Virginia Key Beach Park

Tidal Current Study

Miami-Dade County, Florida

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1.0 INTRODUCTION

1.1 Authorization

Coastal Systems International, Inc. (Coastal Systems) was authorized by the Virginia Key Beach Park Trust (Trust) in May 2009 to conduct a study evaluating the tidal currents in the vicinity of the Virginia Key Beach Park (Park) located on the island of Virginia Key, Miami-Dade County, Florida (see Figure 1.1).

1.2 Purpose

At the Park, beach swimmer safety issues along the shoreline exist due to the severe tidal currents in the adjacent Bear Cut channel. As a result of the proximity of these high current speeds to the shoreline, beachgoers can be exposed to hazardous swimming conditions. Presently, swimming is not supported at the Park, and no lifeguards patrol the Park beach.

Recently, the Trust contracted the National Oceanic & Atmospheric Association (NOAA) to perform extended current measurements. The current measurements exhibited peak current speeds greater than 3.3 ft/sec (1.0 m/s) (NOAA, 2009). In order to further investigate the severity of the current impacts along the shoreline of the Park, Coastal Systems was retained to perform numerical modeling to simulate the current patterns along the shoreline utilizing a hydrodynamic numerical model.

The purpose of this report is to summarize the results and findings of the tidal current study, which includes numerical modeling of the tidal currents in Bear Cut and along the Virginia Key Beach shoreline.

1.3 Scope

The scope of work includes the following:

- **Coastal Data Collection:** This includes the review of available data pertinent to the Project, including nautical charts, aerial photographs, hydrographic data, and engineering reports. In addition, historical meteorological and oceanographic data including wind speed and direction, tides, and currents within the Project vicinity.

- **Coastal Site Visit:** A coastal engineer conducted a site visit and the coastal processes at the project site were evaluated visually.

- **Hydrodynamic Numerical Modeling:** This includes hydrodynamic numerical modeling utilizing the state-of-the-art MIKE21 Hydrodynamic (HD) Flexible Mesh (FM) model of ebb and flood tidal flow conditions within the Project vicinity. The model was calibrated against current measurements conducted by NOAA.

- **Hazardous Areas Mapping:** This includes the delineation of areas relating to the safety of beachgoers based on the results of the hydrodynamic numerical modeling. The defined areas were incorporated into a map figure.

- **Engineering Report:** The results and findings of the aforementioned engineering analyses will be presented and summarized herein.

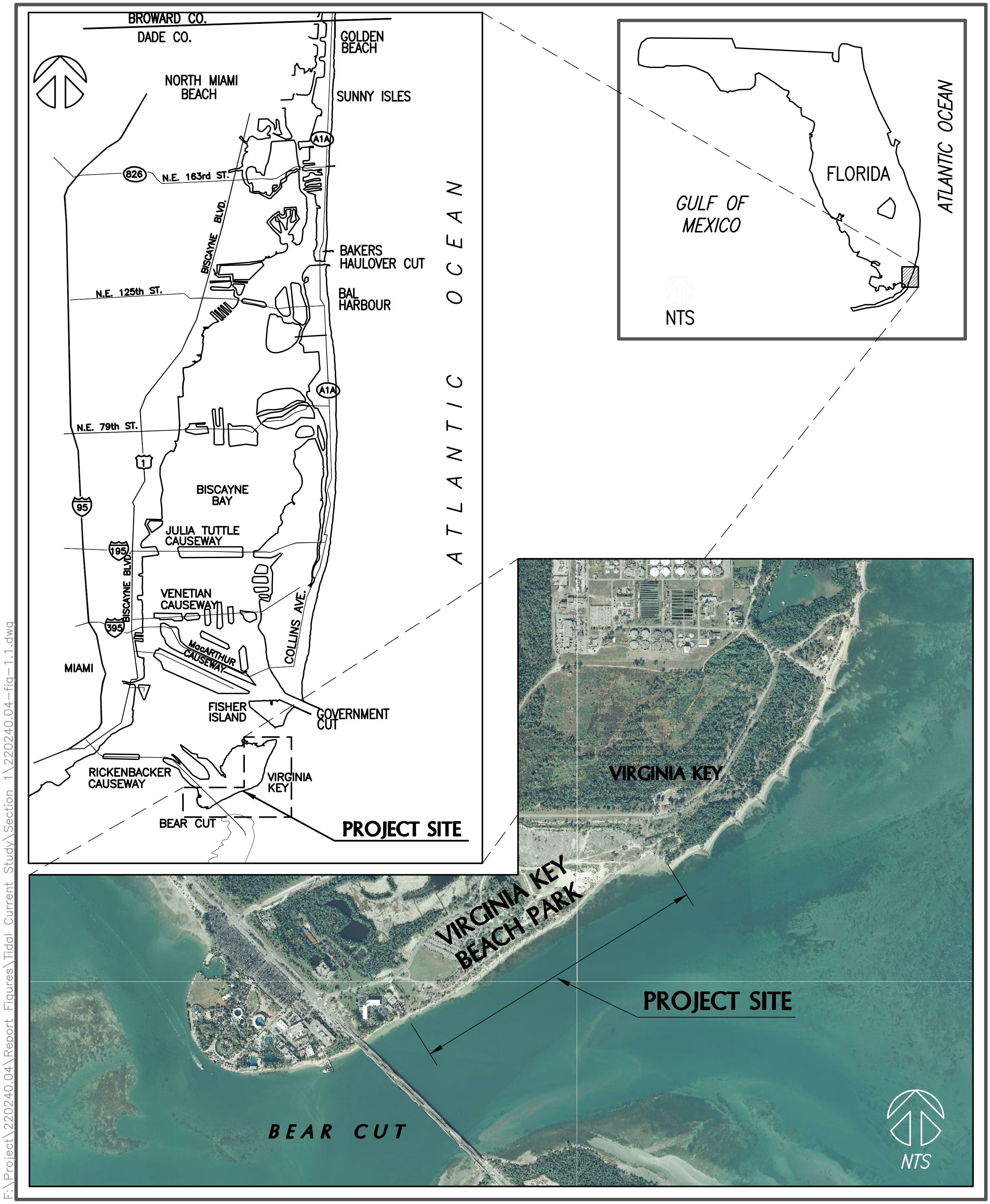

FIGURE 1.1

LOCATION MAP

VIRGINIA KEY BEACH – TIDAL CURRENT STUDY

2.0 SITE CONDITIONS

2.1 General

The Park is situated on the southeastern shoreline of Virginia Key, located in Miami-Dade County, Florida (refer to Figure 1.1). Virginia Key is an 82-acre barrier island, connected to the mainland via the Rickenbacker Causeway and Key Biscayne via Bear Cut Bridge. As illustrated in Figure 2.1, the sandy shoreline is stabilized with many coastal structures, including timber and rock groins.

2.2 Site Observations

A site visit was conducted by a coastal engineer on May 7th, 2009. During the site visit, the conditions were sunny and the local wind and wave climate were relatively calm. The wave conditions along the Park shoreline appear to be generally smaller than the offshore conditions, as a shallow area exists to the east, prior to the deeper water of the Atlantic Ocean. These shallow areas provide some protection to the shoreline under normal conditions.

As previously stated, the majority of the Project shoreline is stabilized with timber groins; however rock groins are utilized along the eastern portion of the Park shoreline (refer to Figure 2.2). The shoreline of the Park is orientated south-southeast and borders the channel separating Virginia Key and Key Biscayne, known as Bear Cut.

The bathymetry along the shoreline is unique. Parallel to the shoreline a shelf covered with, and possibly anchored by, seagrass exists. Beyond the “seagrass shelf”, the depth increases rapidly into the channel of Bear Cut. While onsite, the current speeds on the shallow seagrass shelf appeared to be generally manageable for beachgoers; however the current speeds in Bear Cut channel, immediately beyond the shelf, were likely hazardous to swimmers. The seagrass shelf is widest along the eastern section of the park shoreline, and becomes increasingly narrow along the western half of the Park shoreline (Refer to Figure 2.2).

Along the section of beach immediately west of the rock groins a channel was purposely cut to connect an interior lagoon system with the ocean water (Refer to Photos 3 - 5 in Appendix A and Figure 2.2). As a result, significant sedimentation was observed in the nearshore area resulting from the deposit of material transported out of the lagoons during tidal exchange (refer to Figure 2.2).

2.3 Tide

Tides in the Project vicinity are predominately semi-diurnal with an average extreme range of approximately 2.24 ft (0.68 m) and a period of approximately 12.4 hours. Tidal datum information, presented in Table 2.1, was obtained from the NOAA Center for Operational Oceanographic Products and Services (CO-OPS). An available station located near the Project site is Virginia Key, Biscayne Bay, Florida (Station ID 8723214).

