Southeast Coast Network

National Park Service
Inventory and Monitoring Division

Standard Operating Procedure 1.3.21

Survey Timing and GPS Mission Planning for Coastal Shoreline Monitoring—Version 2.0

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Summary

This standard operating procedure (SOP) details the planning required for coastal shoreline monitoring. Prior to mapping the shoreline, a number of tasks need to be conducted. The topics covered in this SOP include creating a survey window, identifying neap tides, determining satellite availability, checking for storm events, identifying potential resource issues, and points of contact. This SOP is based on the *Northeast Coastal and Barrier Network Geomorphological Monitoring Protocol part I—Ocean Shoreline Position* (Psuty et al. 2010).

Revision Log:

Revision Date	Author	Changes Made	Reason for Change	New Version #
20 May 2020	Lisa Cowart Baron	Updated information related to shoreline data collected within 7 days of a storm tide. Added ocean front tide gauges for CAHA and CALO planning. updated example SECN park contact list	This information was based on discussion with Psuty et al. regarding storm impacts and frequency during the limited neap tide windows used for planning. Updated NC tide gauges because closer tide gauges previously used were not representative of the beach conditions (previous tide gauges were not located on the ocean front). Updated example park contact list so it is more current.	2.0

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Objective

The objective of this SOP is to outline the tasks which must be completed prior to collecting shoreline monitoring data. Because the objective of this effort is to monitor shoreline position change on a long-term time scale, it is important to collect similarly derived shoreline data each year. Winter beaches are bombarded by high-energy storm waves—that result in narrower beaches—whereas milder summer wave activity builds the beach and creates a wider beach profile. In order to maintain consistency in shoreline mapping, this SOP outlines how to pre-determine the optimal shoreline mapping windows for the spring and fall sample periods, how to identify neap tides in the predicted tidal data, and how to utilize satellite availability and geometric configuration (position dilution of precision, or PDOP) in planning for shoreline mapping field work. Once the pre-defined shoreline mapping windows have been defined, this SOP explains filtering out periods influenced by storm events. Additionally, this SOP discusses local resource-related variables that can influence how the survey is conducted, such as threatened and endangered species or restricted areas.

Defining the Survey Window

Shoreline data collection is conducted primarily in the spring. Fall shoreline data collection will be conducted when resources are available and weather permits. The shoreline mapping window is March through April for spring shoreline mapping and mid-September through mid-November for fall shoreline mapping. Ideally, shoreline monitoring would take place in mid-March; however, due to logistical constraints and the number of parks where shoreline monitoring occurs, the shoreline monitoring is generally performed during two or more field work trips. The mapping window has been extended to eight weeks to account for weather cancellations of the March field work trips.

The shoreline mapping window is determined by the predicted and observed tides in the mapping area. The predicted and observed tidal data are analyzed to ensure comparable shoreline data collection. The predicted tidal information is available for the entire year, whereas the observed data are available up to the current date and should be accessed immediately prior to the shoreline mapping window.

The initial task is selecting the temporal window for conducting the shoreline survey. Over the course of a year, the width of sandy beaches changes due to wave energy, sediment supply, and water level. These are called seasonal oscillations and result in the beach narrowing and widening. The spring and fall have been identified as the narrowest and widest times of the year for beaches because they follow a time of high erosion due to storm events (winter) and low erosion (summer).

Identifying Neap Tides

The SECN parks have semidiurnal tides; there are two high tides and two low tides each day. Each month there are two periods when the difference between high and low tide (the tidal range) is at a maximum, **spring tide**, and when it is at a minimum, **neap tide** (Figure1). Times of elevated water levels relative to spring tide have the potential to have wave-generated run-up (swash) overtop the berm crest and spill onto the berm surface. Times of reduced tidal range, such as neap tide, minimize the water level variations within the monthly tidal cycle and thus minimize variations in the swashline position. Therefore, the neap high-tide swashline provides an optimal reference line because it will form on the beach face and will represent similar shoreline positions (SOP#5 – Figure S5.1; Psuty et al., 2010). Consequently, the optimum opportunity for shoreline collection in the eight-week period (March through April and mid-September through mid-November) is any day within two to four days of a neap tide, when the high-tide level is at a minimum, occurring on the order of 12–16 days per month. Running the survey during the neap-tide high-tide levels will establish the comparability of the swashline location between surveys. Predicted tide data contains the water levels through the tidal cycles, provides a means to evaluate the range of high-tide values associated with neap tides and offers a basis for establishing comparability within a neap-tide period and between neap-tide periods. At times, the neap-tide signal is poorly developed and the high-tide elevation is modified. In these cases of modified water levels, the tide table is a good source to evaluate the neap-tide high-tide elevations for comparability and applicability for conducting the survey (to be within 1 foot [0.3 meters or m]) of the lowest neap-tide high tide in the survey period). Figure 1 illustrates a plot of the tidal predictions from a tide gage.

