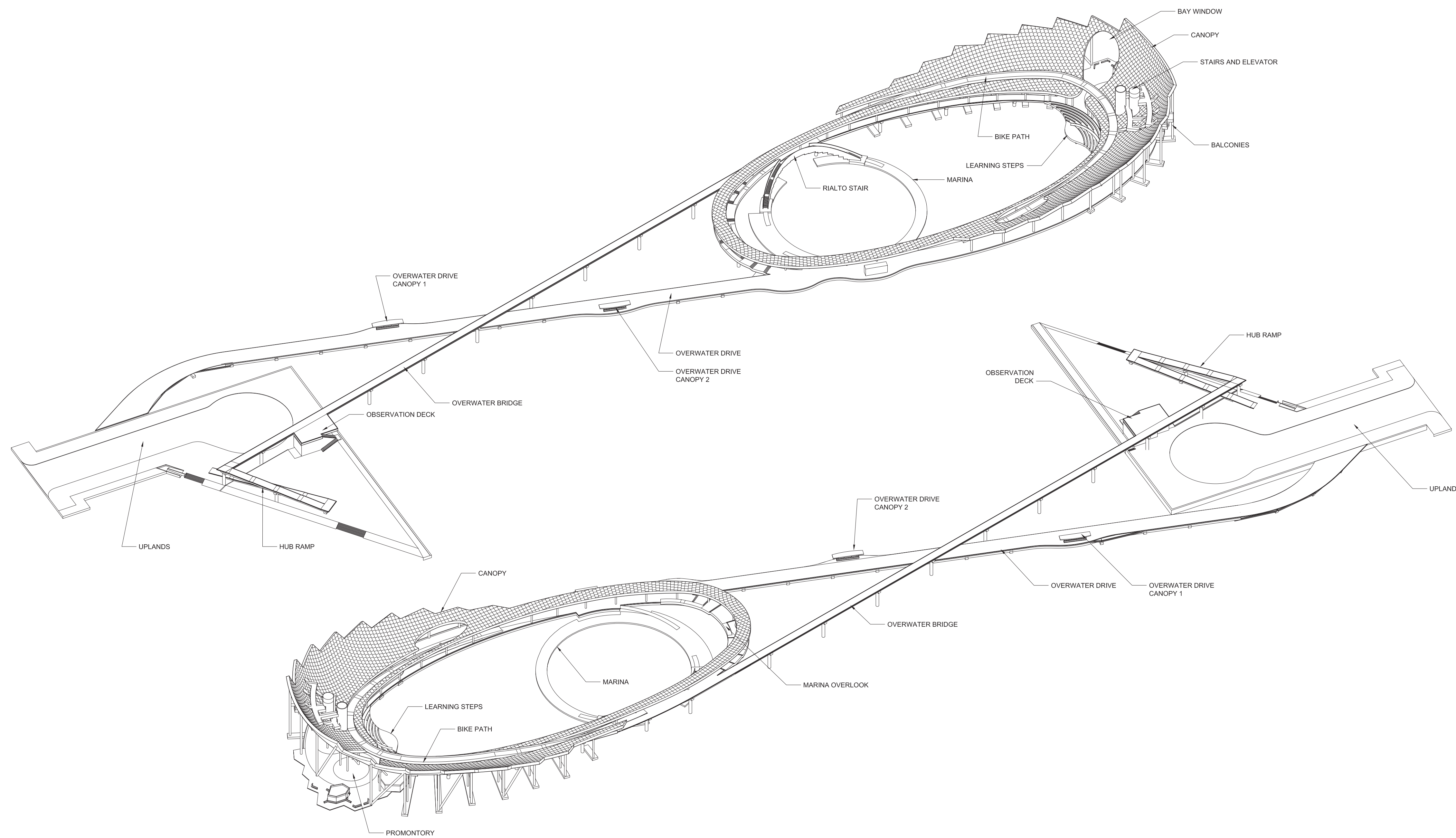
3D VIEWS

1 /
A0-03 Overall View



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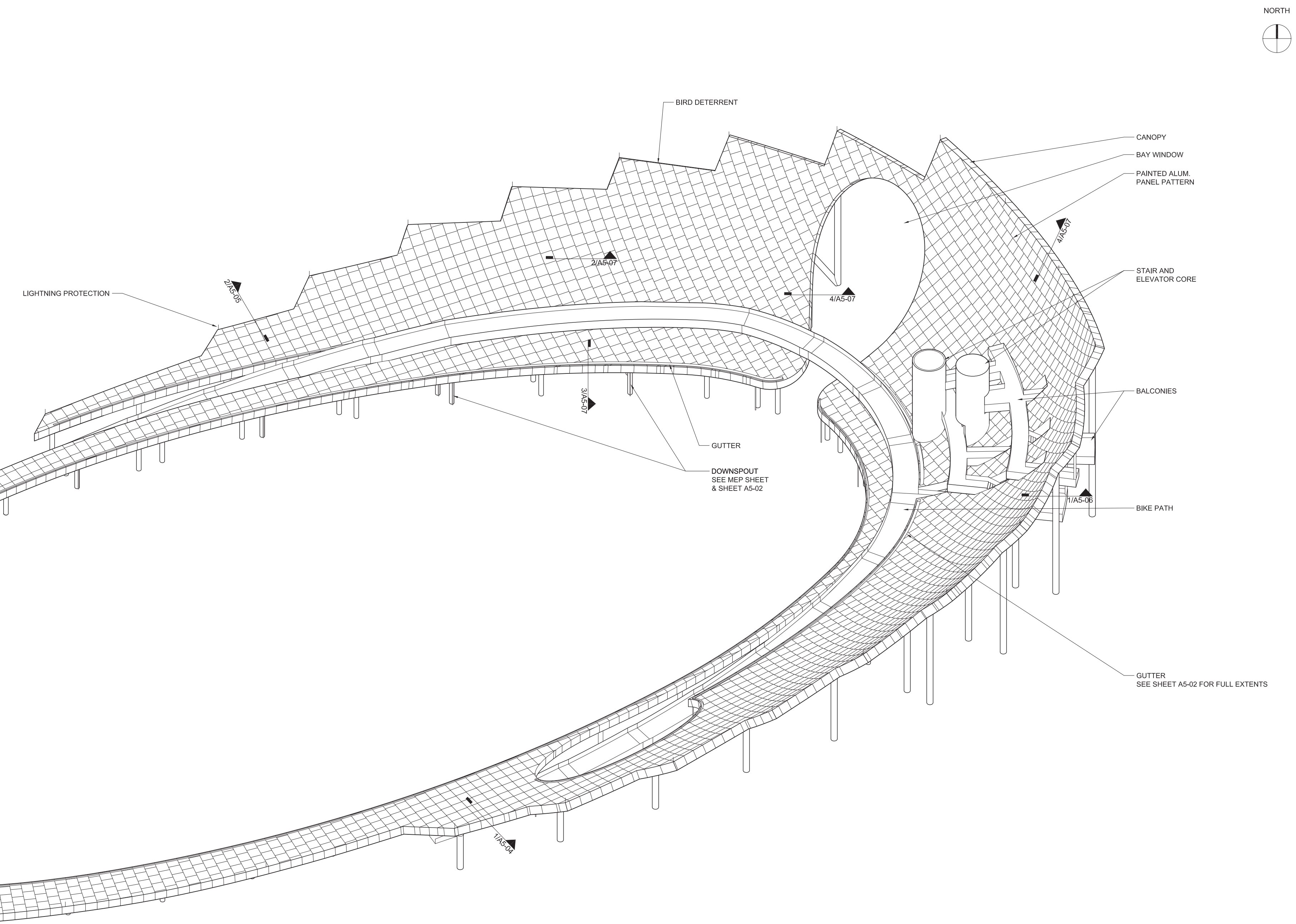
OVERALL
AXONOMETRICS
A0-03

DATE:
SCALE:
DRAWING No:
10864-####

2 /
A5-00 Canopy



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REFERENCE RHINO FILE V5 XXXXXX
FOR CANOPY GEOMETRY AND PANEL PATTERN

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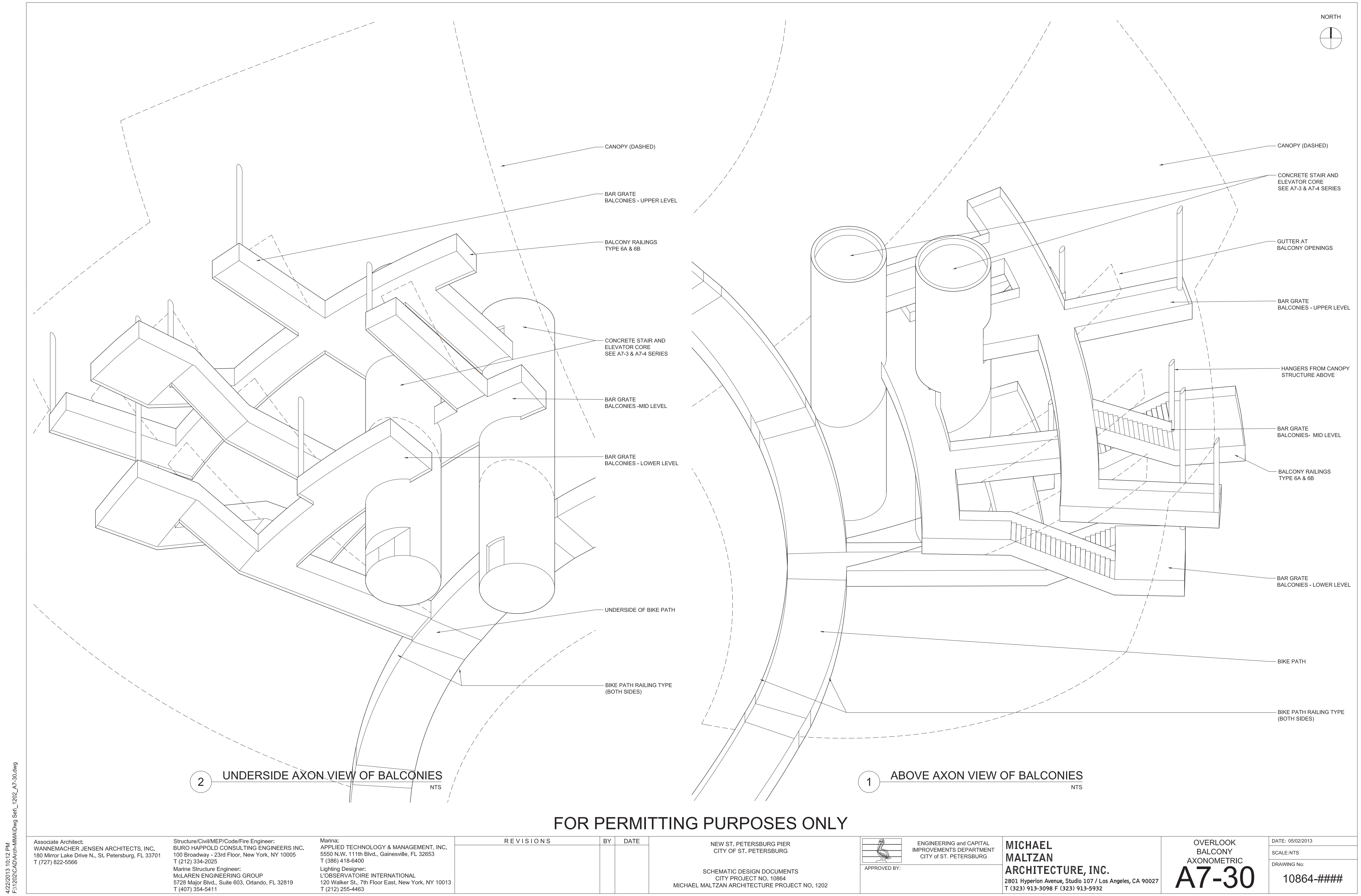
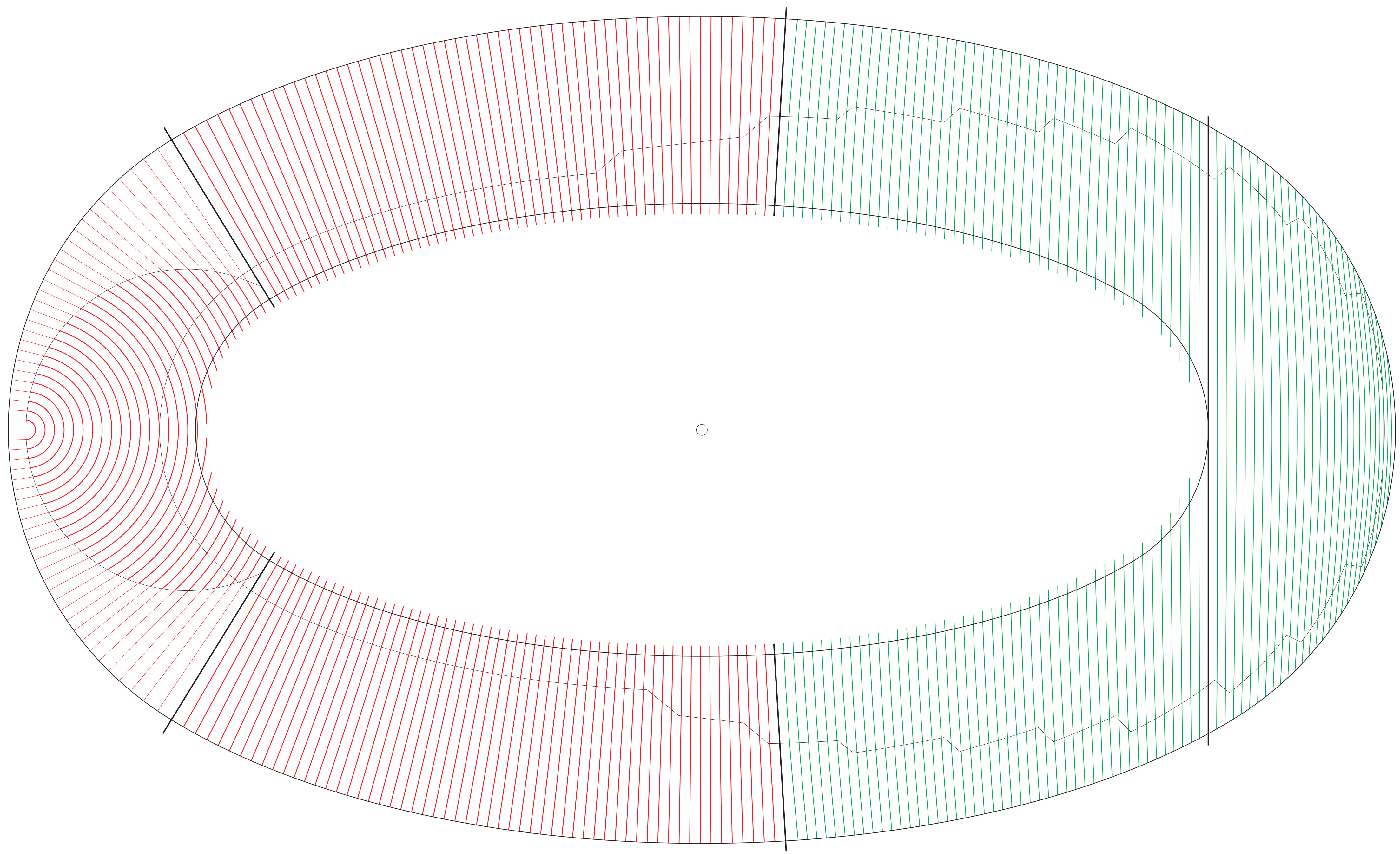
Consultants			Revisions	BY	DATE	Project	Approval	Architect	Sheet	
Associate Architect: WANNEMACHER JENSEN ARCHITECTS, INC. 180 Mirror Lake Drive N., St. Petersburg, FL 33701 T (727) 822-5566	Structure/Civil/MEP/Code/Fire Engineer: BURO HAPPOLD CONSULTING ENGINEERS INC. 100 Broadway - 23rd Floor, New York, NY 10005 T (212) 334-2025 Marine Structure Engineer: McLAREN ENGINEERING GROUP 5728 Major Blvd., Suite 603, Orlando, FL 32819 T (407) 354-5411	Marina: APPLIED TECHNOLOGY & MANAGEMENT, INC. 5550 N.W. 111th Blvd., Gainesville, FL 32653 T (386) 418-6400 Lighting Designer: L'OBSERVATOIRE INTERNATIONAL 120 Walker St., 7th Floor East, New York, NY 10013 T (212) 255-4463				NEW ST. PETERSBURG PIER CITY OF ST. PETERSBURG SCHEMATIC DESIGN DOCUMENTS CITY PROJECT NO. 10864 MICHAEL MALTZAN ARCHITECTURE PROJECT NO. 1202	ENGINEERING and CAPITAL IMPROVEMENTS DEPARTMENT CITY of ST. PETERSBURG APPROVED BY:	MICHAEL MALTZAN ARCHITECTURE, INC. 2801 Hyperion Avenue, Studio 107 / Los Angeles, CA 90027 T (323) 913-3098 F (323) 913-5932	ENLARGED CANOPY AXONOMETRIC A5-00	DATE: 05/02/2013 SCALE: NTS DRAWING No: 10864-####