Table 2.1

Tidal Variations at Virginia Key, Biscayne Bay, Florida

Mean Higher High Water (MHHW):	2.24 ft (0.68 m)
Mean High Water (MHW):	2.17 ft (0.66 m)
Mean Sea Level (MSL):	1.12 ft (0.34 m)
Mean Low Water (MLW):	0.12 ft (0.04 m)
Mean Lower Low Water (MLLW):	0.00 ft (0.00 m)

2.4 Wind

Wind data ranging from January 1, 2008 to December 31, 2008 was obtained from the NOAA National Bouy Data Center (NBDC) Station FWYF1 - Fowey Rocks, FL, which is located at Latitude 25° 35′ 25″ N, Longitude 80° 05′ 48″ W. The percentage occurrences for various directions and wind speeds are summarized in Figure 2.3 as a wind rose. A wind rose is a bar plot with angles showing the directions, bar length showing the percentage occurrences to scale, and varying colors showing the wind speeds. Typical for this part of Florida, winds blow predominantly from the east-northeast with some seasonal variation.

Although wind does not directly drive the currents in Bear Cut, it can have a significant impact on the water surface elevation through wind setup. During a strong east wind, water will tend to build up along the barrier islands of Biscayne Bay, increasing the head difference between the inside and outside of the Bay, thereby further driving flow through the barrier island channels including Bear Cut. Wind was therefore incorporated into the hydrodynamic numerical model.

2.5 Current

Due to the tidal characteristics of Biscayne Bay and the bathymetric features of the Bear Cut channel, the tidal current speeds in the Project vicinity can exceed 3.3 ft/sec (1.0 m/s). Recently, NOAA conducted a current study in the Bear Cut channel with the deployment of an Acoustic Doppler Current Profiler (ADCP) on the seabed at a depth of approximately 13.1 ft (4.0 m), located at Latitude: 25° 44.073′ N, Longitude: 80° 09.305′ W (see Figure 2.1) (NOAA, 2009). The ADCP recorded current velocities as well as the water surface elevation from December 6, 2007 until November 25, 2008. During this study the maximum recorded current velocity was approximately 3.6 ft/sec (1.1 m/s). According to the NOAA study, the measured current speeds were greater than 1.6 ft/sec (0.5 m/s) approximately 40% of the time. A plot of the measured current velocities for the duration of the ADCP deployment is exhibited in Figure 2.4.

FIGURE 2.1

VICINITY MAP

VIRGINIA KEY BEACH – TIDAL CURRENT STUDY

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FIGURE 2.2
LOCAL MAP
VIRGINIA KEY BEACH – TIDAL CURRENT STUDY

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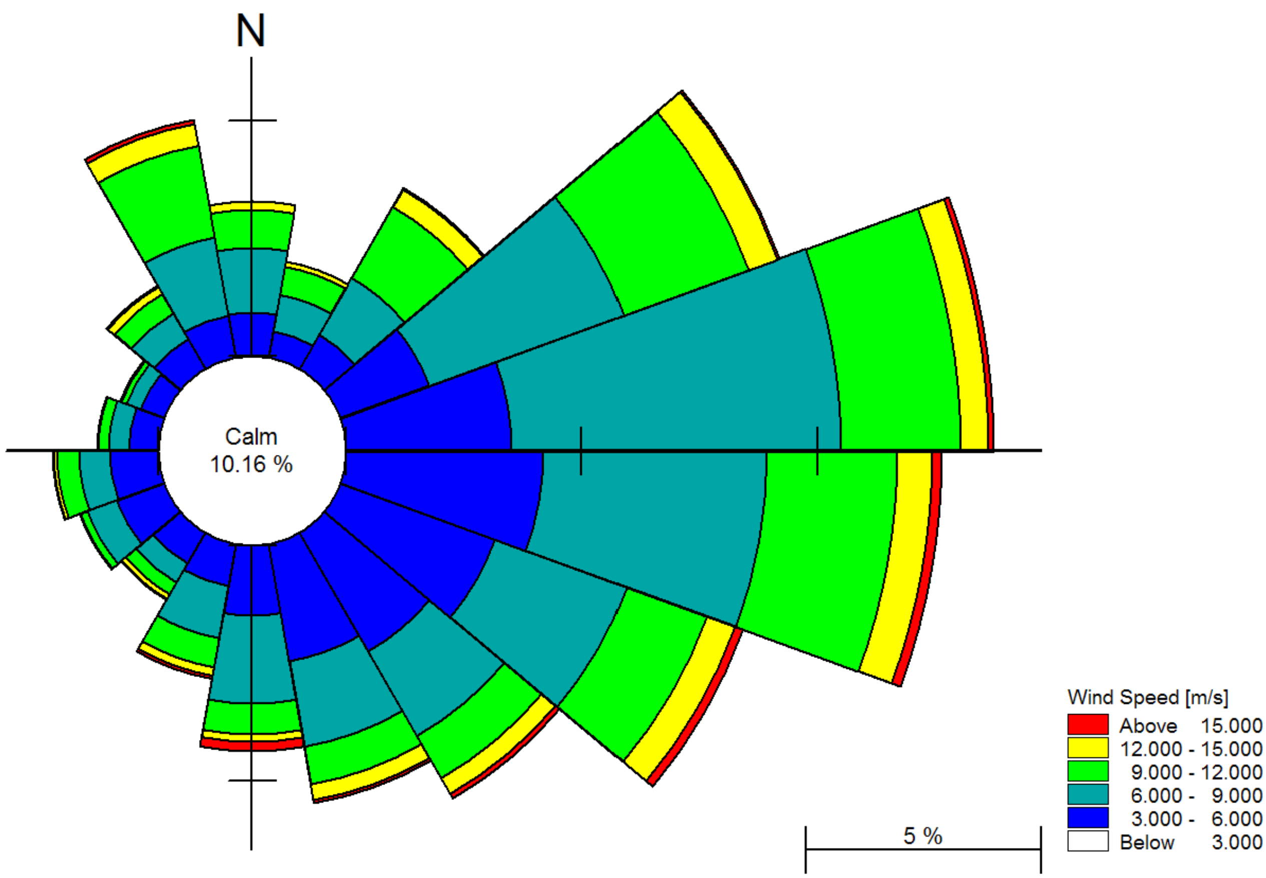