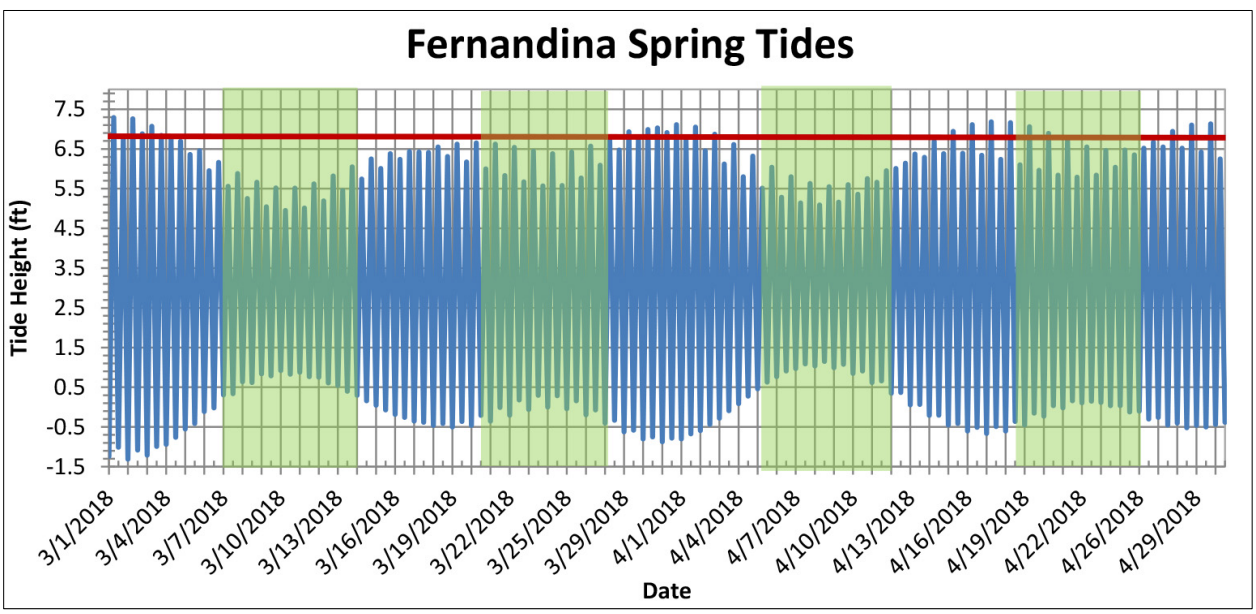

Figure 1. Plot of predicted tidal data for the Fernandina tidal gage (Station ID: 8720030). The highest spring tide for the data range is 01 March 2018. The red line denotes the threshold that is determined by the high tide height (approximately 6.75 feet [2.06 meters]) three days on either side of the peak spring tide. Tides above the red line are not surveyed. The green shaded boxes denote three days on either side of the neap-tide high-tide, which are the ideal survey windows.

Spring tides have the largest tidal variation and are shown in Figure 1 on 01 March 2018, 19 March 2018, 31 March 2018, and 17 April 2018. Periods of neap tide occurred on 10 March 2018, 24 March 2018, 08 April 2018, and 22 April 2018. The neap-tide high-tide windows, identified in Figure 1 by the green shaded boxes, are the ideal survey windows. A survey may be conducted when the high tide is within the three-day pre or post neap-tide high-tide and within 1 foot (0.3 m) of the neap-tide high-tide of the survey period (below the red line). Due to the minimal variation in shoreline position neap tides provide, they are ideal for shoreline mapping. However, due to daylight and weather constraints data collection within the three to four day neap-tide window may not be feasible. If data collection within the three- or four-day neap tide window is not possible, shoreline mapping data collection can occur after a high tide at another time that is within 1 foot (0.3 m) of the neap-tide high tide of the survey window (below the red line).

To determine the predicted tides for the shoreline mapping survey window, download the predicted tides of the closest tidal gage for each park, following the instructions below.

Go to the predicted tide calculations available at the following National Oceanic and Atmospheric Administration's (NOAA) website.

1. Select Products → NOAA Tide Predictions
2. Select the station according to its Station ID (Table 1):

Table 1. List of predicted tide gages used to determine the shoreline mapping survey windows for the SECN park units.