3 /
A7-30 Balconies



CANOPY PANELIZATION

1 /
Control Geometry



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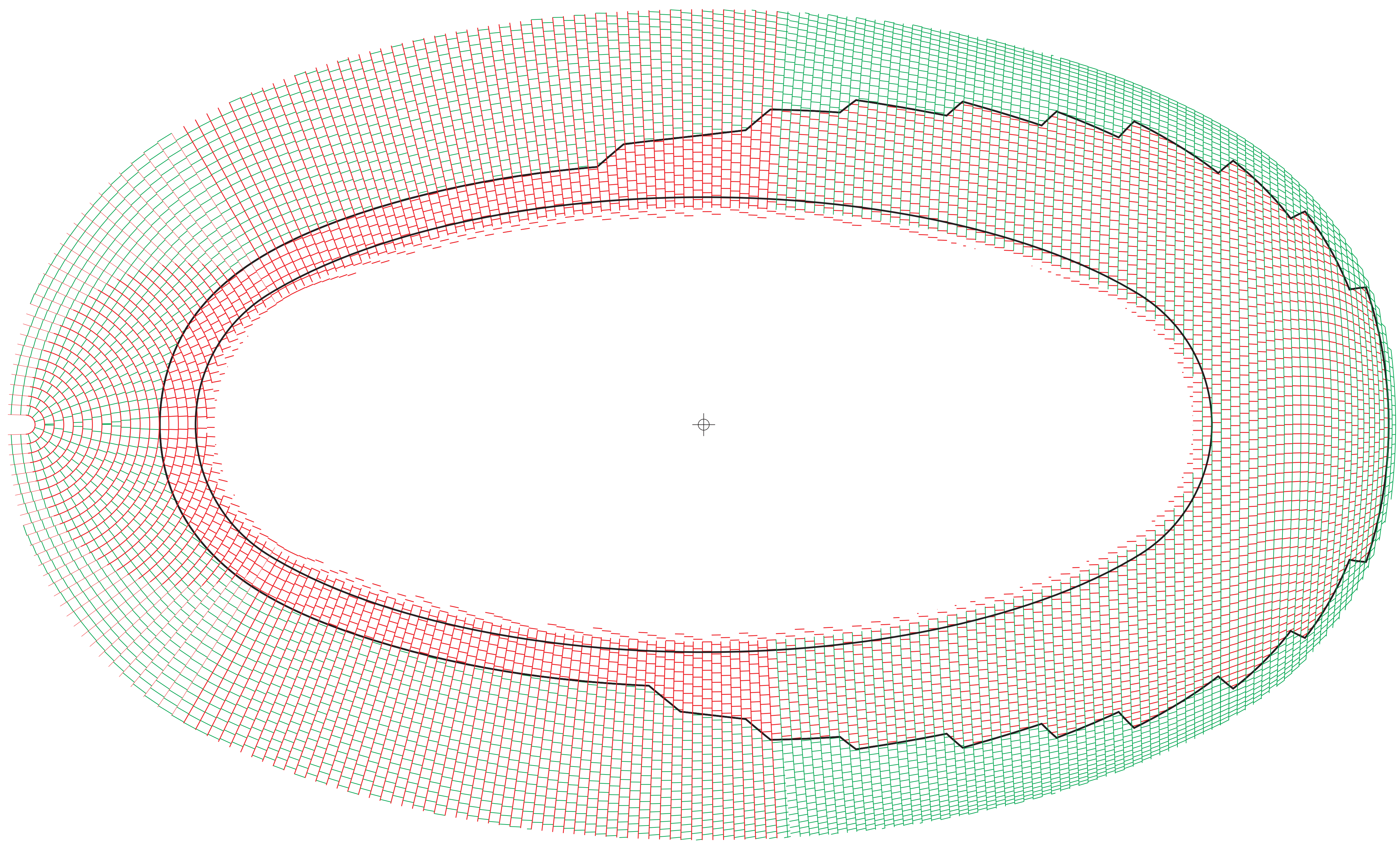
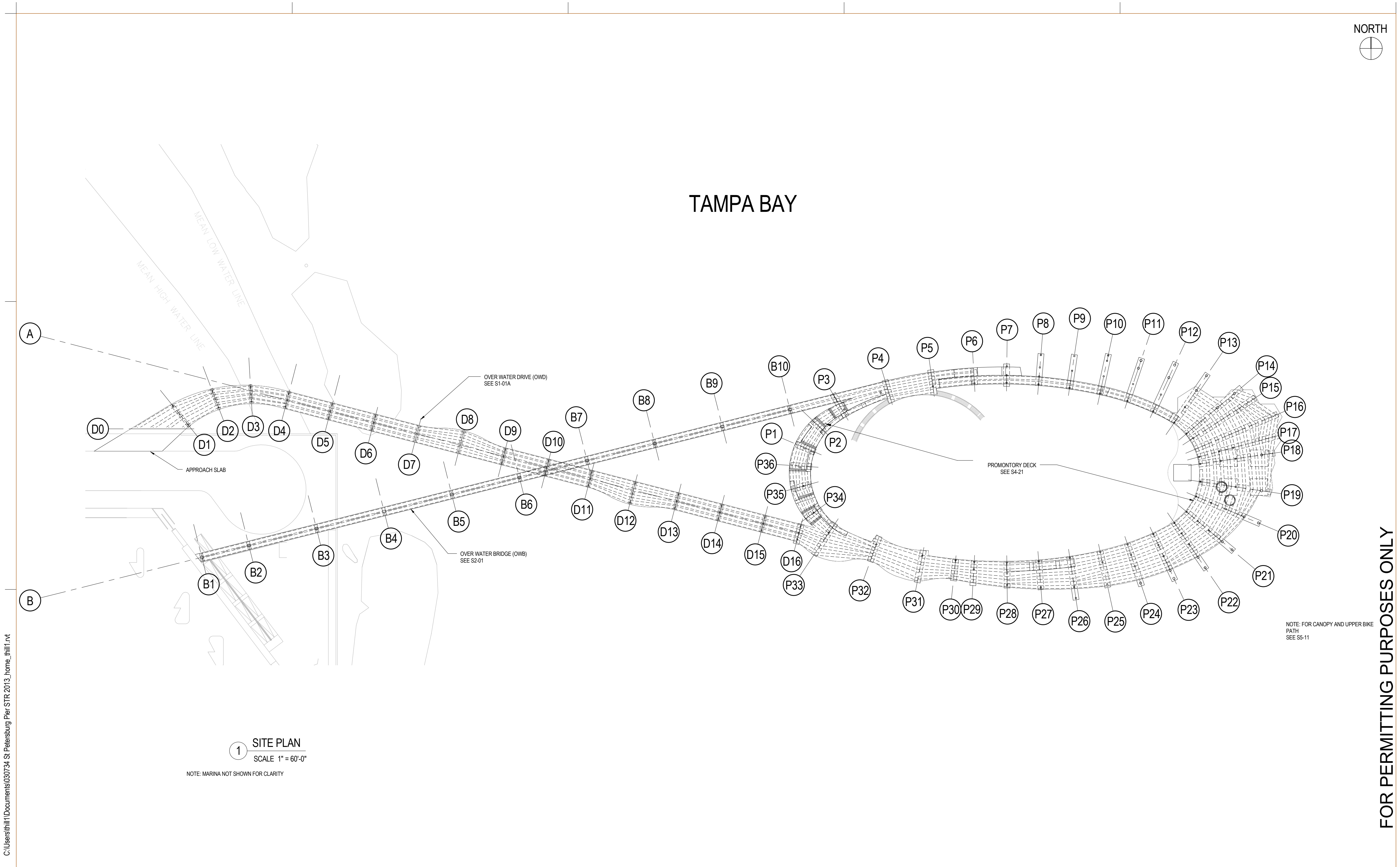
Overall Panelization



1 /
S0-21 Site Structural Plan



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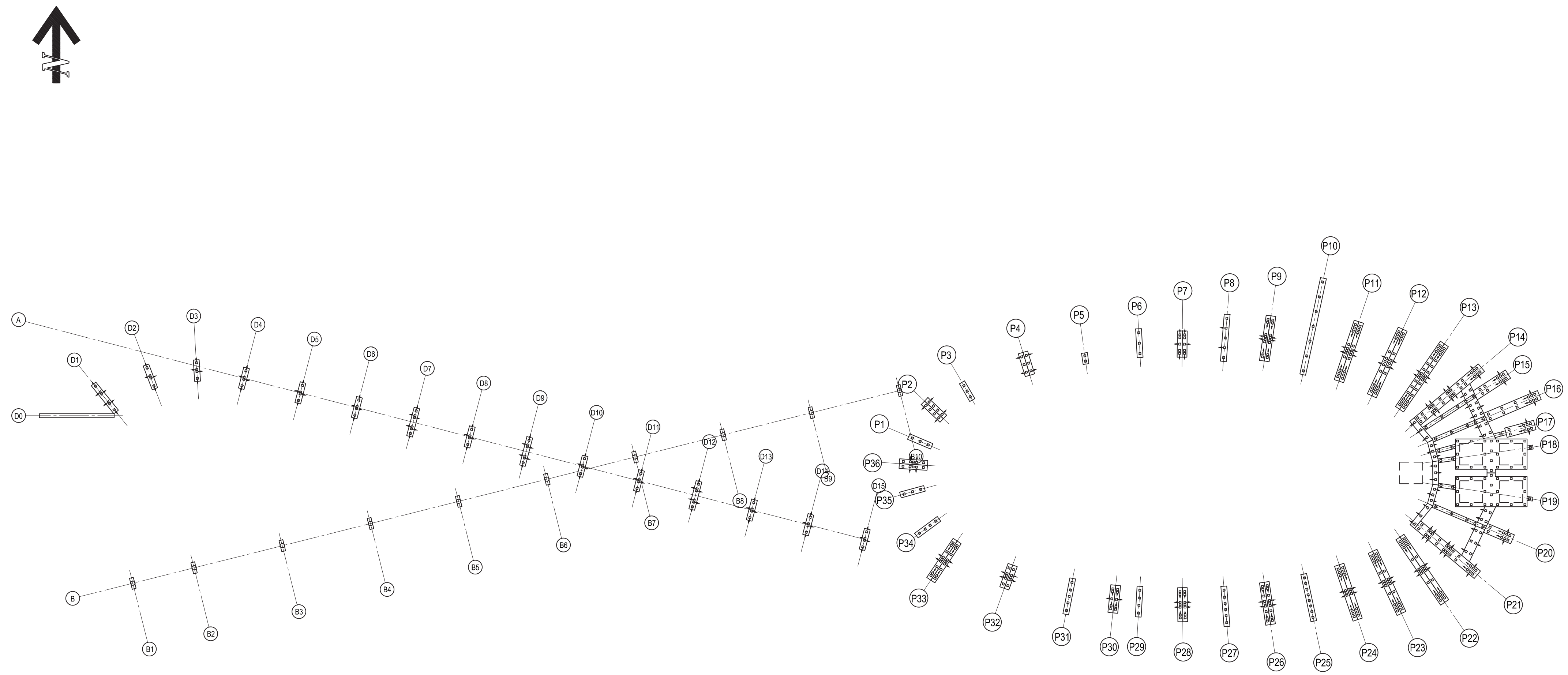
SITE STRUCTURAL PLAN
S0-21

DATE: 5/2/13
SCALE: 1" = 60'-0"
DRAWING No: 10864-####

2 /
S1-00 Pile Plan



FOUNDATION PLAN - OVERALL
Scale: 1"=60'-0"

PROGRESS SET 04-18-2013

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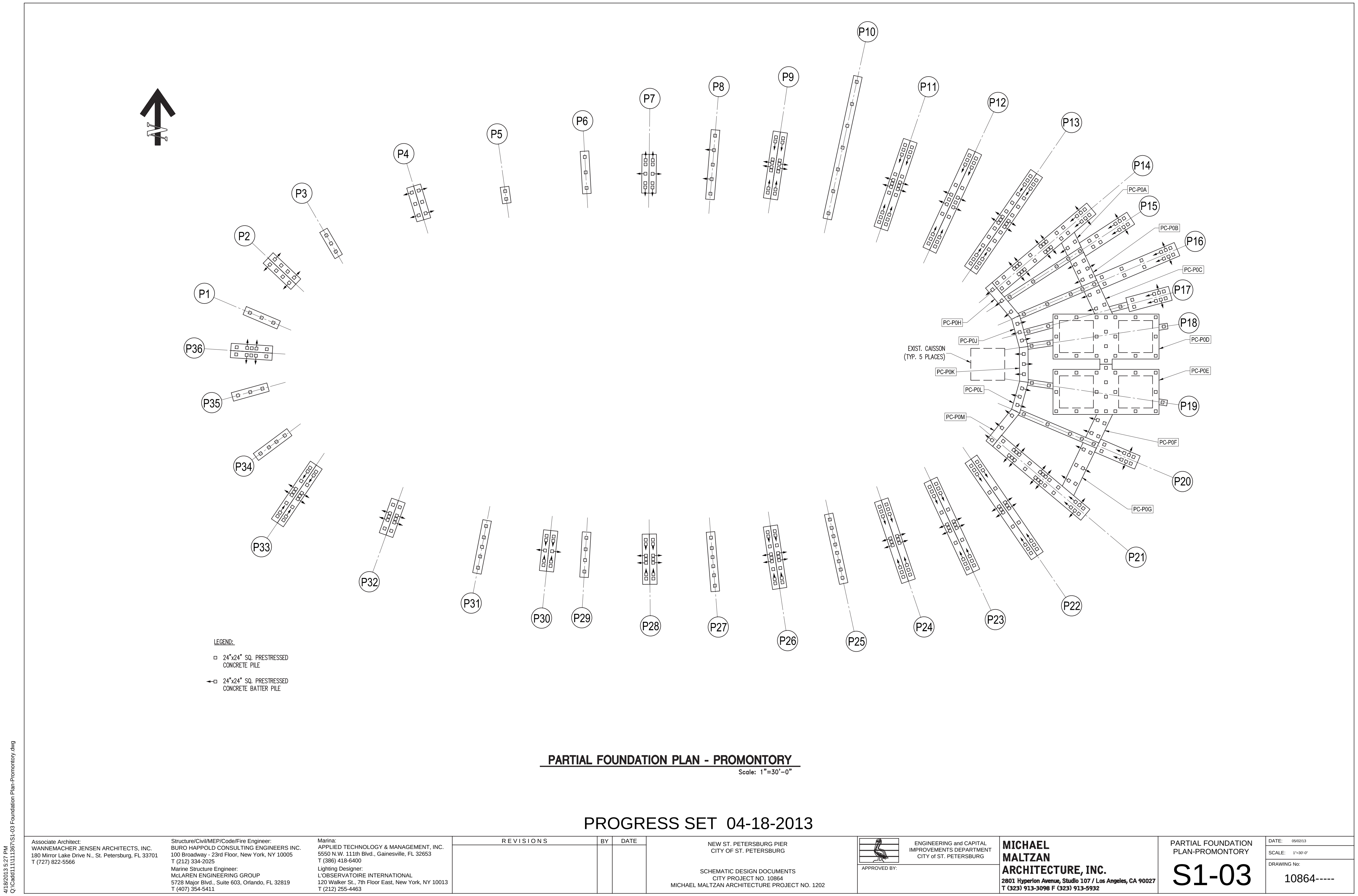
FOUNDATION
PLAN-OVERALL

S1-00

DATE: 05/02/13
SCALE: 1"=60'-0"
DRAWING No: 10864-----

3 /
S1-03 Enlarged Pile Plan



4 /
S5-11 Framing Plan

CANOPY NOTES

I. GENERAL

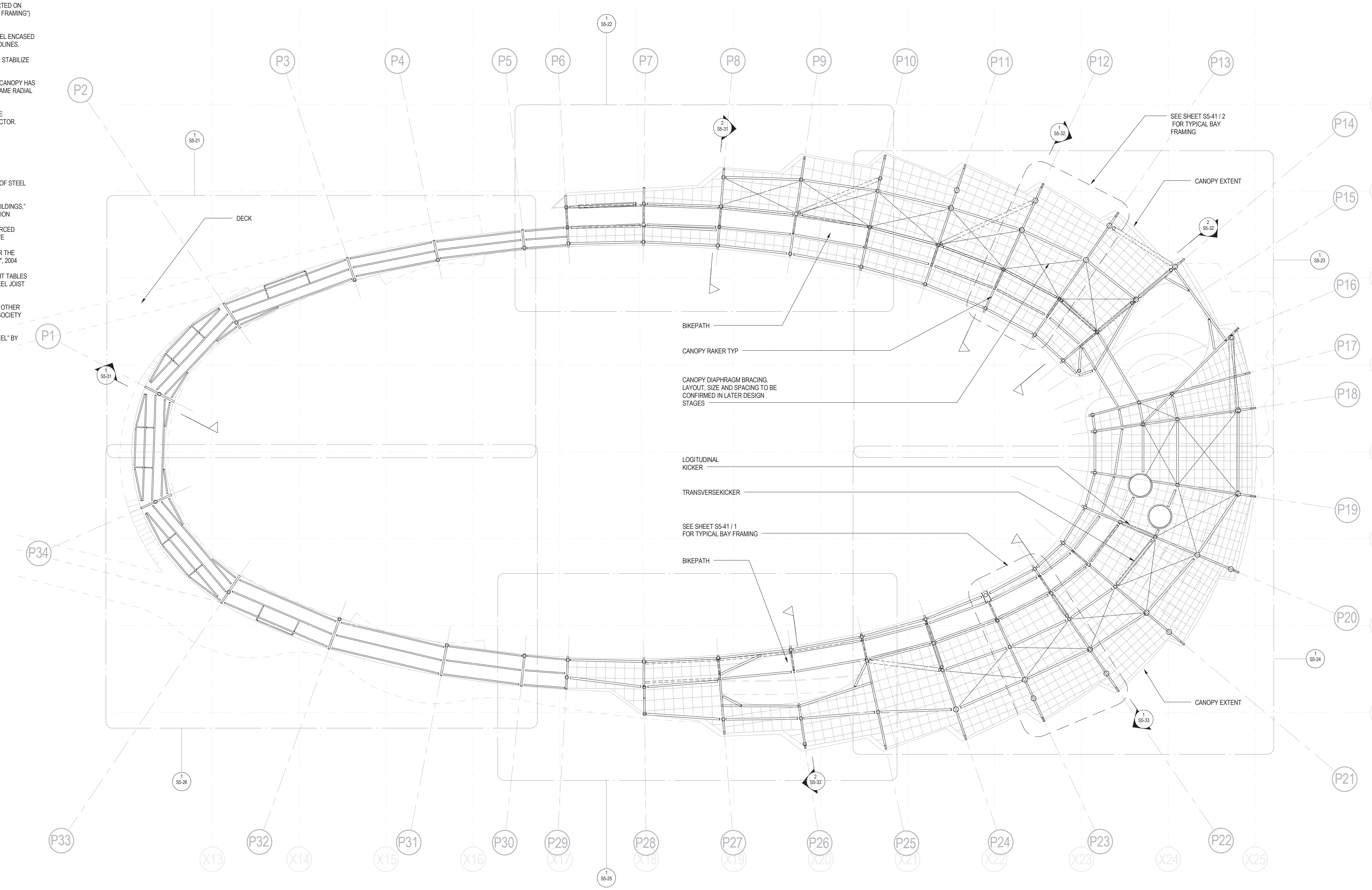
1. THE CANOPY IS DEFINED AS THE SHADE STRUCTURE OF THE PROJECT ALONG WITH THE STRUCTURAL ELEMENTS SUPPORTING IT.
2. THE CLADDING (BY FACADE SUBCONTRACTOR) IS SUPPORTED ON OPEN WEB STEEL JOISTS (REFERRED TO AS "SECONDARY FRAMING") SPANNING BETWEEN RAKER BEAMS.
3. THE RAKER BEAMS ARE SUPPORTED ON COMPOSITE (STEEL ENCASED IN CONCRETE) COLUMNS, LOCATED RADIALLY ALONG GRIDLINES.
4. LONGITUDINAL AND TRANSVERSAL KICKERS ARE USED TO STABILIZE THE CANOPY, AND INCREASE LATERAL RIGIDITY.
5. ALL RAKER BEAMS ARE CURVED. THE GEOMETRY OF THE CANOPY HAS BEEN OPTIMIZED SO THAT ALL RAKER BEAMS HAVE THE SAME RADIAL CURVATURE.
6. CLADDING AND CLADDING ATTACHMENTS DESIGN ARE THE RESPONSIBILITY OF THE FAÇADE SPECIALTY SUBCONTRACTOR.