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FIGURE 2.3

ANNUAL WIND ROSE – 2008

VIRGINIA KEY BEACH – TIDAL CURRENT STUDY

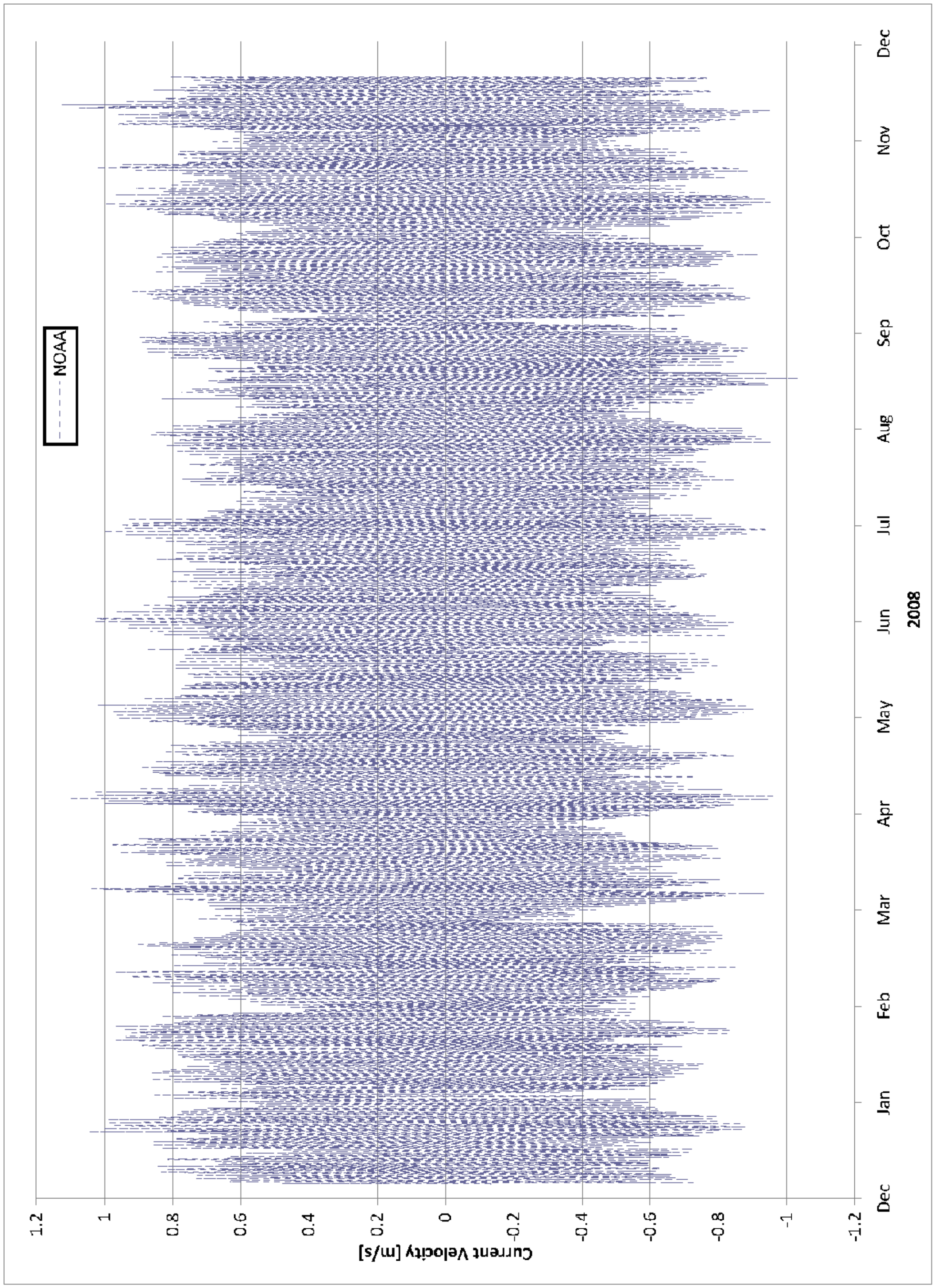

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FIGURE 2.4

NOAA CURRENT MEASUREMENTS

VIRGINIA KEY BEACH – TIDAL CURRENT STUDY

3.0 HYDRODYNAMIC NUMERICAL MODELING

3.1 General

A hydrodynamic analysis was performed to evaluate the tidal flow characteristics along the nearshore area of the Park. For this task, a hydrodynamic numerical model was established for the entire Biscayne Bay region. The numerical model utilized tide level predictions from a global tide model as boundary conditions. The flood and ebb propagation of the tidal wave into and out of Biscayne Bay, respectively, was simulated within the numerical model. The objective of the hydrodynamic analysis presented herein was to obtain the current speed variations along the shoreline of the Park.

3.2 Numerical Model

MIKE21 is a professional engineering software package developed by the Danish Hydraulic Institute (DHI) Group. The MIKE21 Hydrodynamic (HD) Flexible Mesh (FM) model simulates two-dimensional water level variations and flows in response to a variety of forcing functions in lakes, estuaries and coastal areas. In a typical MIKE21 HD FM model, the water levels and flows are resolved on a flexible triangular grid covering the area of interest when provided with the bathymetry, wind field, and hydrographic boundary conditions. The output of the numerical model includes the time series of water surface elevation, flux, current velocity, and directions at all specified grid points.

Other model parameters in the MIKE21 HD FM model include bed resistance and eddy viscosity. Bed resistance is the resistance of the seabed to the current and can be used for model calibration. In the simulations performed for this study, the bed resistance formulation implemented the Manning Equation, and eddy viscosity was used to model the turbulence encountered within the simulation. Specifically, the Smagorinsky formulation, which calculates the eddy viscosity as a time-varying function of the local velocity gradients multiplied by a constant value, was implemented.

3.3 Model Domain

A model domain covering the entire expanse of Biscayne Bay from Dumbfoundling Bay to Card Sound, and extending offshore to the deep water of the Atlantic Ocean was established. A domain of this size was utilized to properly capture the propagation of the tidal wave into Biscayne Bay through the various barrier island channels, including Bear Cut. The mesh utilized in the model domain is comprised of a finer resolution within the vicinity of the project site and a coarser resolution in the offshore regions. A finer resolution mesh was also utilized in the other distinct barrier channels including Bakers Haulover Inlet, Government Cut and Norris Cut. The digitized mesh bathymetry of the entire model domain and a zoom of the project vicinity are illustrated in Figure 3.1. In addition, Figure 3.2 exhibits the model domain bathymetry along the Project shoreline both with and without the model mesh.

The bathymetry for the model domain was digitized from the following nautical charts:

- NOAA Chart 11451
- NOAA Chart 11462
- NOAA Chart 11465
- NOAA Chart 11466
- NOAA Chart 11467
- NOAA Chart 11468

Additionally, hydrographic survey data was collected by Coastal Systems May, 2009, in the nearshore Project vicinity to support the area of refined mesh, and to map the edge of the observed seagrass shelf. Bathymetric survey transects were performed on approximately 50-foot intervals, perpendicular to the shoreline in order to densify the bathymetric data.

3.4 Model Boundary

Hydrodynamic boundaries were established along the north, east and south limits of the numerical model domain (refer to Figure 3.1). A land boundary was implemented along the western limit and along the islands within the model domain. A time series of water surface elevations, varying both in time and space, was utilized at the north, east, and south hydrodynamic boundaries. The water surface elevations were extracted from the DHI Global Tidal Model database. A time range was chosen, in which a peak current velocity within Bear Cut would reach above 3.3 ft/sec (1 m/s).

In addition to the tidal variations, the aforementioned time series of wind speed and direction obtained from the NDBC were utilized as input into the MIKE21 HD FM model. Wind setup is primarily dependent on the wind speed, wind direction, bathymetry within the Project vicinity, and the geometry of land/water boundaries. The evaluation of wind setup is complex, especially in cases with irregular bathymetry and geometry of land/water boundaries. However, the numerical model considers the land geometry and incorporates the wind effects through a friction factor, which relates the force of the wind to the elevation of the water surface.

3.5 Model Calibration

The purpose of model calibration is to "tune" the numerical model to simulate actual conditions. Current measurements provided by NOAA from the ADCP deployment were utilized to calibrate the numerical model. The primary intention of the calibration process is to ensure the numerical model simulates the peak current speeds (i.e. greater than 3.3 ft/sec (1.0 m/s) observed during the ADCP deployment. The dates chosen for the model calibration are from January 20th to 26th, 2008. These dates were chosen due to several consecutive occurrences of high peak current velocities. Specifically, a flood current velocity of approximately 3.3 ft/sec (1.0 m/s) was recorded on January 21st, and an ebb current velocity of approximately 2.7 ft/sec (0.8 m/s) was recorded on January 23rd.

The model simulation was performed with sufficient time prior to the calibration period in order to allow for stabilization of the numerical model. Several tidal cycles were completed before reaching the peak current velocities utilized for the calibration process.

The modeled current speeds were compared with the field measurements at the NOAA ADCP location (refer to Figure 2.1), and the results are displayed in Figure 3.3. As illustrated in Figure 3.3, the modeled and measured current speeds are in general agreement. Specifically, the peak measured current speeds are simulated by the numerical model. Therefore, the numerical model was successfully calibrated.

It should be noted that calibration of the model was based on data provided by NOAA from a single measurement location. Hence, correct values in the measurement location do not directly correlate to accurate results in other locations of the numerical model, in which differing local factors may dominate. Therefore, performance and accuracy of the numerical model in areas other than the exact measurement location may vary from what is naturally occurring.

3.6 Model Results

A graphical plot of the typical flow patterns during flood and ebb tide are illustrated in Figures 3.4 and 3.5, respectively. The vector arrows represent the direction and magnitude of current speed.

As anticipated from the field observations, the current is highest in the main channel of Bear Cut. Within the approximate limits of the Bear Cut channel the flow remains consistent, as observed during the NOAA measurements. Based on the modeling results, the tidal flow approaches the Park shoreline from the east, and the flow is then diverted to the southwest in the direction of the channel. This diversion of flow appears to induce acceleration in certain areas. The primary observation of the model results is the consistently high current speeds along the entire Park shoreline, and lack of calm areas suitable for swimming.