Park	Station Name	Station ID
Canaveral National Seashore (CANA)	Trident Pier, Florida	8721604
Fort Matanzas National Monument (FOMA)	Mayport (Bar Pilots Dock), Florida	8720218
Timucuan Ecological and Historic Preserve (TIMU)	Mayport (Bar Pilots Dock), Florida	8720218
Cumberland Island National Seashore (CUIS)	Fernandina Beach, Florida	8720030
Cape Lookout National Seashore (CALO)	Wilmington, North Carolina	8658163
Cape Hatteras National Seashore (CAHA)	Duck, North Carolina	8651370

3. On the right side of the window there are three buttons to download the predicted tides in three different formats:
    a. Annual PDF
    b. Annual TXT
    c. Annual XML
4. Click Annual TXT to download the annual predicted tides for the given location for local standard time.

5. The TXT file can be opened in Excel.

Within each of the eight-week survey windows designated for the spring and fall surveys, there will be many available survey days around the dates of neap tide water levels. The selected survey day should be the earliest convenient day in the window to allow for rescheduling if necessary.

Optimizing Satellite Availability

The availability of satellites for the proposed surveying window needs to be determined before heading out to collect the shoreline survey data. The GPS data collected during the shoreline survey are derived from the time signals sent from satellites. Each surveyed position requires a minimum of four satellites (Trimble 2007). More satellites will improve accuracy; however, it is both the satellite geometry and the number of available satellites that determines the accuracy of the data collected. Dilution of Precision (DOP) position is a unitless value that describes the accuracy of the derived position based on satellite count and geometry. Dilution of precision Position may vary during a survey and thus needs to be considered in the date and time selection of the survey window. A DOP position between zero and six is necessary to collect accurate and precise shoreline positions. Dilution of Precision position is a predictable value that can be plotted for the planned survey day. A DOP position plot can be created via Trimble Planning software (Figure 2).

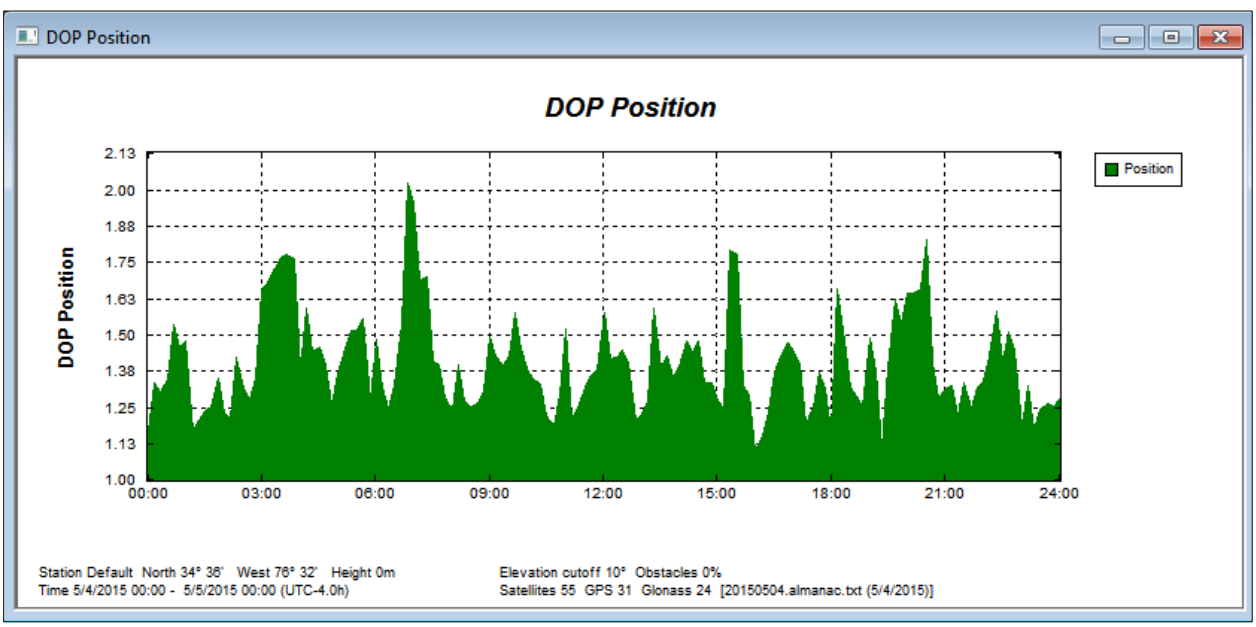

Figure 2. Plot of DOP position for Cape Lookout National Seashore starting on 4 May 2015. The plot was created using the steps below.