II. CODES AND STANDARDS

1. 2010 FLORIDA BUILDING CODE
2. AISC-LRFD 325-05: "MANUAL OF STEEL CONSTRUCTION," THIRTEENTH EDITION, 2005, BY THE AMERICAN INSTITUTE OF STEEL CONSTRUCTION
3. AISC 360-05: "SPECIFICATION FOR STRUCTURAL STEEL BUILDINGS," 2005, BY THE AMERICAN INSTITUTE OF STEEL CONSTRUCTION
4. ACI 318-08: "BUILDING CODE REQUIREMENTS FOR REINFORCED CONCRETE," 2008, BY THE AMERICAN CONCRETE INSTITUTE
5. AISI-NASPEC 2004: "NORTH AMERICAN SPECIFICATION FOR THE DESIGN OF COLD-FORMED STEEL STRUCTURAL MEMBERS", 2004
6. SJI: "STANDARD SPECIFICATION, LOAD TABLES AND WEIGHT TABLES FOR STEEL JOISTS AND JOIST GIRDERS," 2010, BY THE STEEL JOIST INSTITUTE
7. ASCE 7-10: "MINIMUM DESIGN LOADS FOR BUILDINGS AND OTHER STRUCTURES, CHAPTERS 26-31" 2010, BY THE AMERICAN SOCIETY OF CIVIL ENGINEERS
8. AWS D1.1/D1.1M 2008: "STRUCTURAL WELDING CODE – STEEL" BY THE AMERICAN WELDING SOCIETY

III. MATERIALS

1. CONCRETE:
   F'C = 5,000PSI - NORMAL WEIGHT
2. HSS: ASTM A500 GR B
   ANGLES: ASTM A572 – GR 50
   BUILT-UP GIRDERS: ASTM A572 – GR 50
   PLATES: ASTM A36
   JOISTS: ASTM A572 – GR 50
   (ALL EXPOSED STEEL SHALL BE HOT DIP GALVANIZED)
3. BOLTS
   A490 – GALVANIZED
4. ANCHOR BOLTS
   F1554 GRADE 55



1 PLAN CANOPY
SCALE 1" = 30'-0"

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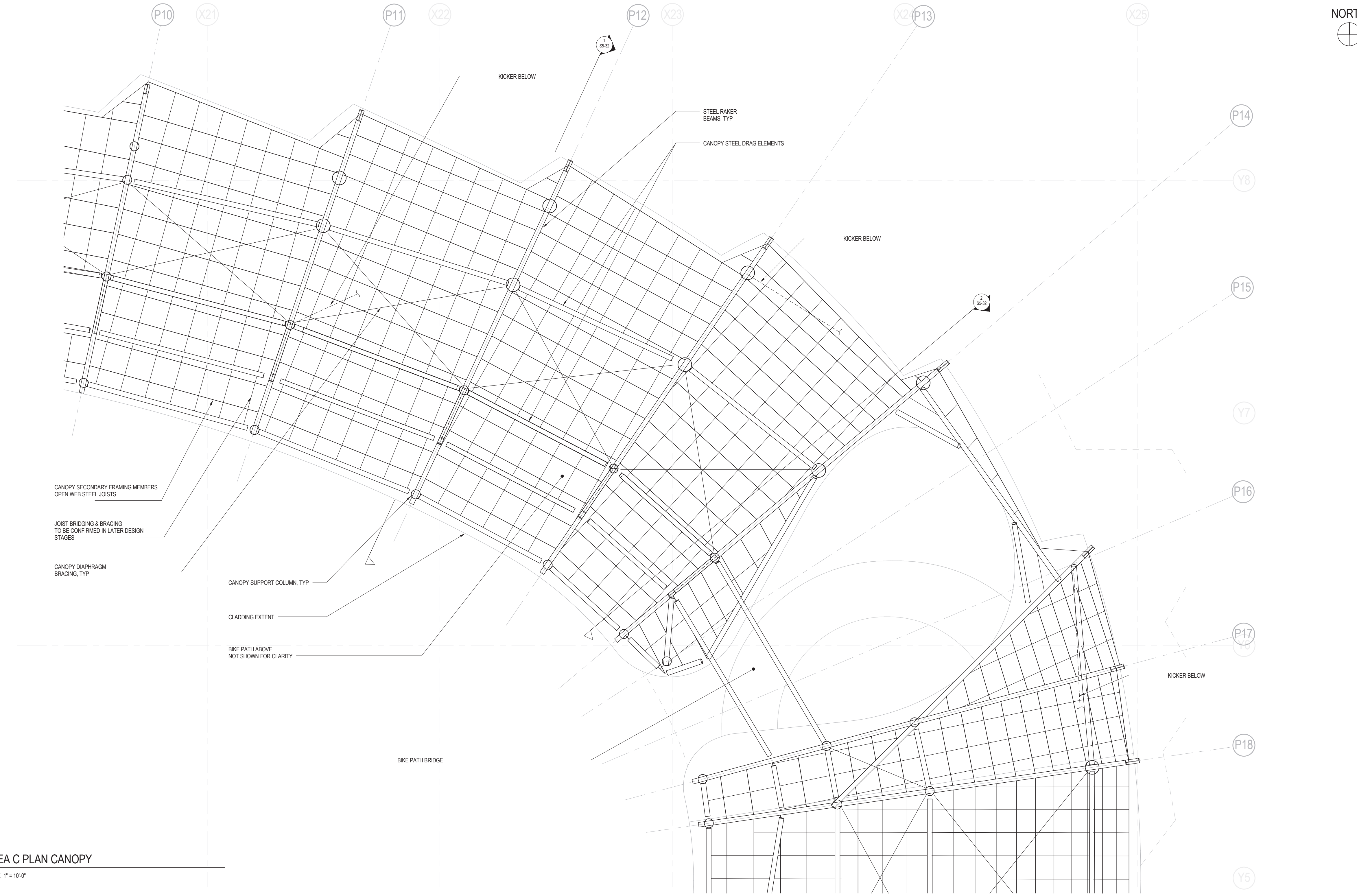
Associate Architect: WANNEMACHER JENSEN ARCHITECTS, INC. 180 Mirror Lake Drive N., St. Petersburg, FL 33701 T (727) 822-5566	Structure/Civil/MEP/Code/Fire Engineer: BURO HAPPOLD CONSULTING ENGINEERS INC. 100 Broadway - 23rd Floor, New York, NY 10005 T (212) 334-2025 Marine Structure Engineer: McLAREN ENGINEERING GROUP 5728 Major Blvd., Suite 603, Orlando, FL 32819 T (407) 354-5411	Marina: APPLIED TECHNOLOGY & MANAGEMENT, INC. 5550 N.W. 111th Blvd., Gainesville, FL 32653 T (386) 418-6400 Lighting Designer: L'OBSERVATOIRE INTERNATIONAL 120 Walker St., 7th Floor East, New York, NY 10013 T (212) 255-4463	REVISIONS	BY	DATE

NEW ST. PETERSBURG PIER CITY OF ST. PETERSBURG SCHEMATIC DESIGN DOCUMENTS CITY PROJECT NO. 10864 MICHAEL MALTZAN ARCHITECTURE PROJECT NO. 1202	ENGINEERING and CAPITAL IMPROVEMENTS DEPARTMENT CITY of ST. PETERSBURG APPROVED BY:	MICHAEL MALTZAN ARCHITECTURE, INC. 2801 Hyperion Avenue, Studio 107 / Los Angeles, CA 90027 T (323) 913-3098 F (323) 913-5932	CANOPY GENERAL PLAN S5-11	DATE: 5/2/13 SCALE: As indicated DRAWING No: 10864-####

5 /
S5-23 Enlarged Framing Plan



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1 AREA C PLAN CANOPY

SCALE 1" = 10'-0"

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CANOPY PLAN AREA C

S5-23

DATE: 5/2/13
SCALE: 1" = 10'-0"
DRAWING No:
10864-####

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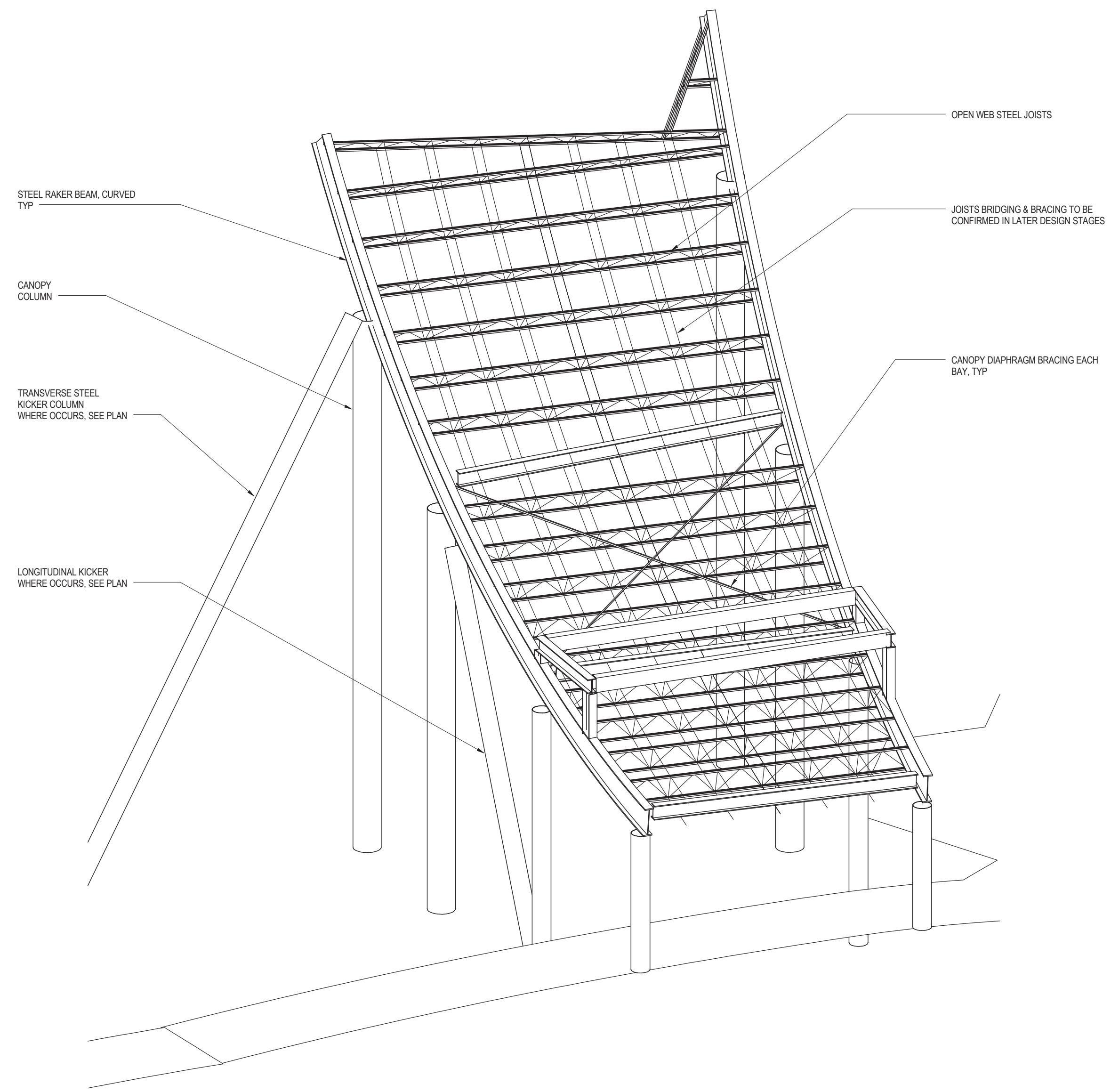
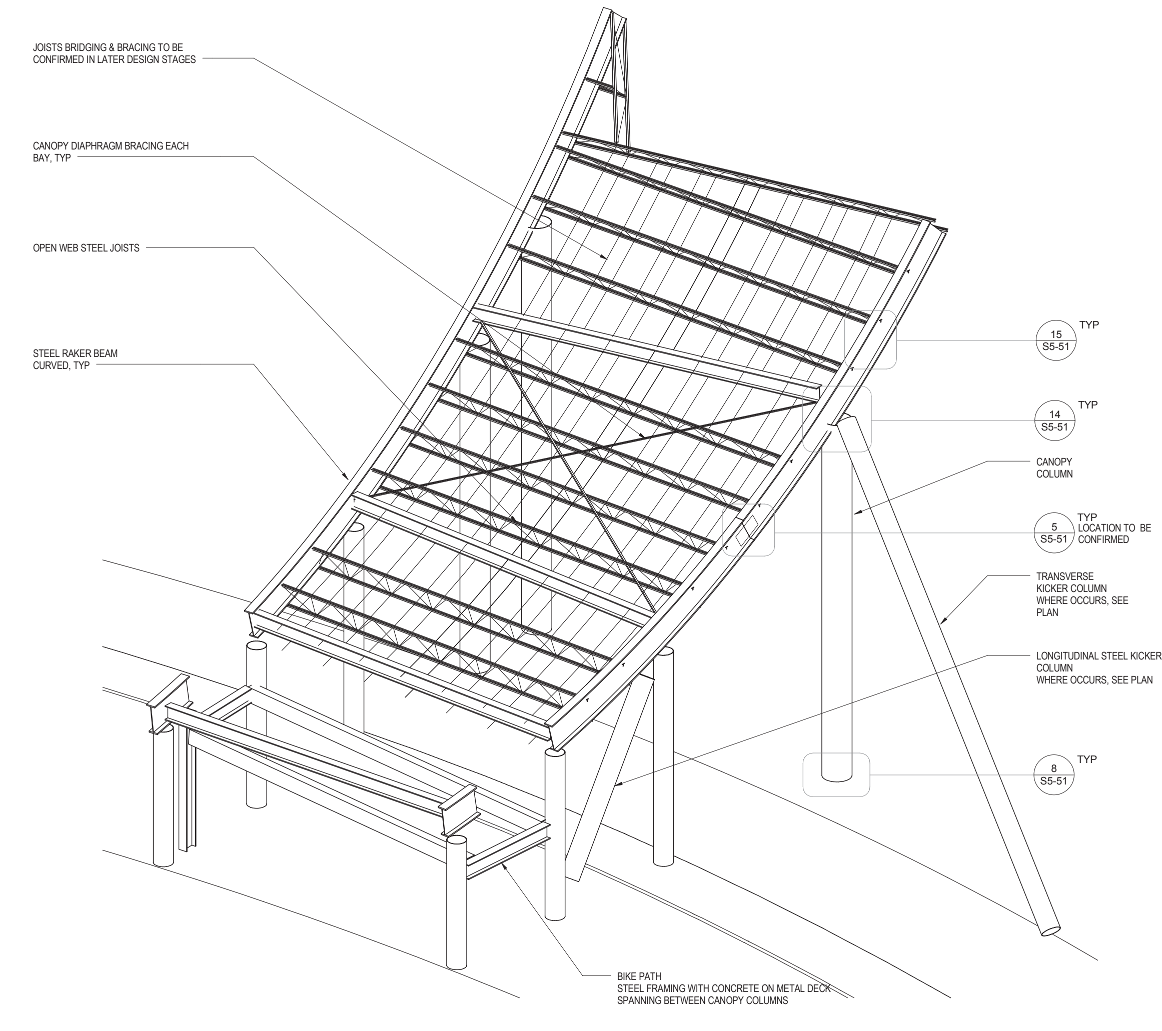
S5-41 Framing Axonometric