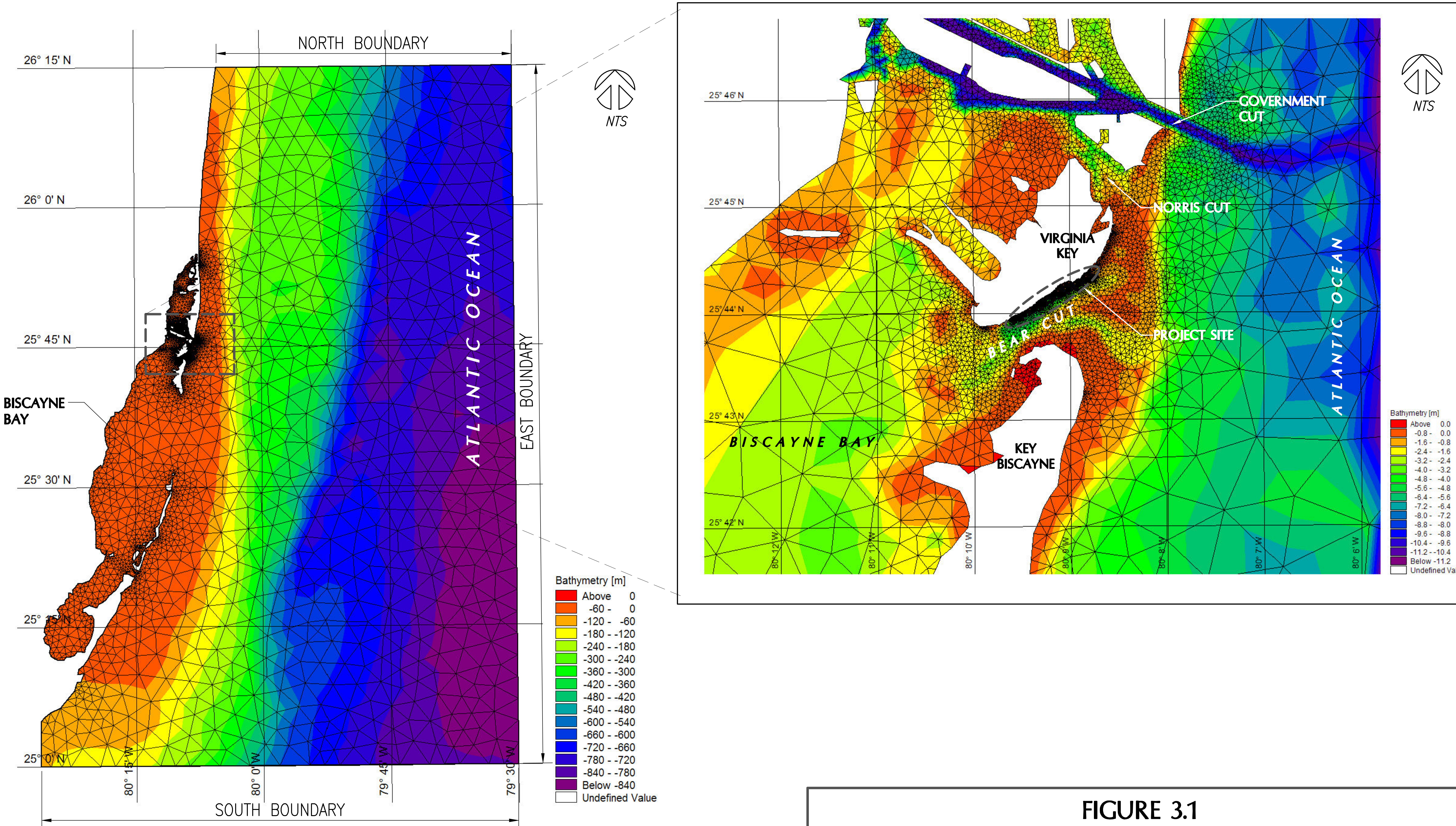

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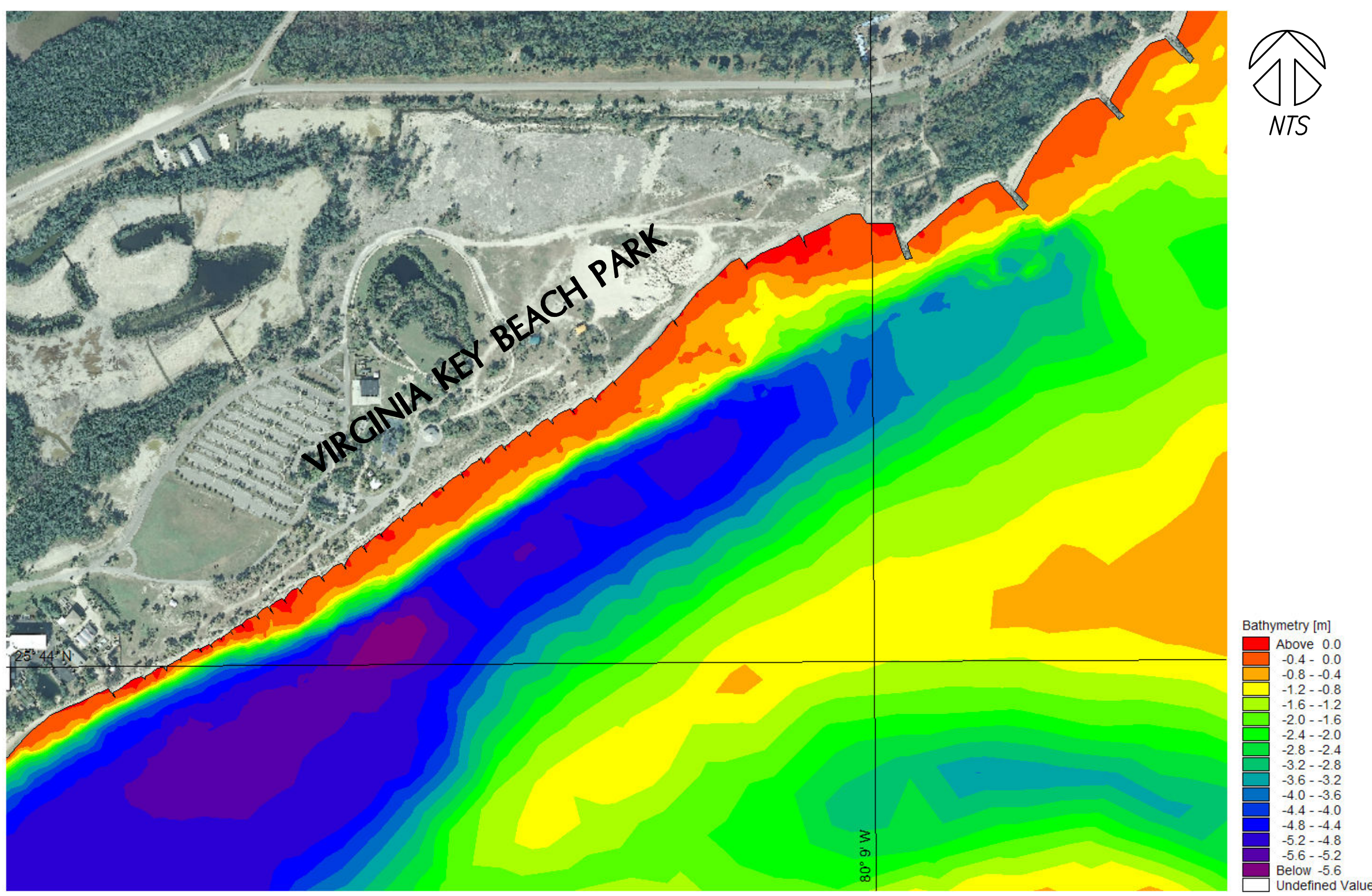
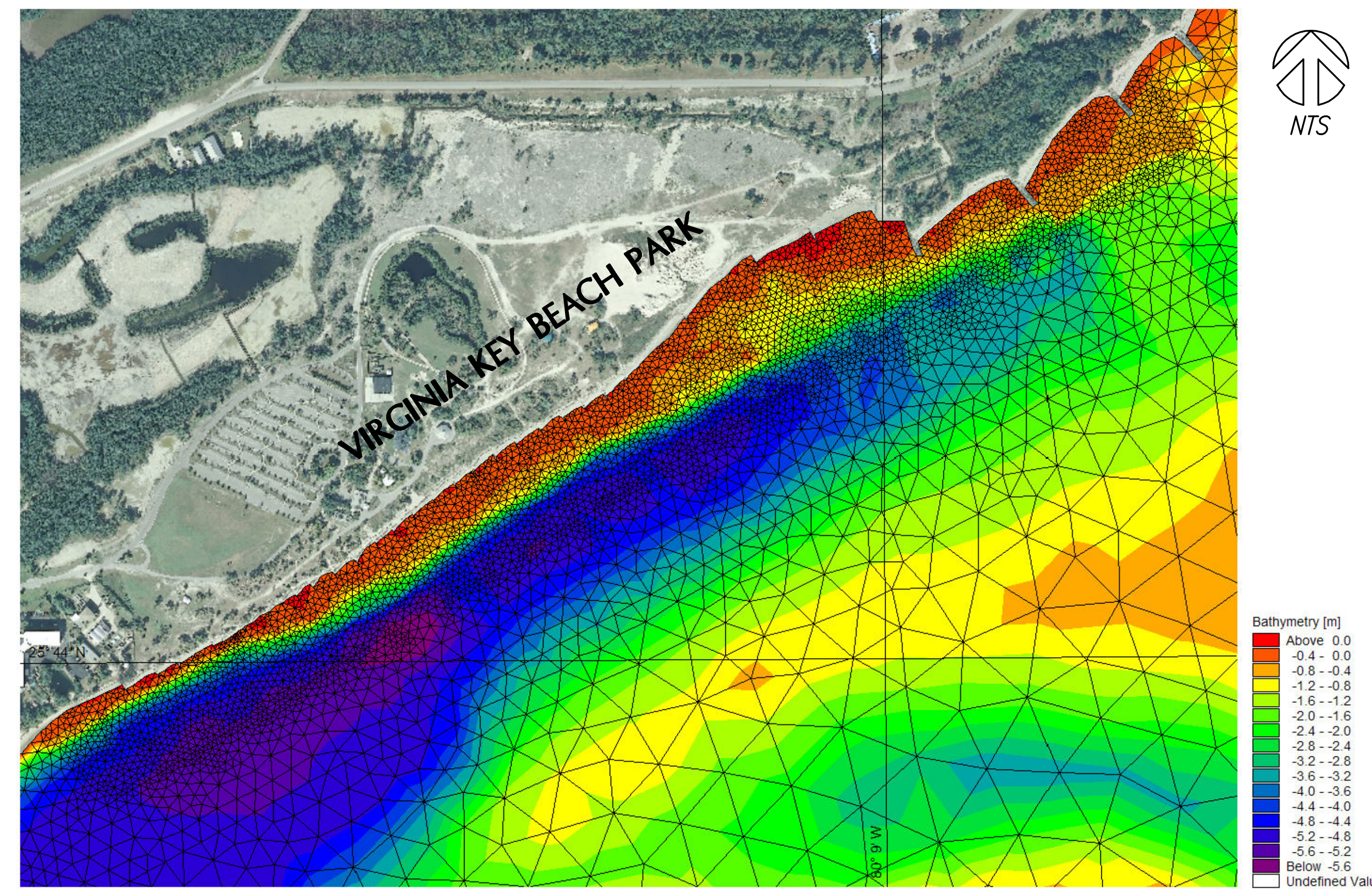
FIGURE 3.1

MODEL DOMAIN – DIGITIZED BATHYMETRY MESH

VIRGINIA KEY BEACH – TIDAL CURRENT STUDY



LOCAL BATHYMETRY



LOCAL MODEL MESH

FIGURE 3.2

MODEL DOMAIN – LOCAL

VIRGINIA KEY BEACH – TIDAL CURRENT STUDY

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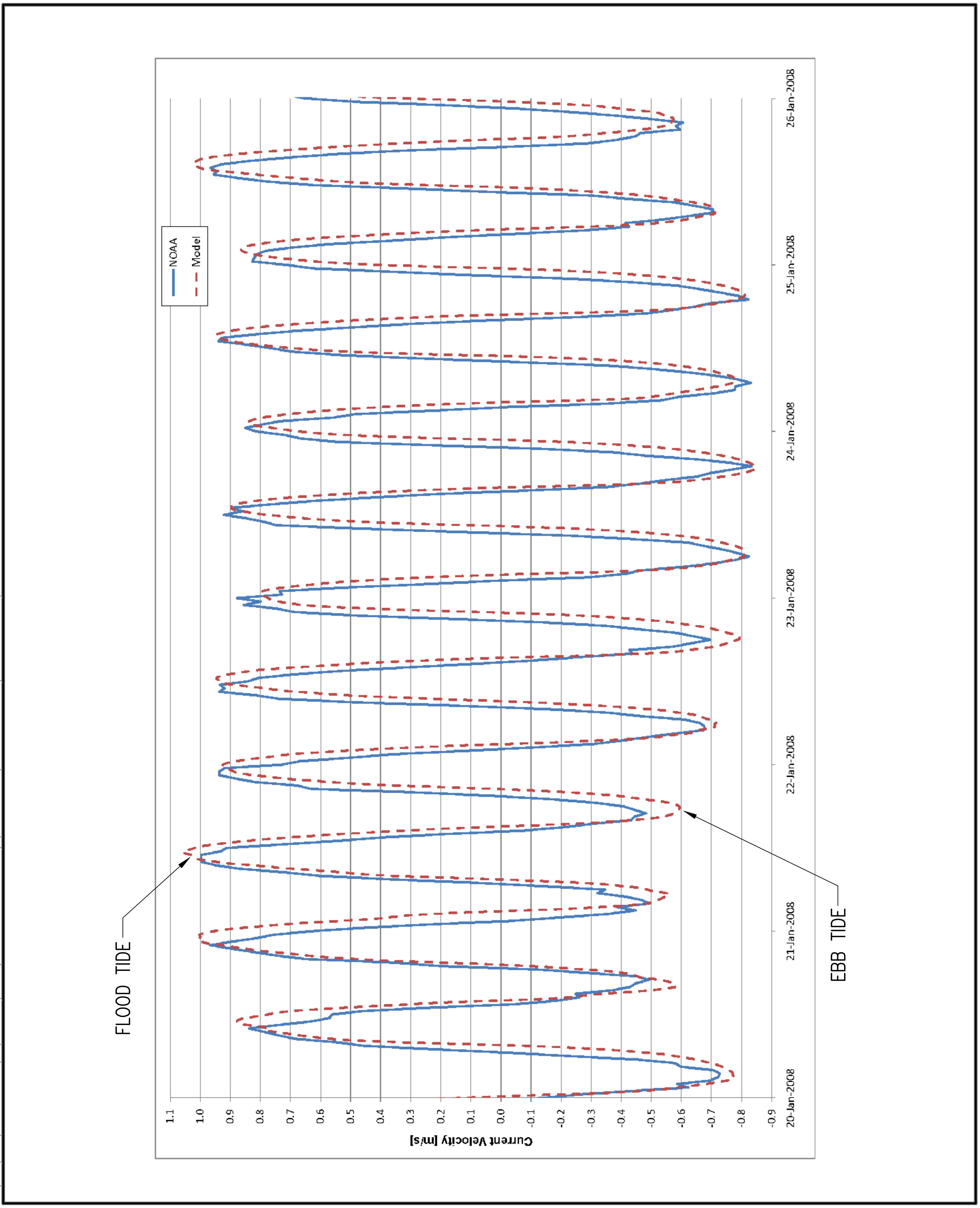