2 TYPICAL BAY WITH BIKE PATH ABOVE ISO P12 - P13



1 TYPICAL BAY WITH BIKE PATH CUT - ISO P22 - P23

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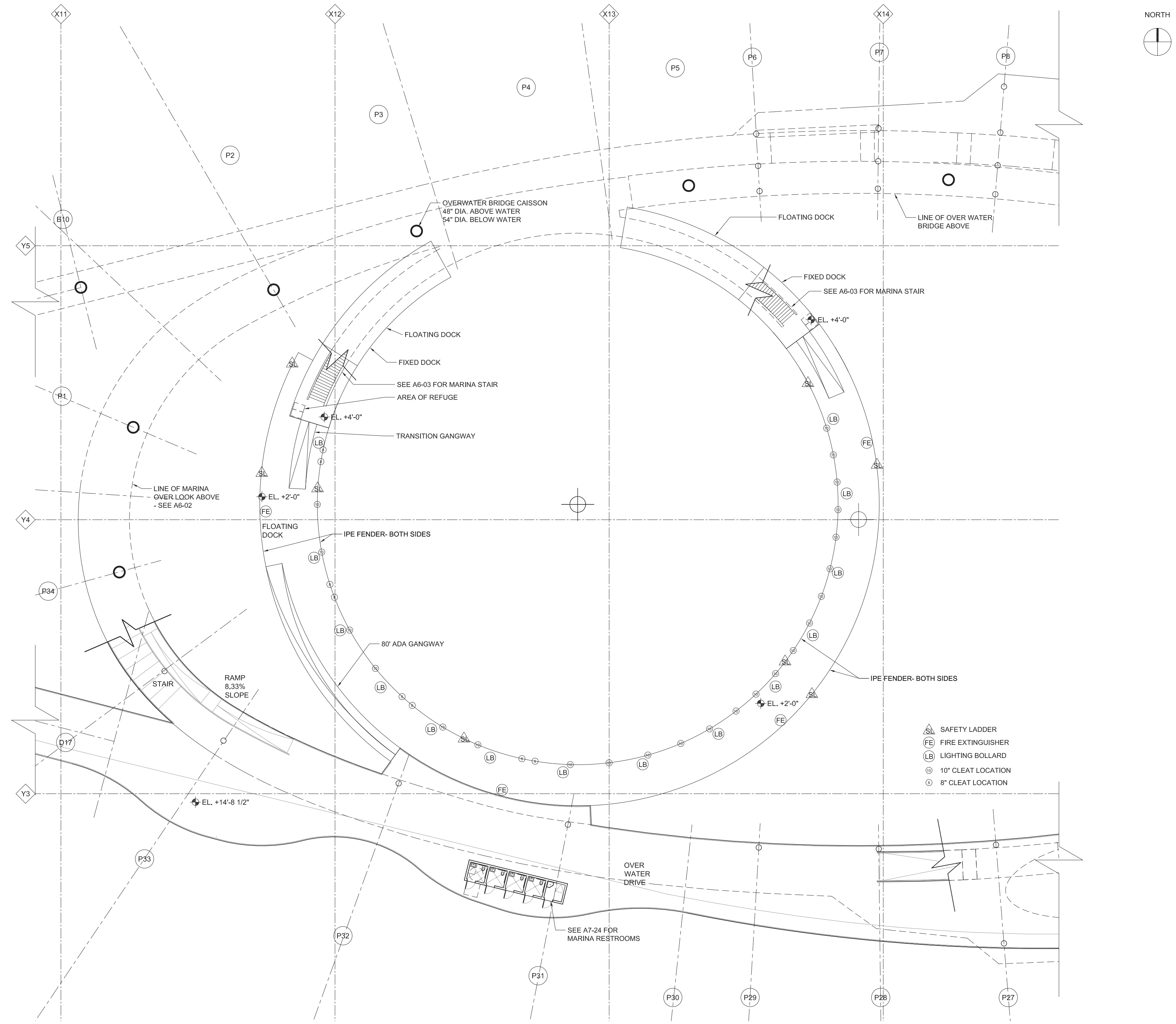
CANOPY ELEVATION
S5-41

DATE: 5/2/13
SCALE: 1/2" = 1'-0"
DRAWING No: 10864-####

1 /
A8-01 Enlarged Marina Plan



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McLAREN ENGINEERING GROUP
5728 Major Blvd., Suite 603, Orlando, FL 32819
T (407) 354-5411

Marina:
APPLIED TECHNOLOGY & MANAGEMENT, INC.
5550 N.W. 111th Blvd., Gainesville, FL 32653
T (386) 418-6400
Lighting Designer:
L'OBSERVATOIRE INTERNATIONAL
120 Walker St., 7th Floor East, New York, NY 10013
T (212) 255-4463

REVISIONS	BY	DATE

NEW ST. PETERSBURG PIER
CITY OF ST. PETERSBURG

SCHEMATIC DESIGN DOCUMENTS
CITY PROJECT NO. 10864
MICHAEL MALTZAN ARCHITECTURE PROJECT NO. 1202

ENGINEERING and CAPITAL IMPROVEMENTS DEPARTMENT
CITY of ST. PETERSBURG

APPROVED BY:

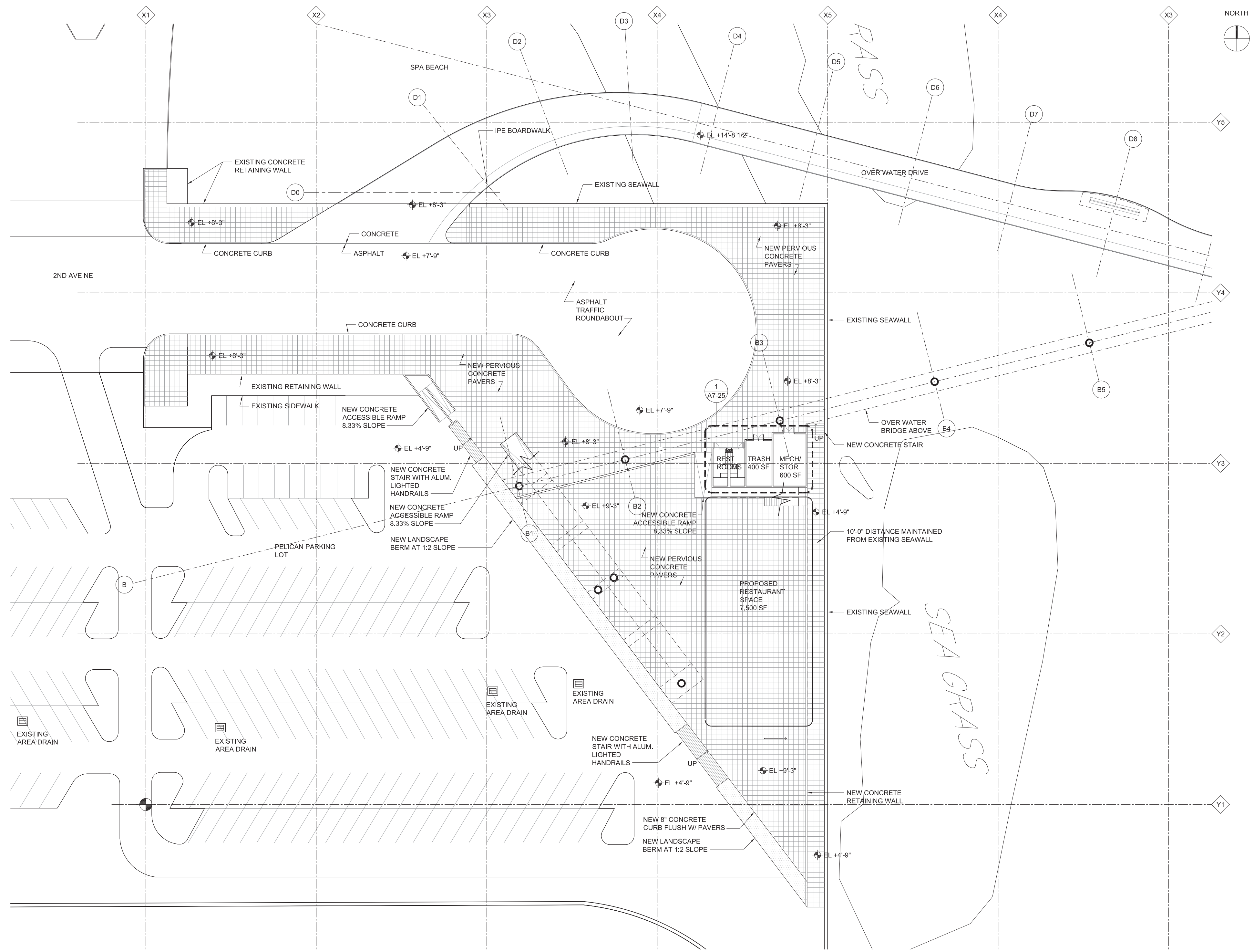
MICHAEL MALTZAN ARCHITECTURE, INC.
2801 Hyperion Avenue, Studio 107 / Los Angeles, CA 90027
T (323) 913-3098 F (323) 913-5932

ENLARGED MARINA PLAN
A8-01

DATE: 05/02/2013
SCALE: 1" = 20'-0"
DRAWING No:
10864-####

HUB / RESTAURANT

1 /
Enlarged Hub Plan



FOR PERMITTING PURPOSES ONLY

Associate Architect:
WANNEMACHER JENSEN ARCHITECTS, INC.
180 Mirror Lake Drive N., St. Petersburg, FL 33701
T (727) 822-5566

Structure/Civil/MEP/Code/Fire Engineer:
BURO HAPPOLD CONSULTING ENGINEERS INC.
100 Broadway - 23rd Floor, New York, NY 10005
T (212) 334-2025
Marine Structure Engineer:
McLAREN ENGINEERING GROUP
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REVISIONS	BY	DATE

NEW ST. PETERSBURG PIER
CITY OF ST. PETERSBURG

SCHEMATIC DESIGN DOCUMENTS
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2801 Hyperion Avenue, Studio 107 / Los Angeles, CA 90027
T (323) 913-3098 F (323) 913-5932

ENLARGED UPLANDS PLAN
A4-01

DATE: 05/02/2013
SCALE: 1" = 30'-0"
DRAWING No:
10864-####

4/24/2013 5:12 PM
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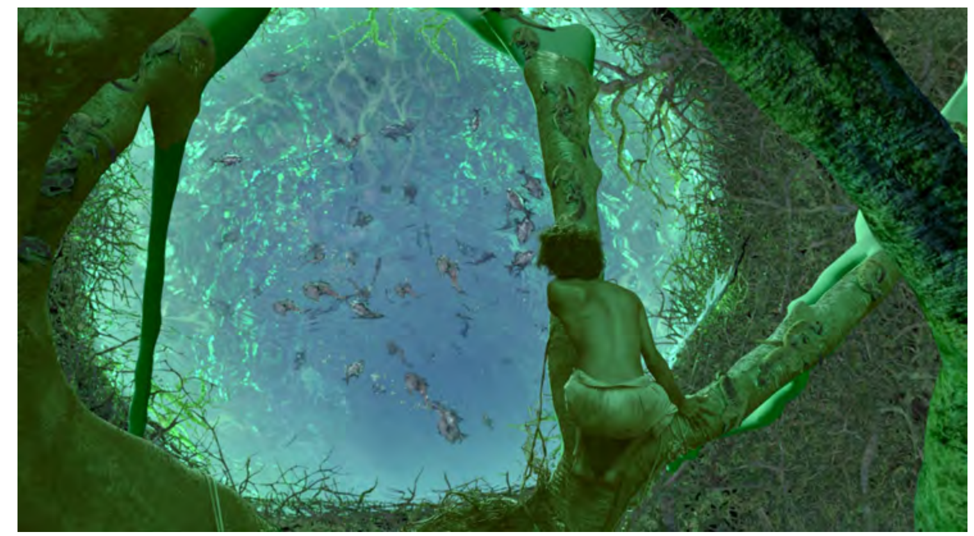
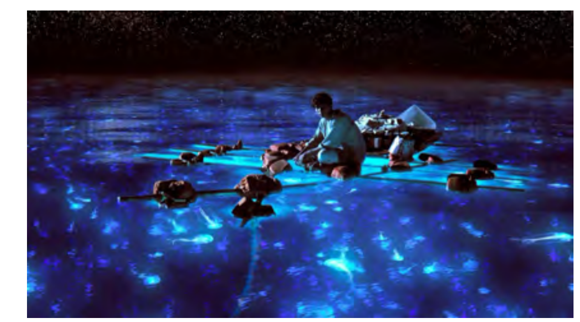
ST. PETERSBURG PIER

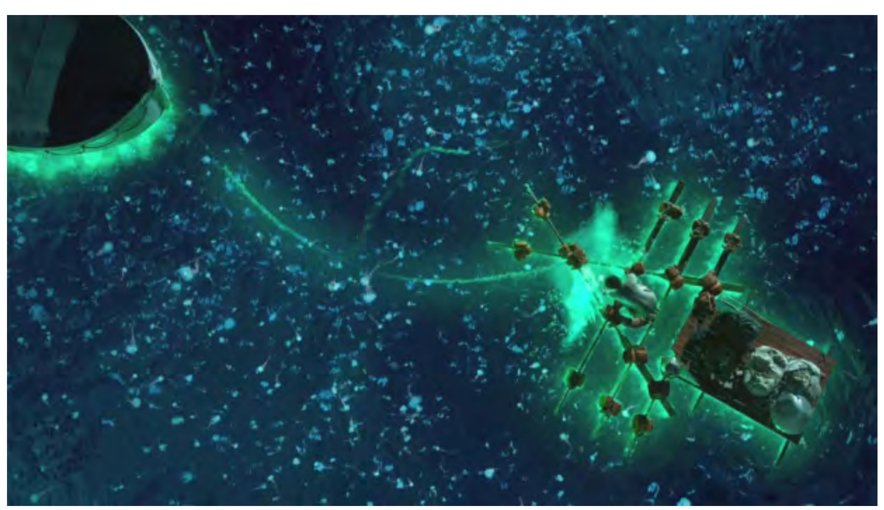
PRELIMINARY SCHEMATIC LIGHTING DESIGN PROPOSAL

SPP11073 SCHEMATIC LIGHTING DESIGN 15 APRIL 2013

L'OBSERVATOIRE INTERNATIONAL, LIGHTING DESIGNERS 120 WALKER STREET, 7TH FLOOR EAST NEW YORK NY 10013







OUR LIGHTING STRATEGY IS TO PRESENT THE WATER AS THE MAIN ATTRACTION OF THE NEW PIER. AN ORGANIC ATMOSPHERE INSPIRED BY BIOLUMINESCENCE WILL HIGHLIGHT THE MARINA AND PIER WATER ENCLOSURES AS THE FEATURES WHERE OTHER PROGRAMS REVOLVE AROUND.

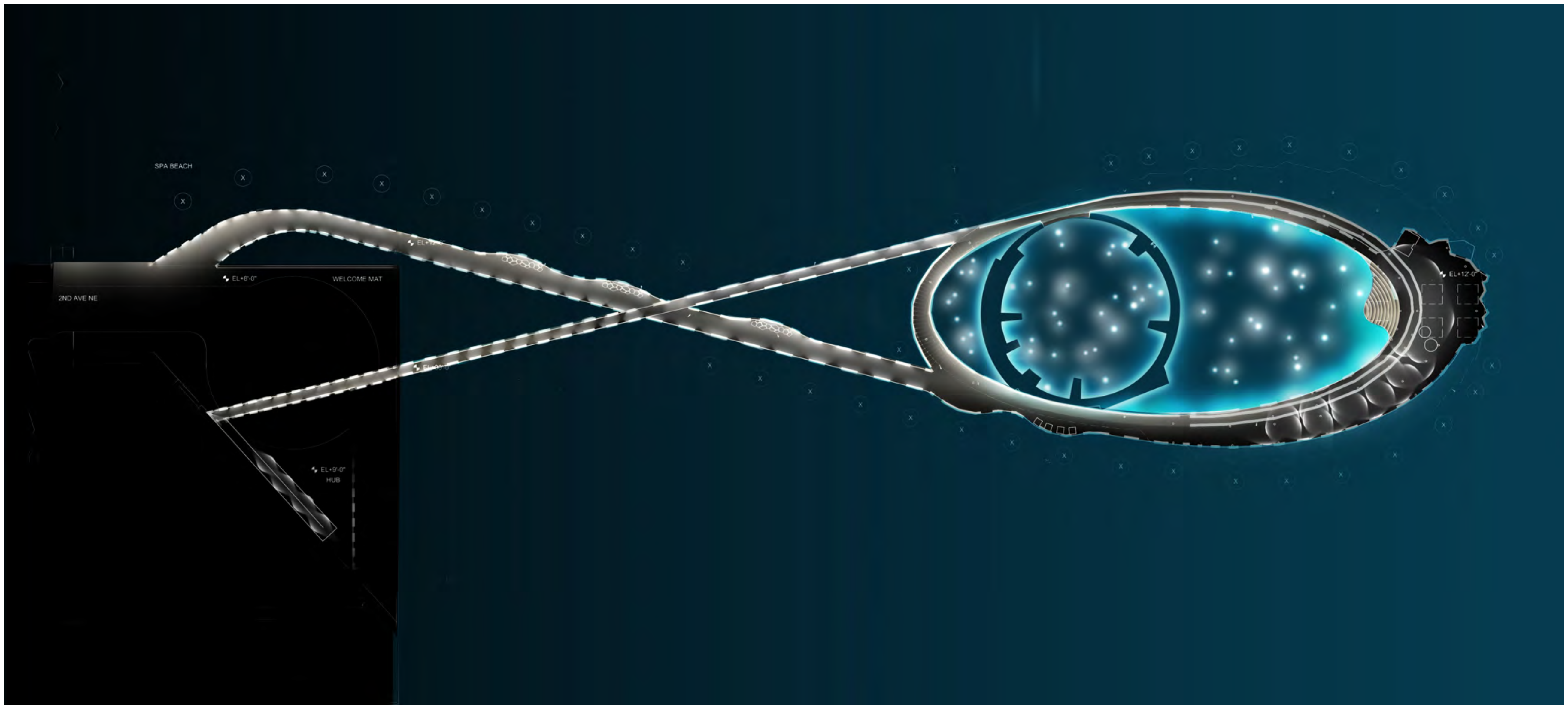
SUPPORTING THIS WILL BE THE CIRCULATION ASPECT WHERE THE DRIVE AND BRIDGES LOOP AROUND AND SOLIDIFY THE JOURNEY ALONG THE WATER.