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FIGURE 3.3

CURRENT COMPARISON

VIRGINIA KEY BEACH – TIDAL CURRENT STUDY

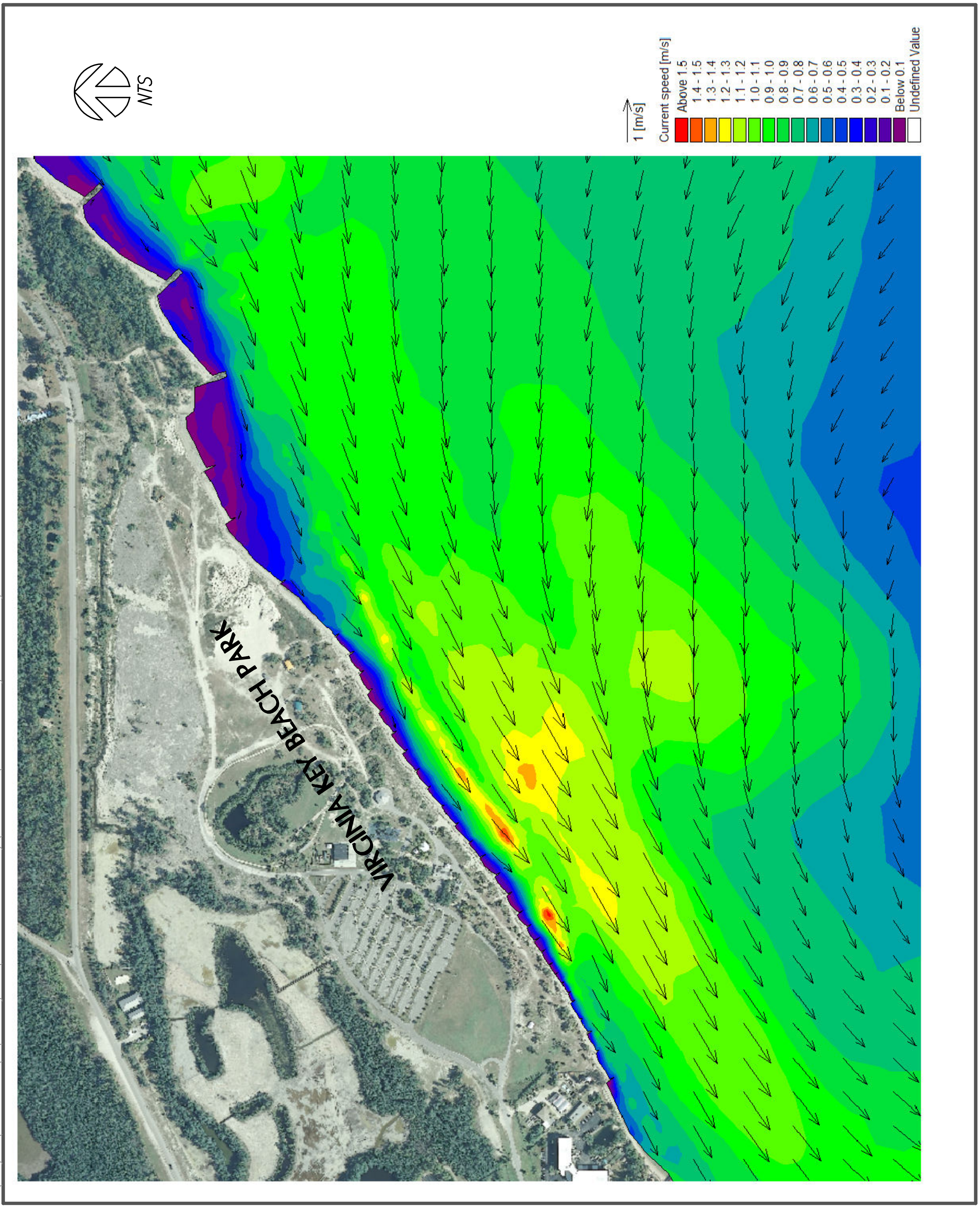

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FIGURE 3.4

CURRENT FLOW PATTERN – FLOOD TIDE

VIRGINIA KEY BEACH – TIDAL CURRENT STUDY

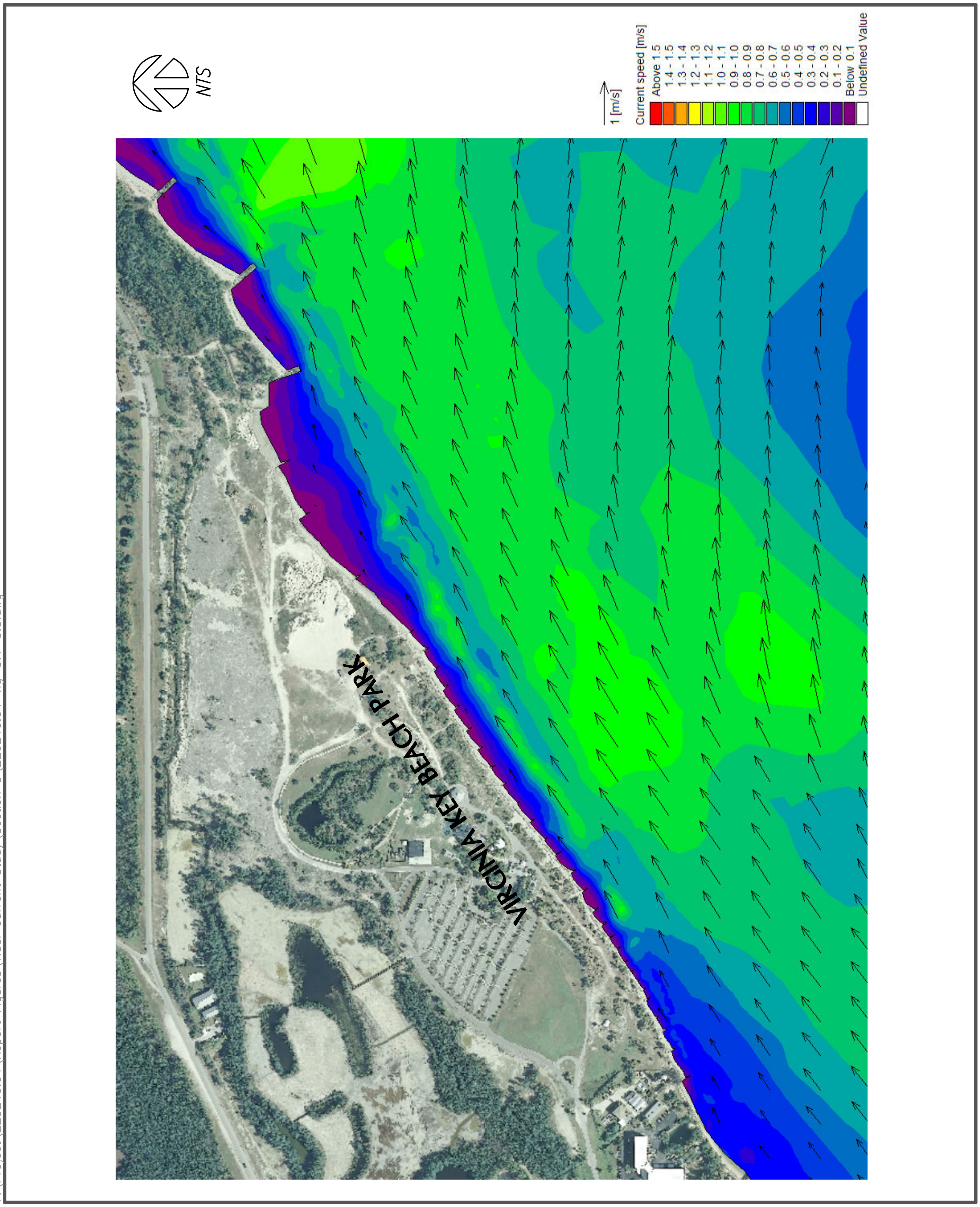

FIGURE 3.5

CURRENT FLOW PATTERN – EBB TIDE

VIRGINIA KEY BEACH – TIDAL CURRENT STUDY

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4.0 HAZARDOUS AREAS

4.1 General

As previously discussed the current speeds in Bear Cut reach hazardous levels and pose a threat to nearby beachgoers along the Park shoreline. To further complicate the situation; the nearshore Park bathymetry is unique, characterized with a seagrass shelf and sudden variations in water depth. These bathymetric changes result in current speed variations in both the longshore and crosshore directions. The inconsistency of current speeds increases the risk for swimmers to encounter high currents that are beyond their physical ability.

The hazard level of a nearshore swimming area can be defined as a function of current speed and water depth in relation to the height and physical condition of an individual. The nearshore bathymetric survey and the results of the hydrodynamic numerical modeling provided the foundation for assessing the severity of the present conditions at the Park. Wave activity is generally not a dominating factor along the Park shoreline during normal conditions.

4.2 Parameters

Current Speed

It is difficult to define a specific current speed, in which the forces exceed the safety of an individual. Olympic swimmers can reach speeds greater than 7.0 ft/sec (2.1 m/s) during a sprint; however, the average person's swimming capability is far less. The duration of the current speed is also a factor in addition to the magnitude of the current. An average swimmer with limited endurance can become fatigued quickly and correspondingly their swimming capability will decrease rapidly. The currents along the Park are directly related to the tidal variations in Biscayne Bay, and therefore the hazardous currents can last for hours.

Along the entire shoreline of the Park, the current speeds offshore the beach reach hazardous levels; however, the distance from the shoreline at which this occurs varies.

Along the western segment of shoreline, during peak flood flow conditions, the current speeds greater than 1.0 ft/sec (0.3 m/s) and 2.0 ft/sec (0.6 m/s) generally occur approximately 30 and 60 feet from the shoreline, respectively (Refer to Figures 4.1, 4.2 and 4.3). However, due to a local shoreline orientation change, the same current contours can occur more than 200 and 300 feet from the shoreline along the eastern segment of the Park (Refer to Figures 4.1, 4.3 and 4.4). Therefore, the eastern segment of shoreline along the Park provides greater potential for areas of safer swimming.

Water Depth

Water depth also plays a key role on the hazard level for beachgoers. Due to the local tidal variations and potential wind setup factor, the water depth can vary more than two feet (0.6 m) in a single day. As the water level reaches between the waist and chest of an individual, buoyancy becomes significant and their ability to secure a position decreases. However, the relationship between water depth and buoyancy for an individual depends on the individual's height. For example, a water depth of three feet for a 6-foot tall individual will result in considerably different buoyancy issues than a 4-foot tall individual.

Water depth is inconsistent throughout the seagrass shelf and therefore the hazardous areas generally require definition in relation to the height of the individual. Beyond the seagrass shelf in all areas of the park the water is generally hazardous for all individuals. The following section will describe the hazardous areas in further detail.

4.3 Hazardous Map

The above parameters and results from the numerical modeling provided the foundation for the following mapping. Figure 4.5 exhibits the hazardous swimming areas along the Park shoreline corresponding to the high current speeds simulated during a typical peak flood tide.

The nearshore water in Area 1, characterized with current speeds ranging from 1.0 ft/sec (0.3 m/s) to 3.0 ft/sec (0.9 m/s), is deemed hazardous for individuals in water depths approximately above the knee to waist level, depending on the physical condition of the individual. The nearshore water in Area 2, characterized with current speeds greater than 3.0 ft/sec (0.9 m/s), is deemed hazardous for all individuals and no swimming is recommended.

Current directions and magnitudes will vary over differing tidal cycles and ranges. The maps presented herein are representative of typical extreme flow conditions. Therefore, as the conditions may become better or worse, the hazardous areas will change accordingly. The above described areas are intended to provide a general understanding of how severe the current speeds can become along the shoreline and assist in the development of a safe operational program. In addition, the map of hazardous areas will illustrate the locations with the greatest potential for enhancement and increasing usable space.

FIGURE 4.1

TYPICAL CURRENT SPEED CONTOUR MAP – FLOOD TIDE – OVERVIEW
VIRGINIA KEY BEACH – TIDAL CURRENT STUDY

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CURRENT SPEED TABLE	
Meters per second (m/s)	Feet per second (ft/sec)
0.1	0.3
0.2	0.7
0.3	1.0
0.4	1.3
0.5	1.6
0.6	2.0
0.7	2.3
0.8	2.6
0.9	3.0
1.0	3.3

LEGEND

—0.4— CURRENT SPEED CONTOUR (0.4 m/s)

FIGURE 4.2

TYPICAL CURRENT SPEED CONTOUR MAP – FLOOD TIDE – ZONE 1

VIRGINIA KEY BEACH – TIDAL CURRENT STUDY

CURRENT SPEED TABLE	
Meters per second (m/s)	Feet per second (ft/sec)
0.1	0.3
0.2	0.7
0.3	1.0
0.4	1.3
0.5	1.6
0.6	2.0
0.7	2.3
0.8	2.6
0.9	3.0
1.0	3.3

LEGEND

—0.4— CURRENT SPEED CONTOUR (0.4 m/s)

FIGURE 4.3

TYPICAL CURRENT SPEED CONTOUR MAP – FLOOD TIDE – ZONE 2

VIRGINIA KEY BEACH – TIDAL CURRENT STUDY

CURRENT SPEED TABLE	
Meters per second (m/s)	Feet per second (ft/sec)
0.1	0.3
0.2	0.7
0.3	1.0
0.4	1.3
0.5	1.6
0.6	2.0
0.7	2.3
0.8	2.6
0.9	3.0
1.0	3.3

LEGEND

— 0.4 — CURRENT SPEED CONTOUR (0.4 m/s)

FIGURE 4.4

TYPICAL CURRENT SPEED CONTOUR MAP – FLOOD TIDE – ZONE 3

VIRGINIA KEY BEACH – TIDAL CURRENT STUDY

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FIGURE 4.5

HAZARDOUS SWIMMING AREAS

VIRGINIA KEY BEACH – TIDAL CURRENT STUDY

5.0 BEACH SAFETY

5.1 General

According to the National Center for Injury Prevention and Control, drowning is the third leading cause of accidental death in the United States. In some states, including Florida, drowning is the leading cause of injury death for persons under 15 years of age. In addition, numerous swimming related injuries are reported each year.

Although many drowning deaths occur in pools and other bodies of water; Table 5.1 presents the significant number of reported drowning deaths on beaches in the United States, as published by the United States Lifesaving Association.

Table 5.1

2004 – 2008 National Lifesaving Drowning Statistics

Category	2004	2005	2006	2007	2008
Drowning Deaths	122	83	100	109	102
Unguarded	103	71	89	89	84
Guarded	19	12	11	20	18

It is apparent that safety on beaches is a priority in the United States, specifically on unguarded beaches, such as the Park beach. Several methods to increase public awareness and reduce the number of drownings are being implemented throughout the U.S., including proper signage and education.

5.2 Public Awareness

In 2005, Section 380.276 of the Florida Statutes was amended to require that all public beaches displaying warning flags use only the flags developed for the State's warning program. The statute also supports the development and utilization of beach safety educational material. For reference, a copy of the statute is provided in Appendix B. Information regarding the state's flag program can be found at the following website:

http://www.dep.state.fl.us/cmp/programs/flags.htm

To compliment the flag program, signs for exhibiting the potential current hazards along the Park shoreline should be implemented. Figure 5.1 shows an example of a sign that is utilized in Florida to warn against the danger of rip currents. Although rip currents are not the primary concern along the Park beach, a similar sign could be developed to provide warning for the dangerous tidal currents in Bear Cut. The sign could potentially illustrate the importance of water depth in relation to the height of an individual.

A sample signage plan, based on the results of the hazardous area mapping (refer to Section 4.0) and the local bathymetry, is illustrated in Figure 5.2. The first sign would warn against hazards of swimming in depths greater than waist deep. The second row of signs would impose a recommended swimming limit, which beyond this limit swimming should not occur under any conditions. The distances from the approximate high water line to the first and second row of signs ranges from 15 feet and 60 feet, respectively, in the western segment of the Park shoreline. However, in the eastern segment of the Park shoreline the distance from the approximate mean high water line to the first and second row of signs can range rang up to 250 feet and 400 feet, respectively. This sample signage plan was prepared for discussion purposes and should not be applied directly. Prior to establishing a final signage plan, the proper spacing between signs as well as the lateral buffer zones between hazardous conditions and signage should be evaluated.

In addition to onsite precautionary measures, such as signage, off the beach education can be a useful tool to increase public awareness as well. Promotion of water safety education programs is essential to communicating the dangers of swimming in potentially high current areas, methods of accident avoidance, along with escape and rescue techniques.

The information presented in this section are general recommendations; the Park should prepare a complete operations program based on the results of the tidal current study and recommendations presented herein.

5.3 Beach Use Alternative

Although the majority of the Park beach is deemed hazardous for swimming based on the numerical modeling results, the eastern segment of the Park exhibits the potential for enhancement, as it is characterized with lower current speeds (refer to Figure 4.5). The segment of shoreline includes the beach immediately west of the first rock groin in the location of the new flushing channel and the beach stabilized between the first and second rock groins.

The beach located between the rock groins, in its present state, is usable; however, the shoreline immediately west of the first groin consists of clay and debris (refer to Photo 14 in Appendix A). In addition, the nearshore water depth in this area is extremely shallow, which is, at least partially, due to the sedimentation caused by the new flushing channel. Therefore, the latter mentioned area of beach is recommended for enhancement in order to increase usability and improve visitor experience.

Due to the potential for seagrass impacts, any seaward enhancement would likely be limited, and therefore landward expansion should be considered. Figure 5.3 illustrates a concept for landward expansion in the low current area. The flushing channel would be relocated along the existing rock groin, and stabilized with an additional rock groin along the western side of the channel. The shoreline would then be moved landward and the nearshore water deepened to create a pleasant swimming environment.

One drawback to enhancing and utilizing this area is the location relative to the existing upland infrastructure, including parking. Although, improved pedestrian corridors could be incorporated into the masterplan along with beach enhancement, in order to navigate people to the less hazardous beach areas.