SUBTLE LIGHTING TOUCHES FOR THE AMENITIES AND OTHER AREAS WILL SERVE AS BACKDROP TO THE STRONG PRESENCE OF THE WATER AND THE CIRCULATION PATTERN.

INSPIRATIONS & CONCEPT

SPP11073 SCHEMATIC LIGHTING DESIGN 15 APRIL 2013
L'OBSERVATOIRE INTERNATIONAL, LIGHTING DESIGNERS 120 WALKER STREET, 7TH FLOOR EAST NEW YORK NY 10013

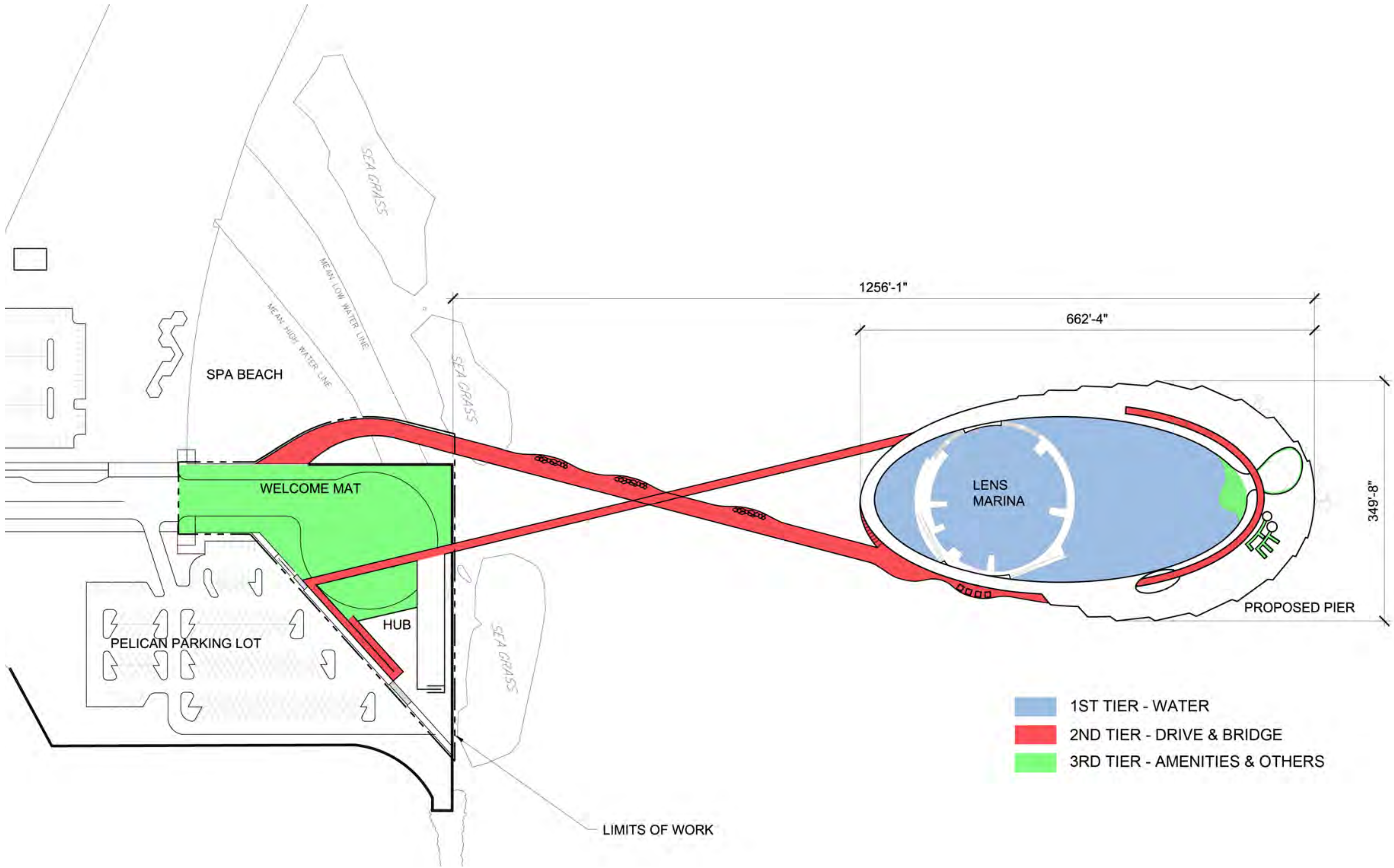
RENDERINGS SHOW DESIGN INTENT ONLY



RENDERED LIGHTING PLAN

SPP11073 SCHEMATIC LIGHTING DESIGN 15 APRIL 2013

L'OBSERVATOIRE INTERNATIONAL, LIGHTING DESIGNERS 120 WALKER STREET, 7TH FLOOR EAST NEW YORK NY 10013



LIGHTING STRATEGY DIAGRAM

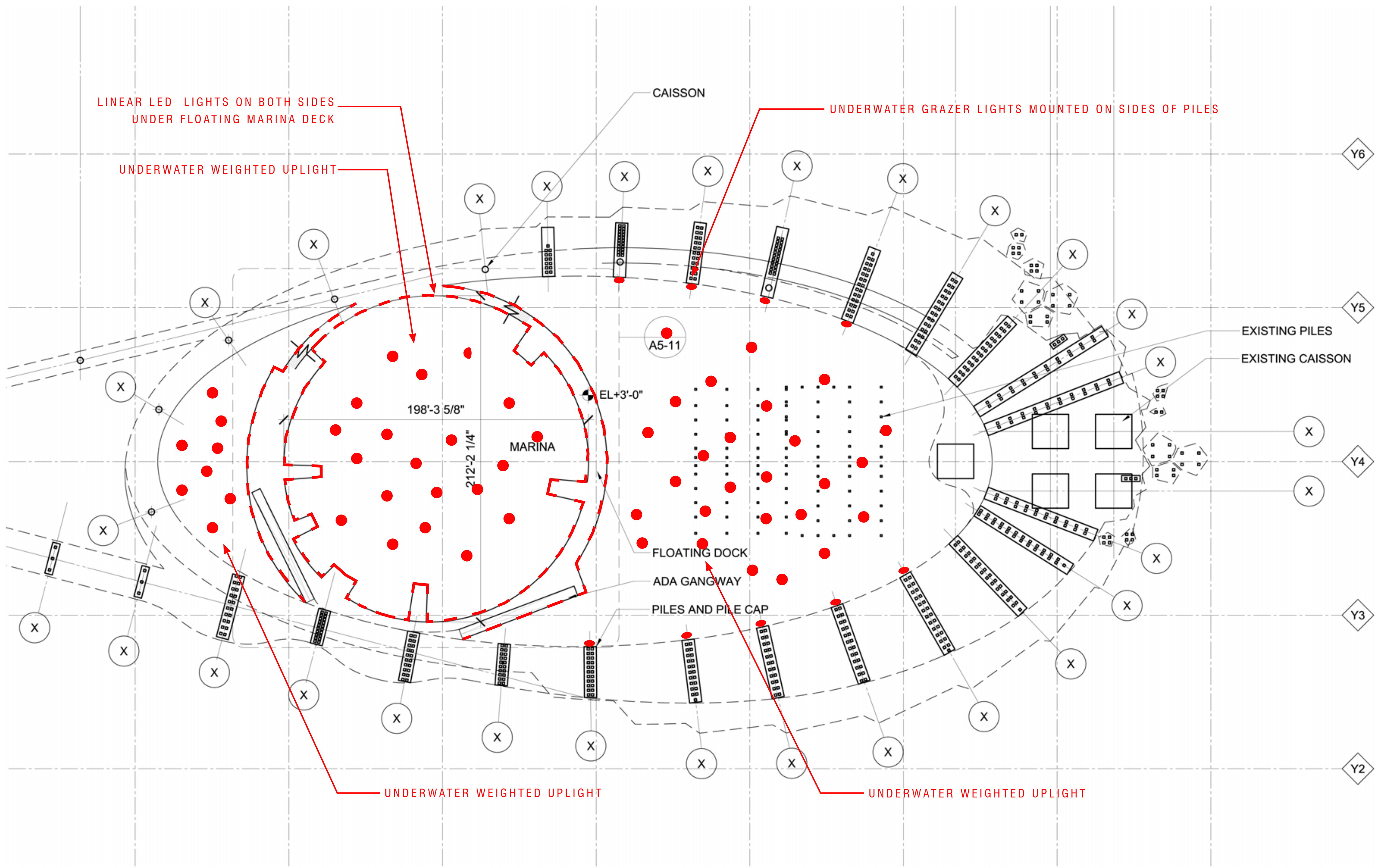
SPP11073 SCHEMATIC LIGHTING DESIGN 15 APRIL 2013
L'OBSERVATOIRE INTERNATIONAL, LIGHTING DESIGNERS 120 WALKER STREET, 7TH FLOOR EAST NEW YORK NY 10013

RENDERINGS SHOW DESIGN INTENT ONLY

1ST TIER - WATER LIGHTING

SPP11073 SCHEMATIC LIGHTING DESIGN 15 APRIL 2013

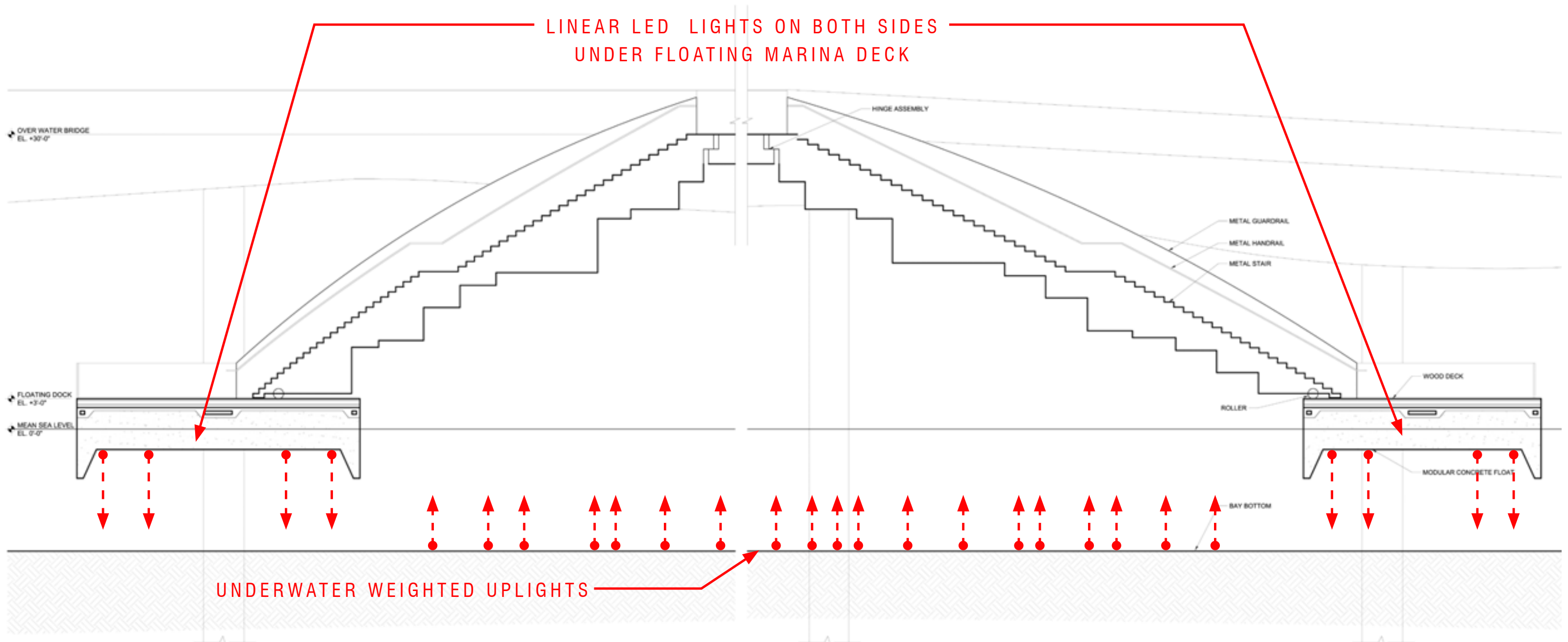
L'OBSERVATOIRE INTERNATIONAL, LIGHTING DESIGNERS 120 WALKER STREET, 7TH FLOOR EAST NEW YORK NY 10013



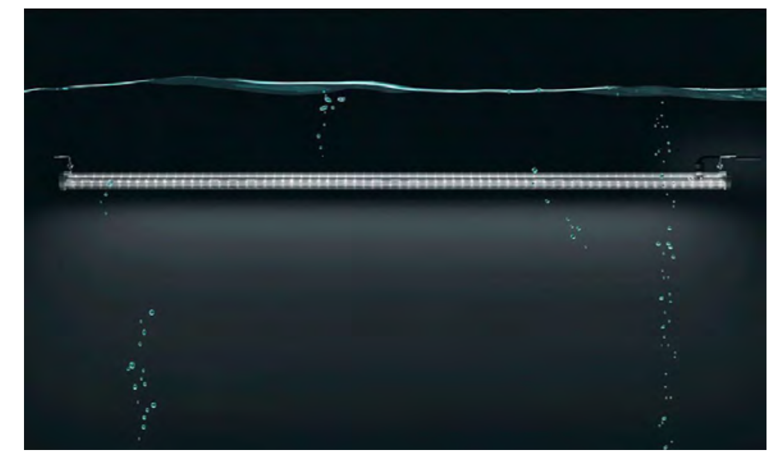
WATER LIGHTING PLAN

1ST TIER - WATER LIGHTING

SPP11073 SCHEMATIC LIGHTING DESIGN 15 APRIL 2013
L'OBSERVATOIRE INTERNATIONAL, LIGHTING DESIGNERS 120 WALKER STREET, 7TH FLOOR EAST NEW YORK NY 10013



MARINA SECTION



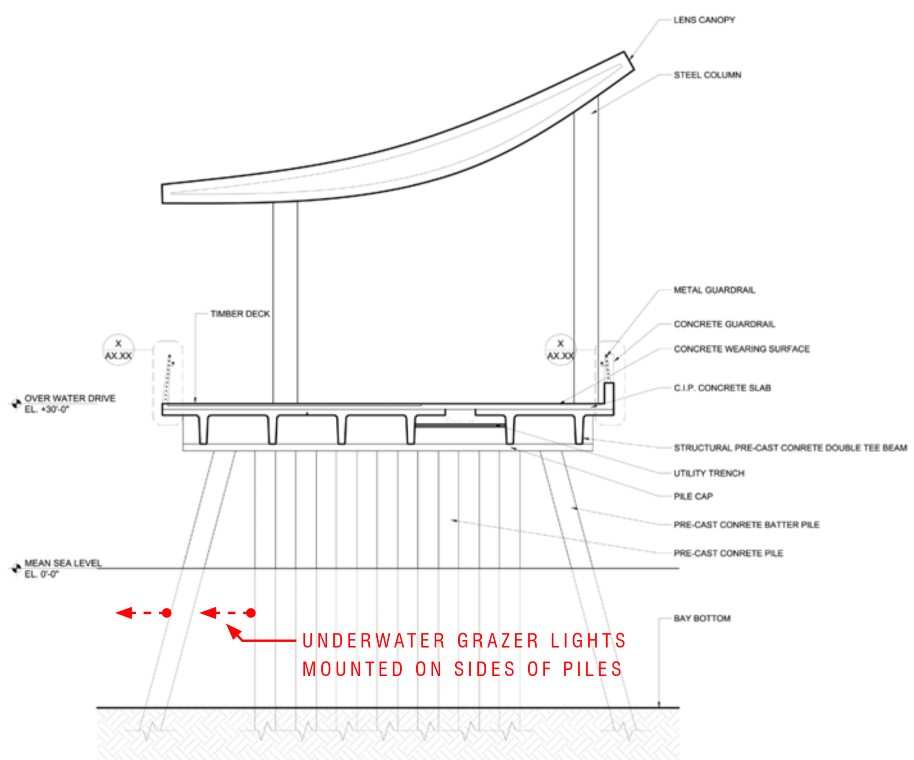
UNDERWATER LINEAR LED LIGHT @ MARINA

UNDERWATER WEIGHTED UPLIGHT

1ST TIER - WATER LIGHTING

SPP11073 SCHEMATIC LIGHTING DESIGN 15 APRIL 2013

L'OBSERVATOIRE INTERNATIONAL, LIGHTING DESIGNERS 120 WALKER STREET, 7TH FLOOR EAST NEW YORK NY 10013



DRIVE SECTION

opticlear™ microAntiLeach™

LS365LED

The LS365LED is a high grade surface mount wet/dry luminaire. The 316 marine grade stainless steel housing is totally sealed and has a rating equivalent to submersion up to 30 ft (10 m) underwater. Choices of LED color, different beam angles and accessories make this a versatile luminaire suitable for a wide range of wet/dry applications.