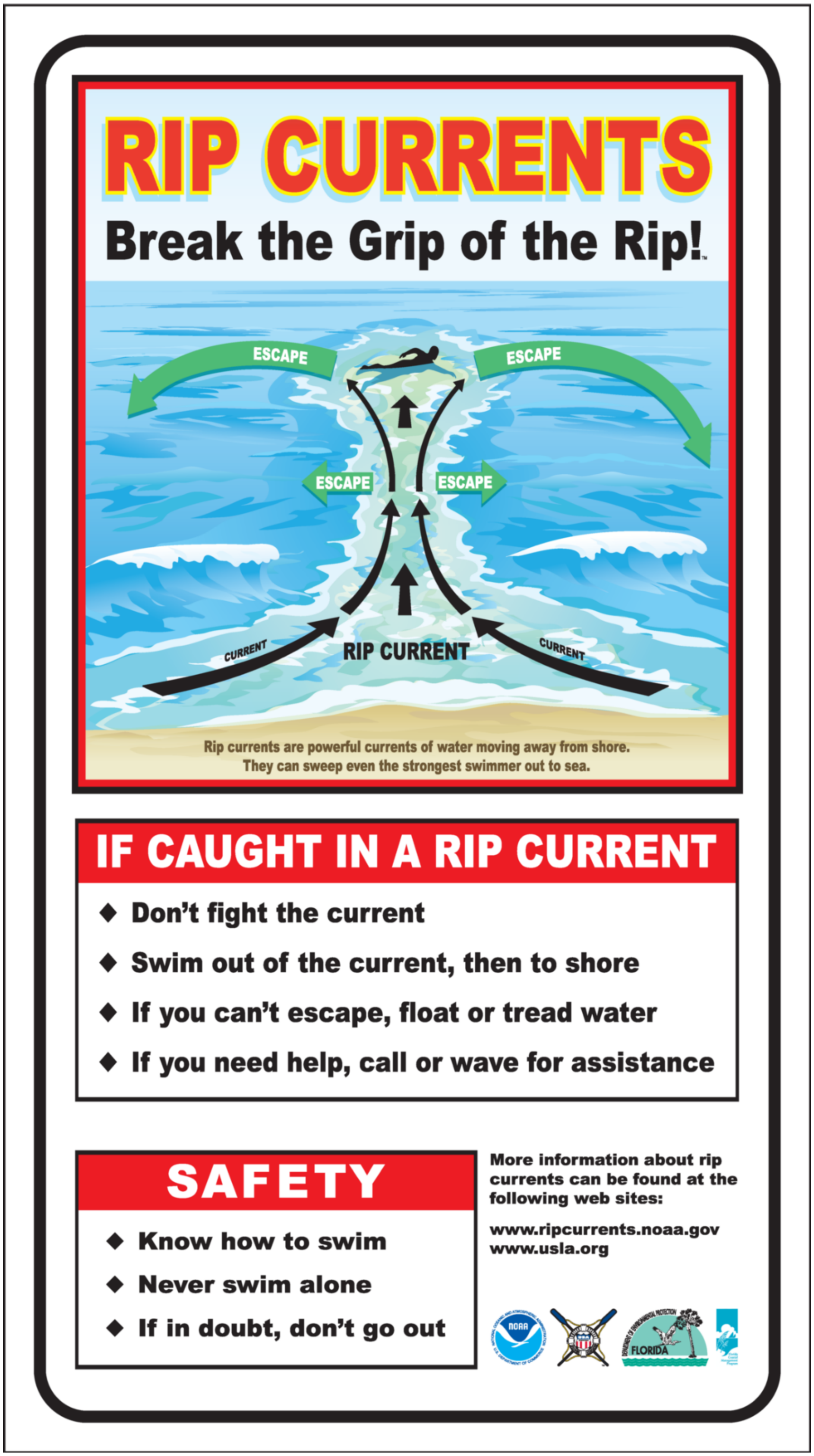

FIGURE 5.1

RIP CURRENT WARNING SIGN

VIRGINIA KEY BEACH – TIDAL CURRENT STUDY

FIGURE 5.2

SAMPLE SWIMMING SIGNAGE PLAN

VIRGINIA KEY BEACH – TIDAL CURRENT STUDY

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FIGURE 5.3

BEACH USE ALTERNATIVE

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6.0 CONCLUSIONS AND RECOMMENDATIONS

A tidal current study was conducted to evaluate the severity and proximity of high current speeds in the nearshore waters along the Park shoreline. Numerical modeling with a state-of-the-art hydrodynamic numerical model developed by DHI Group was utilized for the study. The domain of the numerical model covered not only Bear Cut, but the entire Biscayne Bay area in order to properly simulate the tidal hydrodynamics. Time varying water surface elevations and wind speeds were implemented as boundary conditions within the model. The results of the modeling were then utilized to map hazardous swimming areas characterized with high current speeds. Following the establishment of hazardous areas, recommendations to improve beach safety along with potential beach use alternatives were provided. Appendix C includes a compact disk, which contains a digital copy of this tidal current study and associated figures.

The numerical model was calibrated based on specific measurements obtained by NOAA. The beach and nearshore coastal areas are dynamic with fluctuating winds, waves and tides. The bathymetry and current measurements were obtained on specific dates, and only represent the conditions at that time. Therefore, the results of this study should only be interpreted as general characteristics for this specific time period.

The following conclusions were obtained based on the analysis results:

- Measured current speeds from December 6, 2007 until November 25, 2008 were greater than 1.6 ft/sec (0.5 m/s) approximately 40% of the time.
- Current speeds within the Bear Cut channel regularly exceed 3.3 ft/sec (1.0 m/s).
- Along the western segment of shoreline, during peak flood flow conditions, the current speeds greater than 1.0 ft/sec (0.3 m/s) and 2.0 ft/sec (0.6 m/s) generally occur approximately 30 and 60 feet from the shoreline, respectively.
- Along the eastern segment of shoreline, during peak flood flow conditions, the current speeds greater than 1.0 ft/sec (0.3 m/s) and 2.0 ft/sec (0.6 m/s) can occur more than 200 and 300 feet from the shoreline, respectively.

The following recommendations are provided:

Beach Swimming Safety

Swimming along the Park beaches is currently not permitted by Park Management. To allow swimming at the Park, a swimming safety program should be implemented that would include, but not be limited to, the following elements:

- Lifeguards
- Florida beach warning flag program
- Educational sign program
- Promotion of local water safety education programs

Swimming safety and management recommendations, as well as swimming management operations are beyond the scope of services for this tidal current study. Coastal Systems has no control over the management of the Park, and therefore assumes no liability for any swimming accidents that may occur at the Park. However, the report results can provide general guidance and assist Park Management with the development and management of a comprehensive swimming safety program at the Park. A consultant with experience in developing beach swimming safety programs should be retained to review the results of this study and to work with the Park to develop operations and management plan(s). The City of Miami or Miami-Dade County can also be consulted for additional assistance.

Improvements

- Concepts were presented to enhance the swimming areas characterized with low current speeds.
- Additional coastal engineering analyses are required to refine these design concepts, or to develop additional concepts for review by the Park.
- The environmental permit feasibility for these improvements needs to be evaluated, along with potential sources of funding.
- The report results should be coordinated with the consultant that is designing and permitting the vessel exclusion buoys.

This tidal study report was prepared for the exclusive use of the Trust in accordance with generally accepted coastal engineering practice. Coastal Systems is available to meet with the Trust to present the report recommendations, and we look forward to the opportunity to further evaluate the recommended beach enhancement projects. If we can be of assistance, please contact us.

Respectfully submitted,

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	FL Reg. 55910

7.0 REFERENCES

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Appendix A

Photo 1: Rock groin, typ.

Photo 2: Southwest view along shoreline between rock groins.

Photo 3: Flushing channel - view 1.

Photo 4: Flushing channel - view 2.

Photo 5: Flushing channel - view 3.

Photo 6: Southwest view along shoreline, in area of flushing channel.

Photo 7: Northeast view along shoreline, in area of flushing channel.

Photo 8: Northeast view across area of sedimentation.

Photo 9: Southwest view across area of sedimentation.

Photo 10: Northeast view along eastern segment of timber groin field.

Photo 11: Timber groin, typ.

Photo 12: Southwest view along eastern segment of timber groin field.

Photo 13: Northeast view along middle segment of timber groin field.

Photo 14: Southwest view along middle segment of timber groin field.

Photo 15: Northeast view along western segment of timber groin field.

Photo 16: Southwest view along western segment of timber groin field.

Appendix B

Florida Statute 380.276

Beaches and coastal areas; display of uniform warning and safety flags at public beaches; placement of uniform notification signs; beach safety education.

(1) It is the intent of the Legislature that a cooperative effort among state agencies and local governments be undertaken to plan for and assist in the display of uniform warning and safety flags, and the placement of uniform notification signs that provide the meaning of such warning and safety flags, at public beaches along the coast of the state. Because the varying natural conditions of Florida's public beaches and coastal areas pose significant risks to the safety of tourists and the general public, it is important to inform the public of the need to exercise caution.

(2) The Department of Environmental Protection, through the Florida Coastal Management Program, shall direct and coordinate the uniform warning and safety flag program. The purpose of the program shall be to encourage the display of uniform warning and safety flags at public beaches along the coast of the state and to encourage the placement of uniform notification signs that provide the meaning of such flags. Only warning and safety flags developed by the department shall be displayed. Participation in the program shall be open to any government having jurisdiction over a public beach along the coast, whether or not the beach has lifeguards.

(3) The Department of Environmental Protection shall develop a program for the display of uniform warning and safety flags at public beaches along the coast of the state and for the placement of uniform notification signs that provide the meaning of the flags displayed. Such a program shall provide:

(a) For posted notification of the meaning of each of the warning and safety flags at all designated public access points.

(b) That uniform notification signs be posted in a conspicuous location and be clearly legible.

(c) A standard size, shape, color, and definition for each warning and safety flag.

(4) The Department of Environmental Protection is authorized, within the limits of appropriations or grants available to it for such purposes, to establish and operate a program to encourage the display of uniform warning and safety flags at public beaches along the coast of the state and to encourage the placement of uniform notification signs that provide the meaning of the flags displayed. The department shall coordinate the implementation of the uniform warning and safety flag program with local governing bodies and the Florida Beach Patrol Chiefs Association.

(5) The Department of Environmental Protection may adopt rules pursuant to ss. 120.536(1) and 120.54 necessary to administer this section.

(6) Due to the inherent danger of constantly changing surf and other naturally occurring conditions along Florida's coast, the state, state agencies, local and regional government entities or authorities, and their individual employees and agents, shall not be held liable for any injury or loss of life caused by changing surf and other naturally occurring conditions

along coastal areas, whether or not uniform warning and safety flags or notification signs developed by the department are displayed or posted.

(7) The Department of Environmental Protection, through the Florida Coastal Management Program, may also develop and make available to the public other educational information and materials related to beach safety.