Specifications

Lamp Source	16 W or 20 W LED White (4 300 K typical) Warm white (2 900 K typical) Blue (470 nm) *Other colors by request*
Approved Use	Wet/dry
IP Rating	IP68
Construction	316 marine grade stainless steel
Installation type	Surface mount
Standard inclusions	Teflon coated cover screws **MicroAntiLeach™** cable entry Thermal cutout Humidity absorbing dessicant 16.4 ft (5 m) underwater cable *For extra cable length consult factory*
Ambient Operating Temperature	-22 °F to 122 °F (-30 °C to +50 °C)
Accessories *Order separately*	**LS6074** mounting plate
Photometrics	Refer to www.lumascape.com

UNDERWATER GRAZER LIGHT MOUNTED @ SIDE OF PILES

1ST TIER - WATER LIGHTING

SPP11073 SCHEMATIC LIGHTING DESIGN 15 APRIL 2013
L'OBSERVATOIRE INTERNATIONAL, LIGHTING DESIGNERS 120 WALKER STREET, 7TH FLOOR EAST NEW YORK NY 10013

RENDERINGS SHOW DESIGN INTENT ONLY

2ND TIER - DRIVE & BRIDGE LIGHTING

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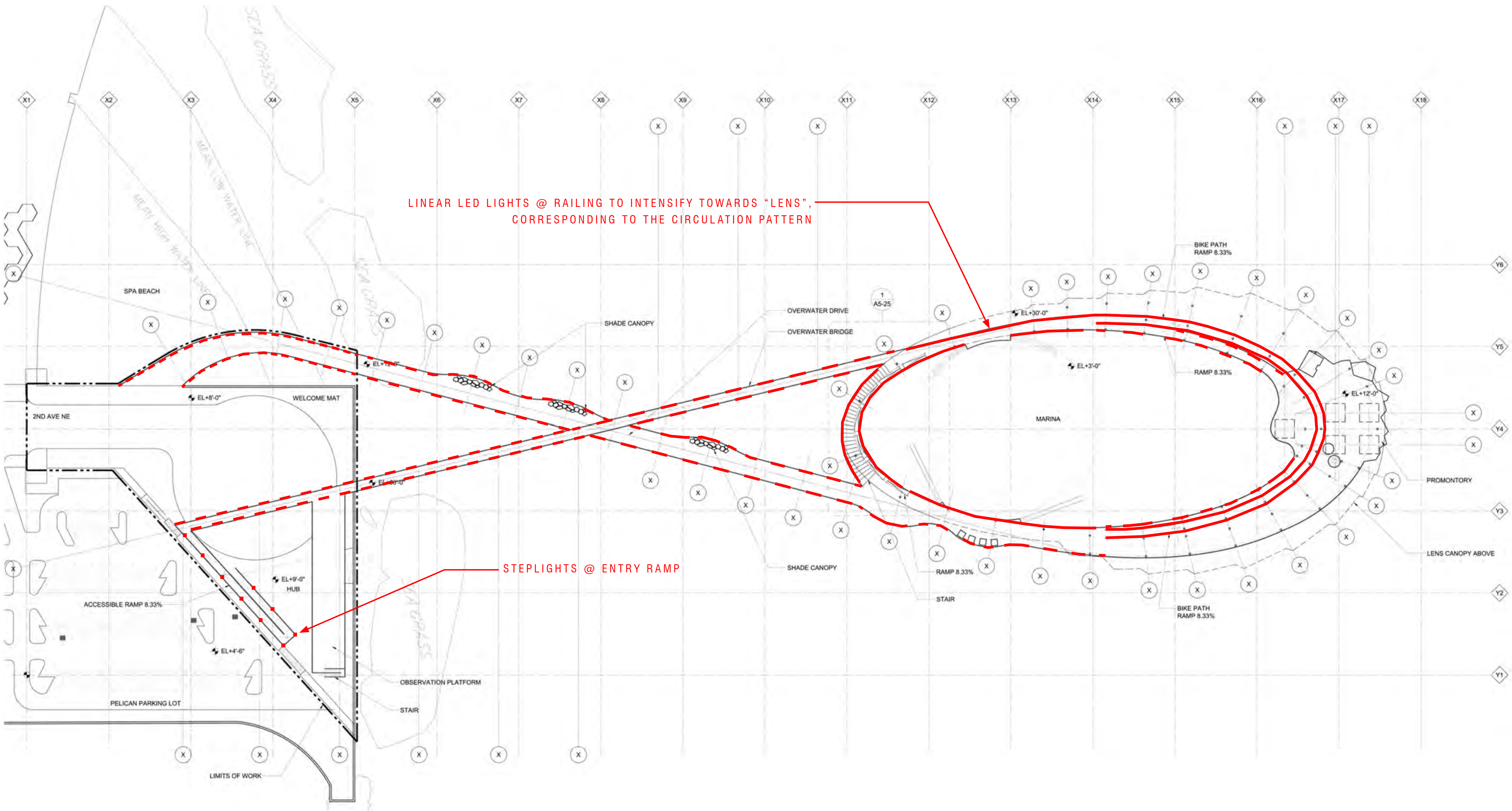
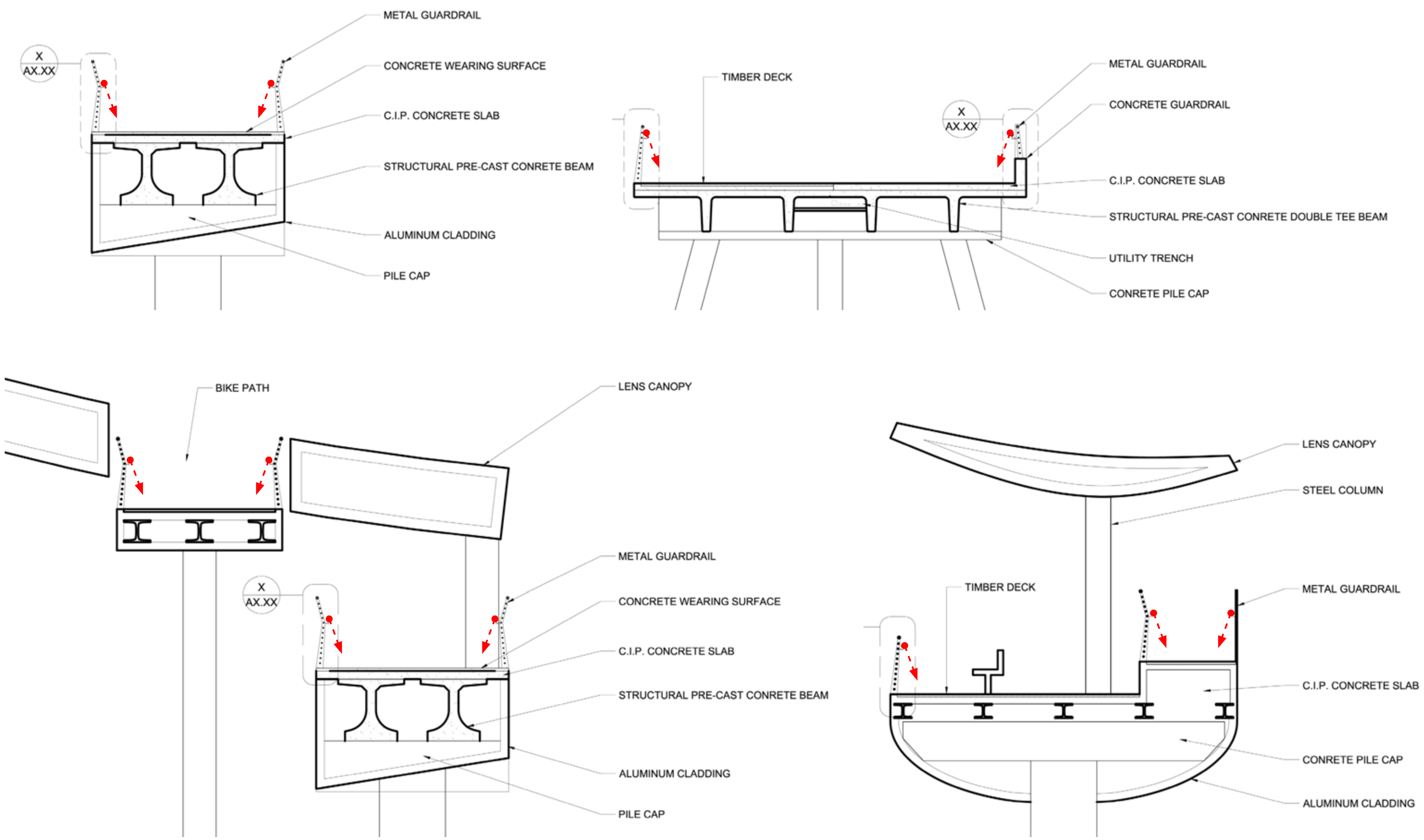


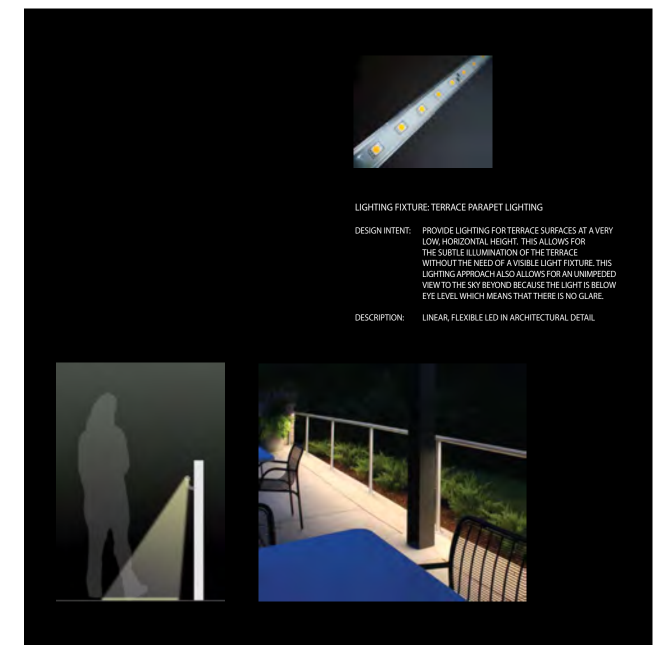
DRIVE & BRIDGE LIGHTING PLAN

2ND TIER - DRIVE & BRIDGE LIGHTING

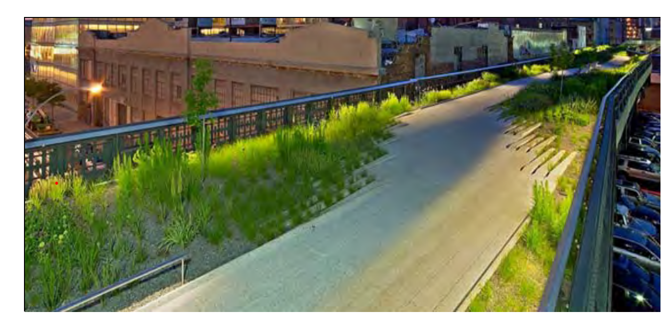
SPP11073 SCHEMATIC LIGHTING DESIGN 15 APRIL 2013
L'OBSERVATOIRE INTERNATIONAL, LIGHTING DESIGNERS 120 WALKER STREET, 7TH FLOOR EAST NEW YORK NY 10013



DRIVE & BRIDGE SECTIONS - LINEAR LED LIGHTS INTEGRATED @ RAIL



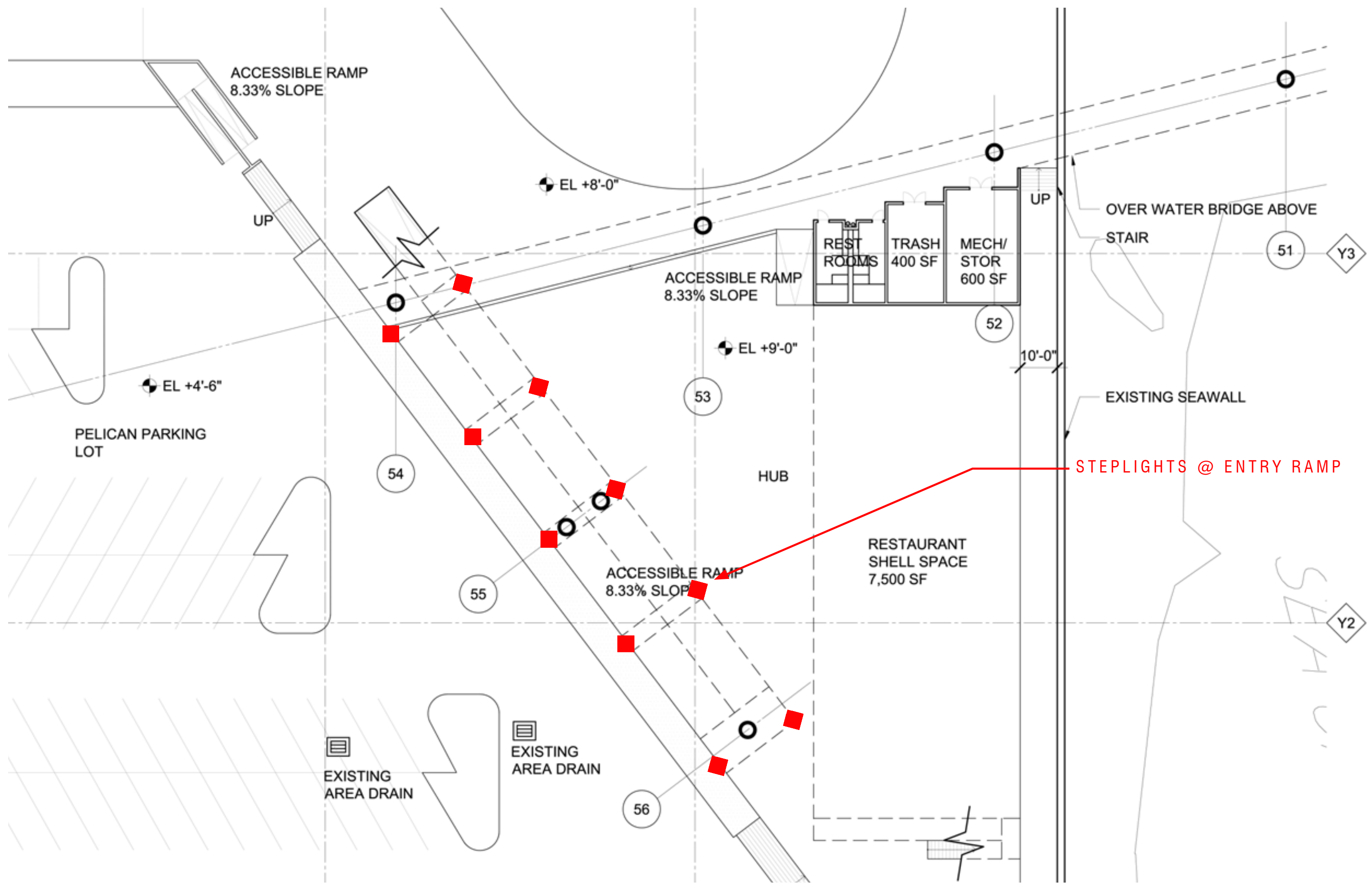
RAIL LIGHTING



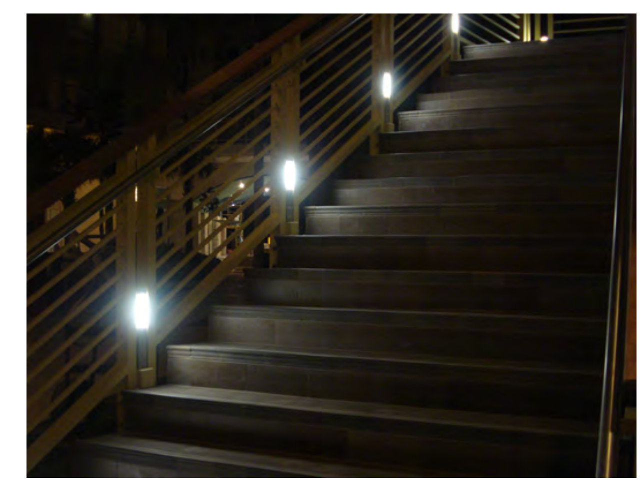
RAIL LIGHTING EFFECT

2ND TIER - DRIVE & BRIDGE LIGHTING

SPP11073 SCHEMATIC LIGHTING DESIGN 15 APRIL 2013
L'OBSERVATOIRE INTERNATIONAL, LIGHTING DESIGNERS 120 WALKER STREET, 7TH FLOOR EAST NEW YORK NY 10013



ENTRY RAMP PLAN @ WELCOME MAT/HUB



STEP LIGHTS @ ENTRY RAMP

2ND TIER - DRIVE & BRIDGE LIGHTING

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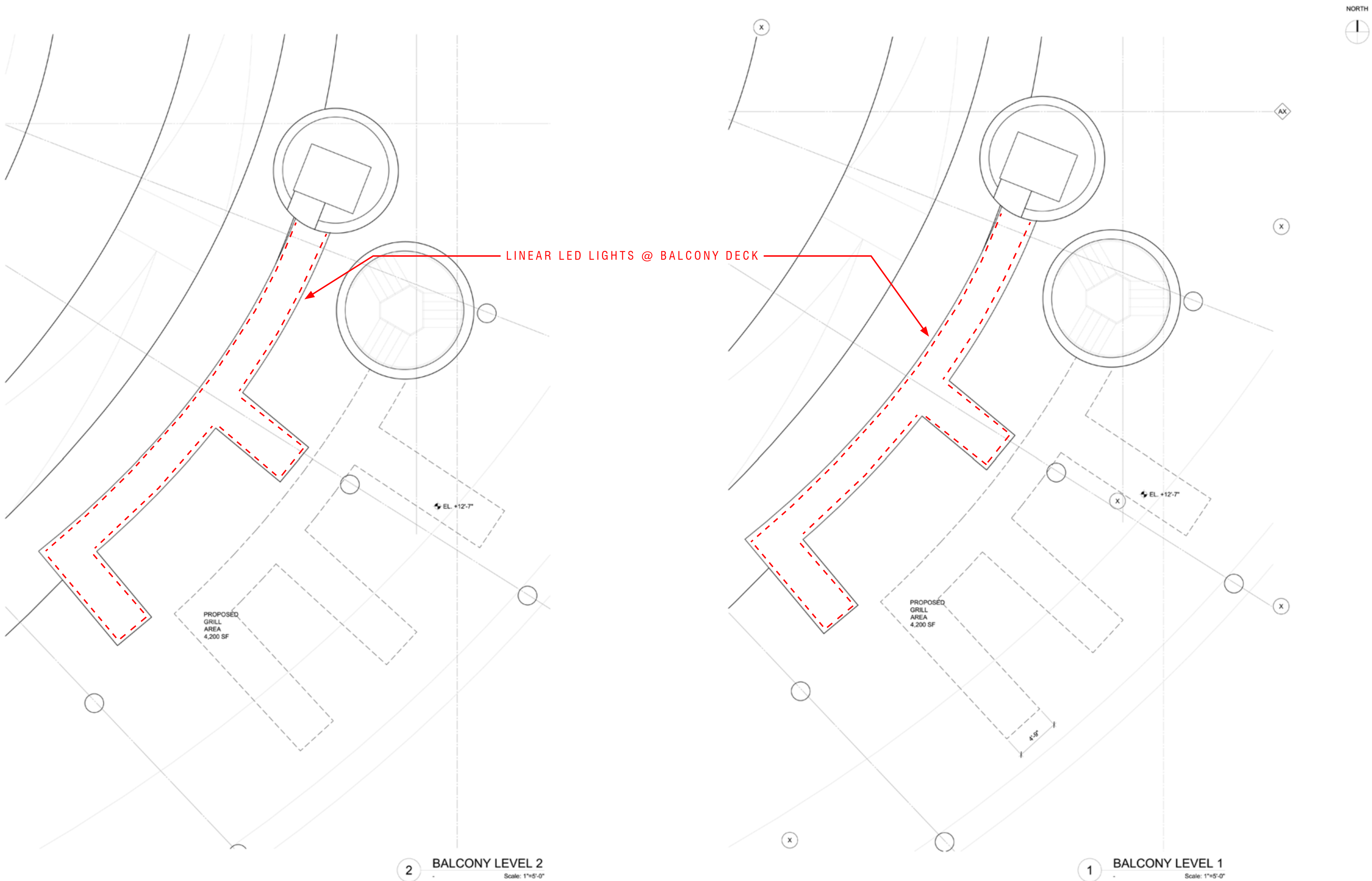
L'OBSERVATOIRE INTERNATIONAL, LIGHTING DESIGNERS 120 WALKER STREET, 7TH FLOOR EAST NEW YORK NY 10013

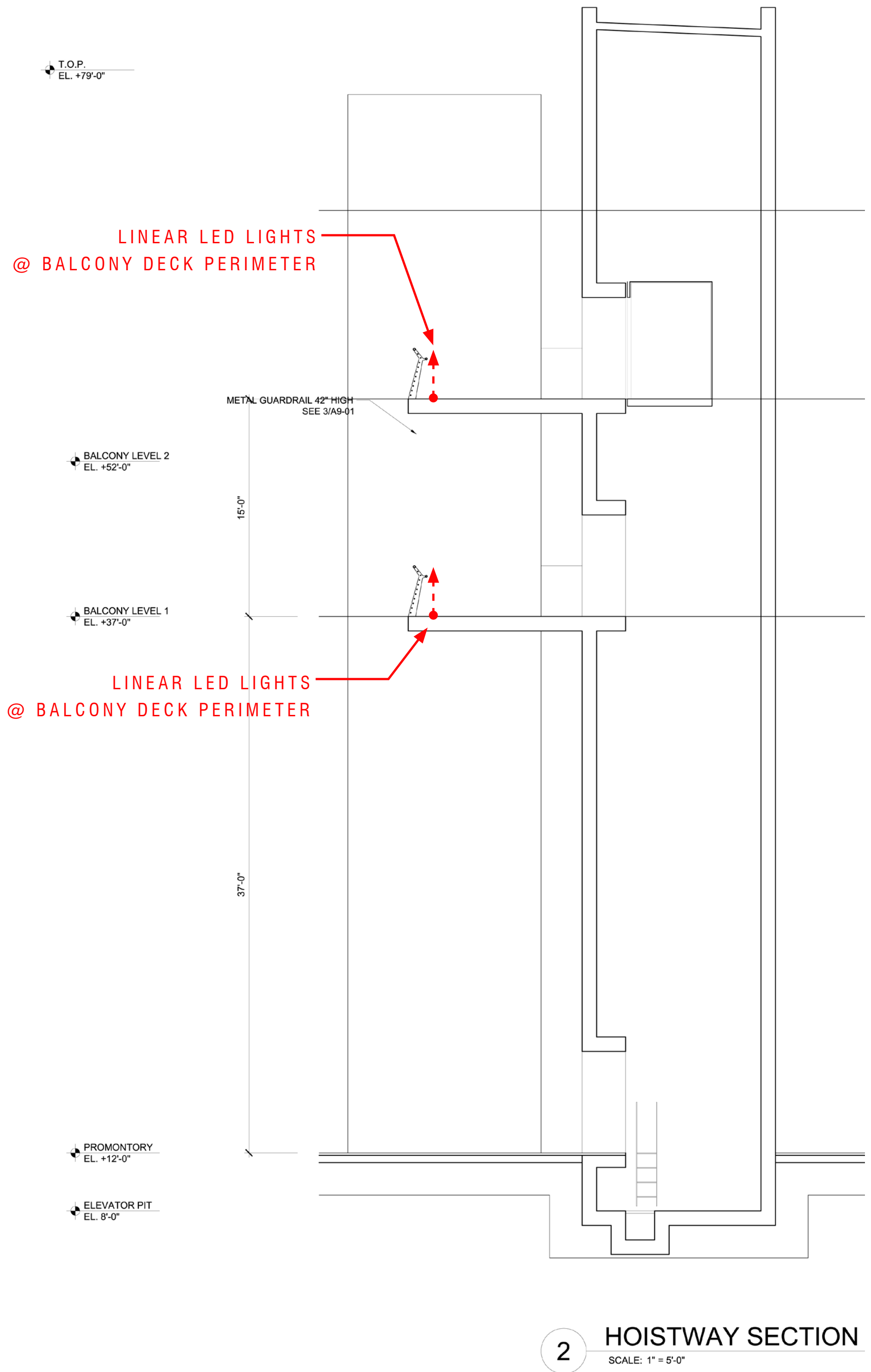


BALCONY LIGHTING PLAN

3RD TIER - AMENITIES & OTHER LIGHTING

SPP11073 SCHEMATIC LIGHTING DESIGN 15 APRIL 2013

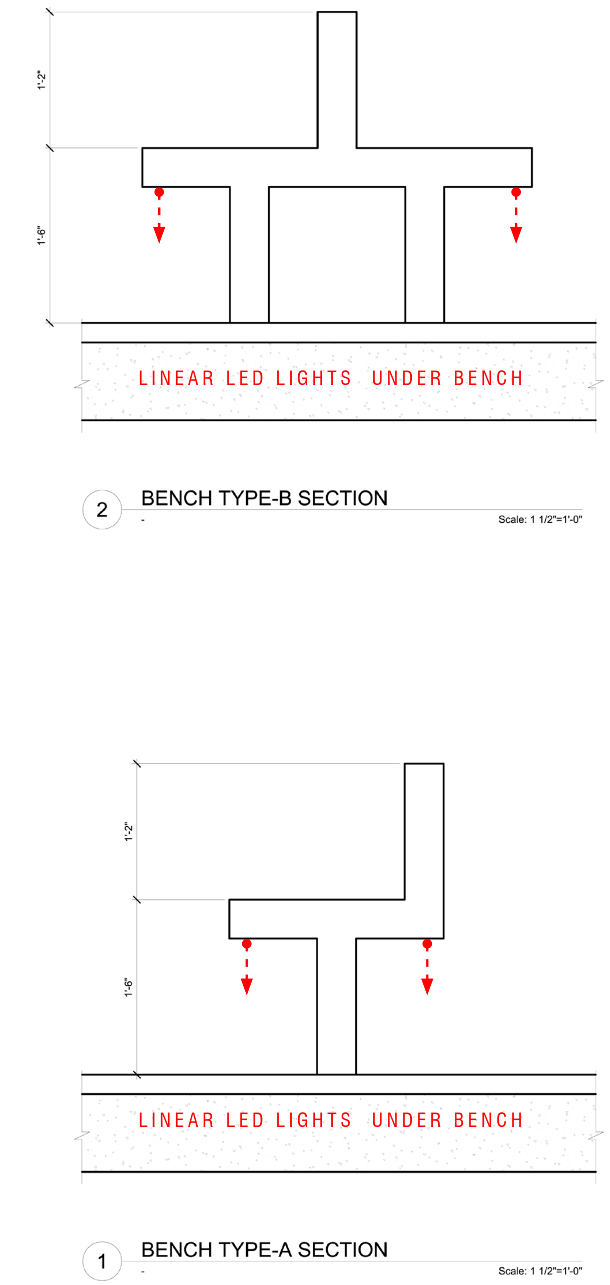
L'OBSERVATOIRE INTERNATIONAL, LIGHTING DESIGNERS 120 WALKER STREET, 7TH FLOOR EAST NEW YORK NY 10013



BALCONY LIGHTING SECTION

LINEAR LED LIGHT@BALCONY DECK

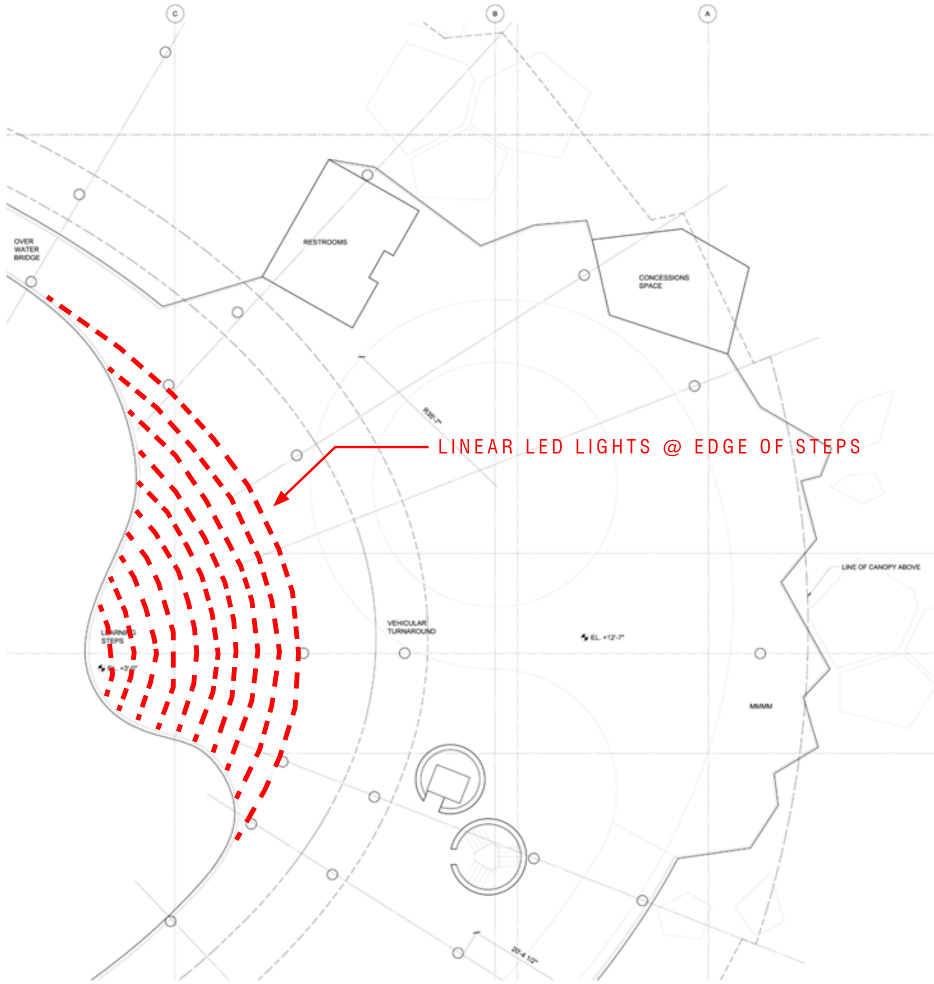
LINEAR LED LIGHT UNDER BENCH



BENCH LIGHTING SECTION

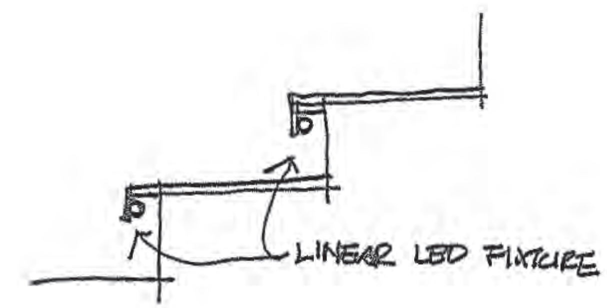
3RD TIER - AMENITIES & OTHER LIGHTING

SPP11073 SCHEMATIC LIGHTING DESIGN 15 APRIL 2013
L'OBSERVATOIRE INTERNATIONAL, LIGHTING DESIGNERS 120 WALKER STREET, 7TH FLOOR EAST NEW YORK NY 10013

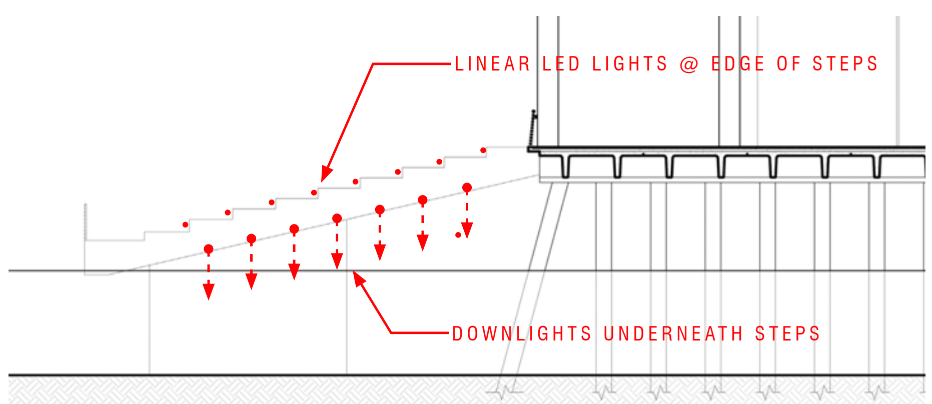


EDUCATIONAL STEPS LIGHTING PLAN

LINEAR LED LIGHT
@EDUCATIONAL STEPS



LINEAR LED LIGHT DIAGRAM
INDIRECT GLOW @ STEPS

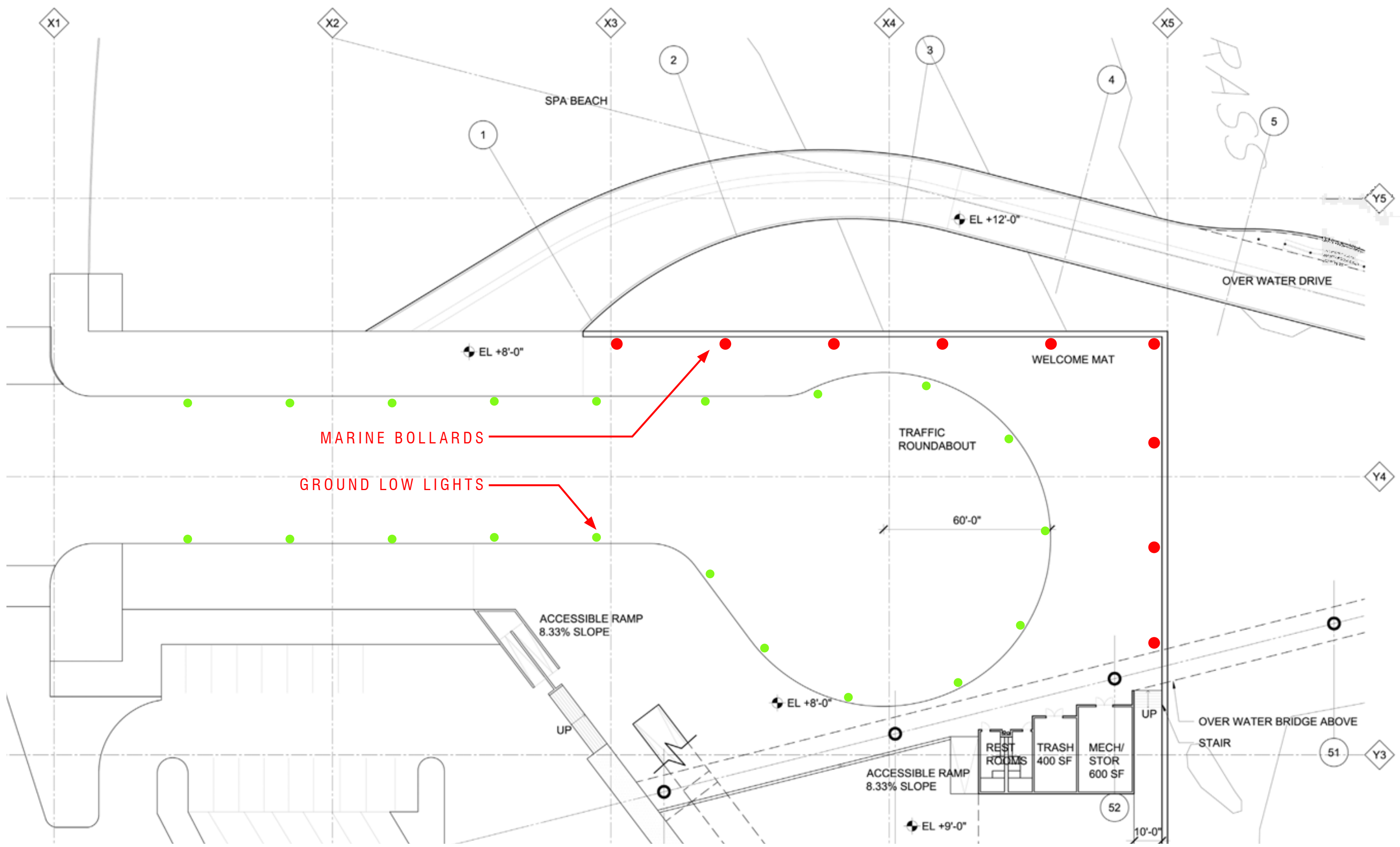


EDUCATIONAL STEPS LIGHTING SECTION

DOWNLIGHT UNDERNEATH
EDUCATIONAL STEPS

3RD TIER - AMENITIES & OTHER LIGHTING

SPP11073 SCHEMATIC LIGHTING DESIGN 15 APRIL 2013
L'OBSERVATOIRE INTERNATIONAL, LIGHTING DESIGNERS 120 WALKER STREET, 7TH FLOOR EAST NEW YORK NY 10013



WELCOME MAT/HUB PLAN

MARINE BOLLARD

GROUND LOW LIGHT

3RD TIER - AMENITIES & OTHER LIGHTING

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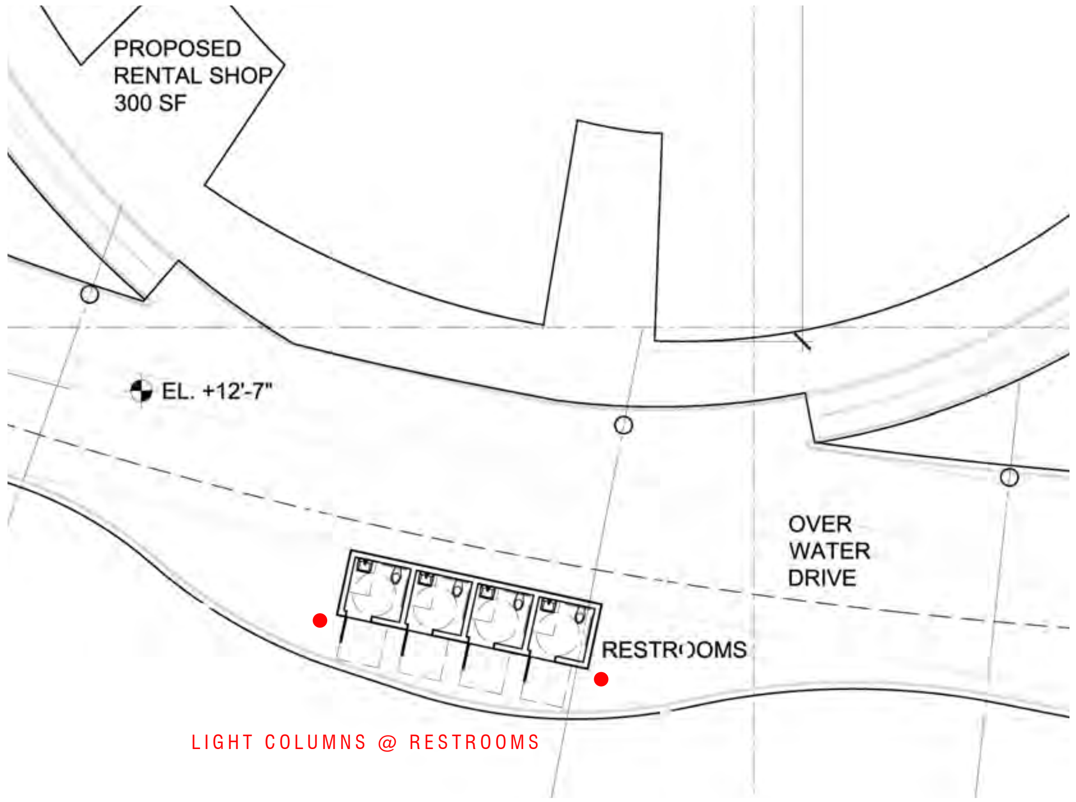
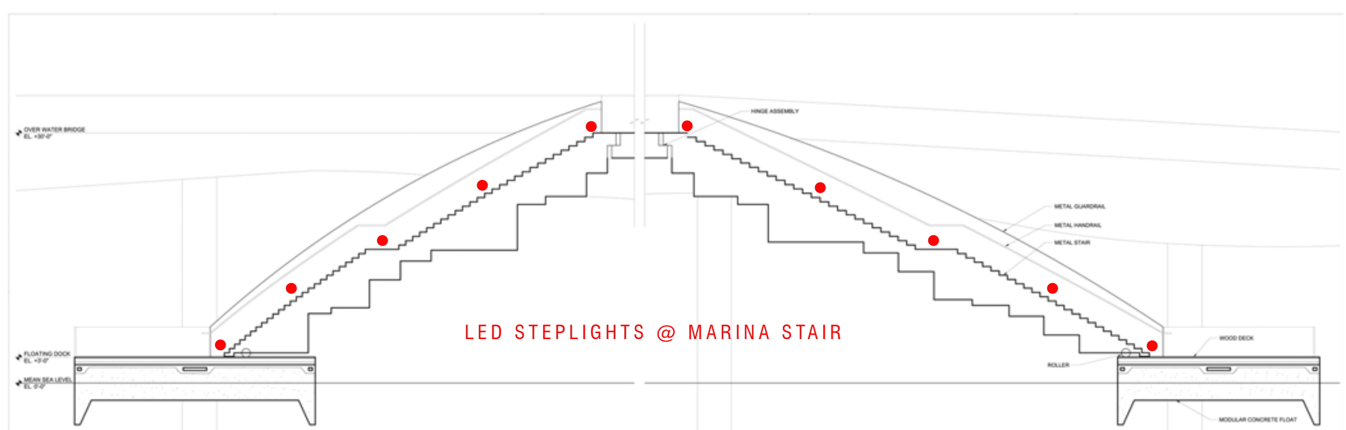


DRIVE/MARINA RESTROOMS

LIGHT COLUMNS



MARINA STAIR

LED STEPLIGHT

3RD TIER - AMENITIES & OTHER LIGHTING

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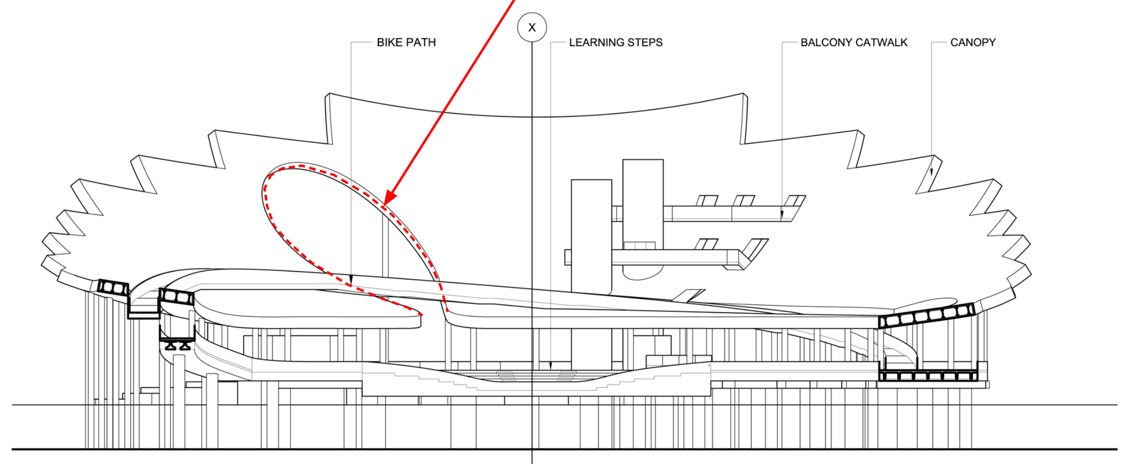
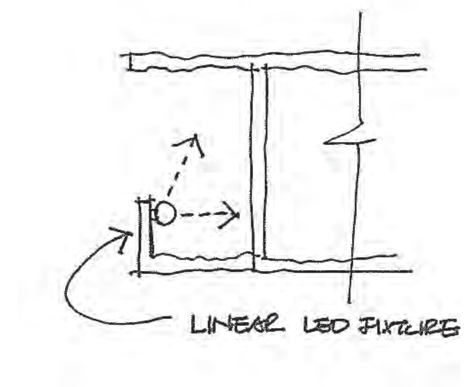


PROMONTORY “LENS” SECTION DIAGRAM



LINEAR LED LIGHTS
@ PROMONTORY DIAGRAM
INDIRECT GLOW @ “LENS”

SUPER AQUA FLEX | 283 LM/FT LINEAR FLEX

Silicon encased, contains 600 SMD LEDs on a 16’ 4” strip, cuttable every 1”. Super Aqua Flex is ideal for locations which may get splashed by water but still require a high light output. Designed for installation around bars, sinks and more. Constant voltage IC’s protect LEDs maintaining the same brightness and maintaining life of the flex. Supplied with fixing clips and end caps. White PCB. Wet location rated. 100-277v Triac Line Voltage Dimmable. Available in 3000k & 6000k. Tested to UL & CSA Standards by ETL. Tested to LM-79-08 & LM80-08. IES file available online. Title 24 Approved.
Lighting Facts Listed. CE Approved. ROHS Approved.
106 lm/ft - 3000k - CRI 85
114 lm/ft - 6000k - CRI 87
L: 16’ 4 4/5” W: 3/5” H: 1/5”

12v DC | SMD | 6w per foot | 47lm/w 3000k | IP67
FPCB | 113° | MP09

AQUA FLEX | 106 LM/FT LINEAR FLEX

Wet location LED Linear Flex. Contains 360 SMD LEDs on a 19’ 8” reel. Cuttable every 2”.
Our first waterproof linear flex created a big splash in North America when introduced and still remains our most popular waterproof LED linear solution. Constant current IC’s protect the LEDs and ensure the same brightness from each LED. Supplied with mounting clips, silicone glue and end caps for rapid and easy installation. White PCB.
100-277v Dimmable with standard triac dimmers. Available in 3000k & 6000k.
Tested to UL & CSA Standards by ETL. Tested to LM-79-08 & LM80-08.
IES file available online. Title 24 Approved. Lighting Facts Listed.
CE Approved. ROHS Approved.
106 lm/ft - 3000k - CRI 85
114 lm/ft - 6000k - CRI 87
L: 19’ 8 1/5” W: 3/5” H: 1/5”

12v DC | SMD | 2.5w per foot | 41 lm/w 3000k | IP67
FPCB | 115° | MP41

LINEAR LED LIGHT OPTIONS @ PROMONTORY “LENS”

3RD TIER - AMENITIES & OTHER LIGHTING

SPP11073 SCHEMATIC LIGHTING DESIGN 15 APRIL 2013
L’OBSERVATOIRE INTERNATIONAL, LIGHTING DESIGNERS 120 WALKER STREET, 7TH FLOOR EAST NEW YORK NY 10013

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OVERALL LIGHTING EFFECTS

SPP11073 SCHEMATIC LIGHTING DESIGN 15 APRIL 2013

L'OBSERVATOIRE INTERNATIONAL, LIGHTING DESIGNERS 120 WALKER STREET, 7TH FLOOR EAST NEW YORK NY 10013

5

CONSTRUCTION MANAGER AT RISK

INTRODUCTION

As in the Basis of Design phase, the process that Skanska, the A/E team, and key representatives of the City of St. Petersburg have engaged in over the past months has been intensive, thorough, and collaborative. Since the initiation of Schematic Design in December of 2012, the process has been based on real-time costing and constructability concepts, using the Basis of Design cost estimate as a guide for moving forward. By reaching out to the A/E team, developing a collaborative process, and keeping all lines of communication open, Skanska was successful not only in describing a project that can be built on budget and on schedule, but also in developing a framework for the team to take on any challenges that may arise as the project moves forward.

This process has involved the following:

- (3) Cost Estimates or Rough Order of Magnitudes.
- (4) Revised 3D cost models which were utilized to capture true quantities for accurate estimates.
- (2) Face-to-face multi-day work sessions that included the A&E team, the client, and collaborative experts contributing real time pricing and constructability input.
- Over a dozen internal meetings with our collaborative experts.
- (5+) all hands on deck conference calls to discuss data as it developed, allowing the team to mutually identify opportunities worth exploring.
- An intensive data sharing session between MMA and Skanska..

Through this immersive process a comprehensive cost estimate has been developed for the full scope of the project. Because decisions made during SD are not final, the architects, engineers and builders of this project look forward to continuing the process described herein, and to engaging the City and the community in the next phases of work. Through a process of fine-tuning, confirming and making adjustments where necessary, the project will be realized on budget and on schedule.

EARLY INVOLVEMENT OF KEY SUBCONTRACTORS

Early involvement of key subcontractors will be critical for the two complex and unique components of the project: the Canopy and the Marina. These components require the adoption of a Design-Assist project delivery method wherein specific subcontractors are brought into the project early and work closely with the project team to deliver the best possible product on time and on budget. In this sense, Design-Assist offers a number of advantages over traditional Design-Bid because the subcontractor helps develop the project in collaboration with the A/E team and is able to help control cost and quality throughout the design process. In the traditional approach, the A/E team develops a design and for a variety of third-party subcontractors to bid on. Although an acceptable process for components that are standard and well understood, this has the potential to cause uncertainties that can translate into cost and quality problems for unique projects.

EARLY INVOLVEMENT OF KEY SUBCONTRACTOR / CANOPY METAL

The Canopy, the first of two key Design-Assist Components, will benefit from this project delivery method for the following reasons:

- The complex form of the Canopy surface requires extensive coordination between the metal panel and steel substructure subcontractors, as well as coordination with the project engineers. By engaging the metal panel subcontractor early, the coordination of the two systems can begin on day one.
- The panelization of the Canopy will require a high level of detail to execute in a manner that meets the Project's standards, both aesthetically and functionally. The Design-Assist delivery method allows seamless communication between the A/E and subcontractor to ensure the quality and cost of the canopy surface.

EARLY INVOLVEMENT OF KEY SUBCONTRACTOR / MARINA

The Marina is the second of the two Design-Assist Components of the Project and will benefit from a Design-Assist project delivery method for the following reasons:

- Because the floating dock performs also as a wave attenuation system, a number of specialized tests and studies will need to be conducted by the subcontractor prior to its construction. These tests will assist the subcontractor and the A/E team in customizing the floating dock system.
- The unique, circular nature of the floating dock requires the fabrication of custom components. Engaging the key subcontractors early will allow the A/E team to collaboratively design the dock components for further cost control and quality, and to ensure the Marina meets all the design requirements of the Project.

THE NEW ST. PETERSBURG PIER

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www.stpete.org

ARCHITECT
Michael Maltzan Architecture, Inc.
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Los Angeles, California 90027
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www.mmaltzan.com

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FIRE AND LIFE SAFETY ENGINEER
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www.georgefyoung.com

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PROJECT ADVISOR
Pete Karamitsanis

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120 Walker Street 7th Floor East
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www.lobsintl.com

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ENVIRONMENTAL PLANNING
Moffat & Nichol Engineers
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Tampa, Florida 33606
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www.moffattnichol.com

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Willis Construction Consulting, Inc.
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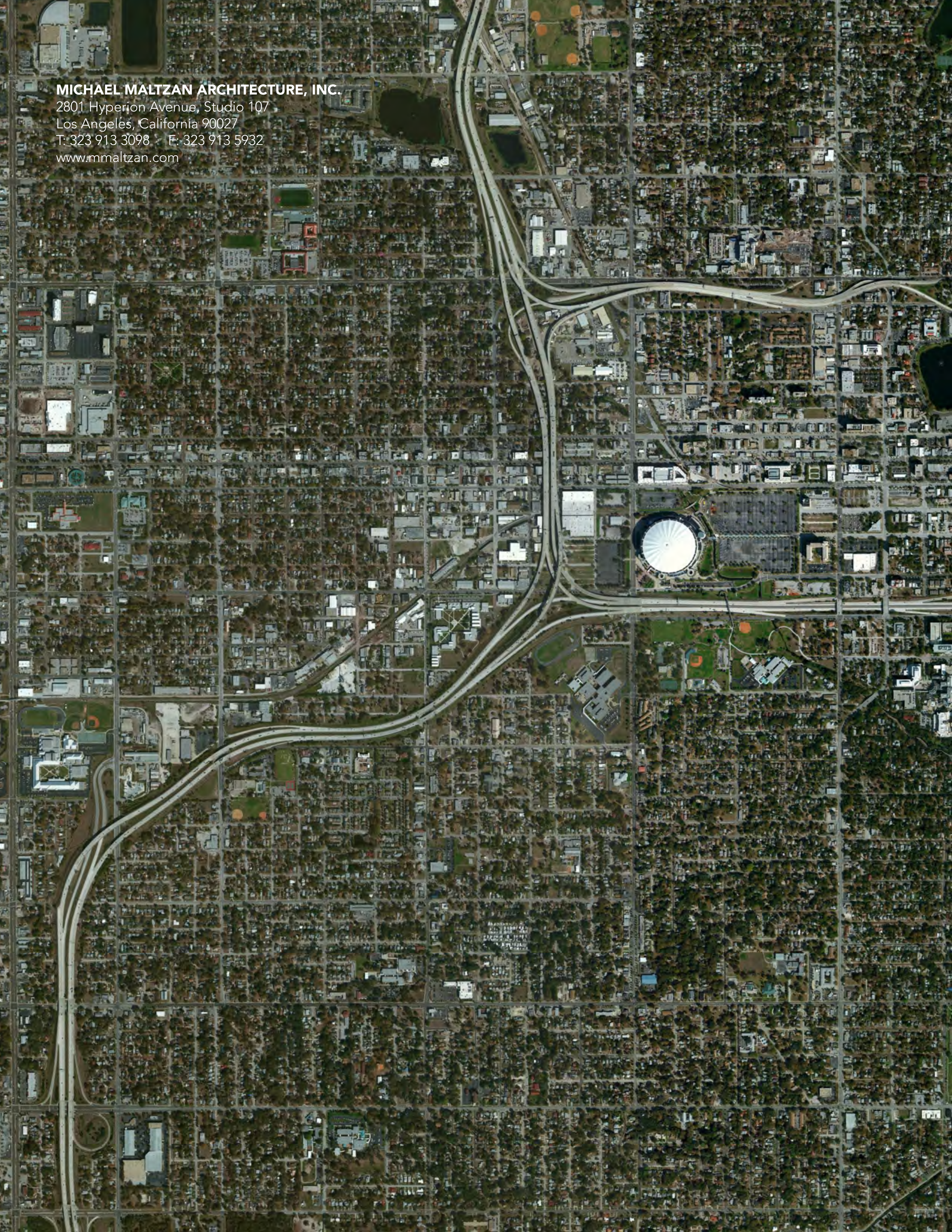
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