To obtain a prediction of DOP position using Trimble Planning:

1. Download and install the GNSS Planning Tool from the Trimble website:

2. Download the most recent almanac from the Trimble website support page] by clicking "GPS/GLONASS almanac in Trimble Planning file format."

    a. A tab will open with the text data.

    b. Open a text editor, such as notepad.

    c. Copy and paste the almanac data into notepad.

    d. Save the notepad file in the folder C:\Program Files\Common Files\Trimble\Almanacs.

    e. Name the file "YYYYMMDD.Almanac.txt". For example, "20150504.Almanac.txt."

3. Open the Trimble Planning Software.

    a. Click File → Station.

    b. The Station Editor window will appear (Figure 3).

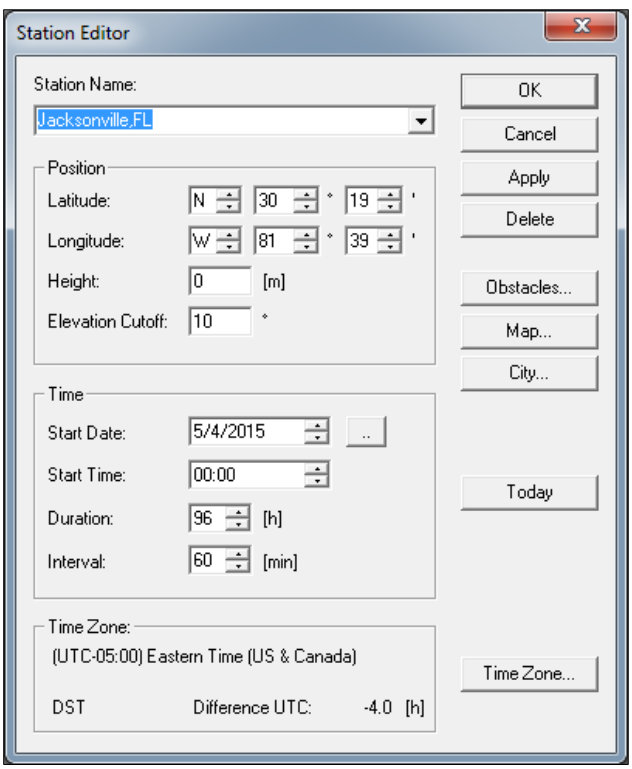

Figure 3. Screenshot of Station Editor window.

    i. Select the date corresponding with the first day in the survey window.

    ii. Select the location of the city nearest the survey site or enter coordinates within the park.

1. CANA—Cape Canaveral, Florida.
2. FOMA—Daytona Beach, Florida.
3. TIMU—Jacksonville, Florida.
4. CUIS—30° 49’ N, 81° 27’ W.
5. CALO—34° 36' N, 76° 32’ W.
6. CAHA—35° 18’ N, 75° 30’ W.

iii. Choose Time Zone → Eastern Standard USA.

iv. Click ‘OK.’

c. Load the almanac by selecting Almanac → Load (Figure 4).

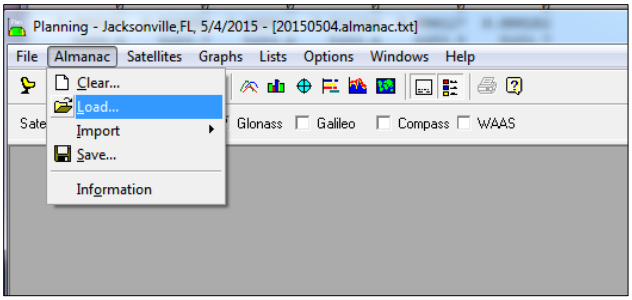

Figure 4. ‘Planning Tool’ window showing how to load an almanac.

i. A window will appear asking if you want to change the almanac (Figure 5). Click ‘Yes.’

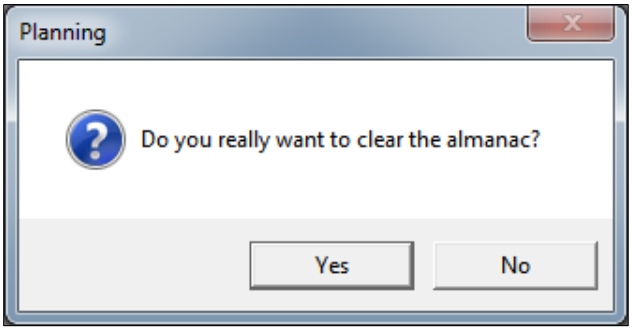

Figure 5. Screenshot of the ‘Planning’ information window.

ii. Navigate to the location where the almanac was saved. You may need to change the file type to “all files.” (Figure 6)

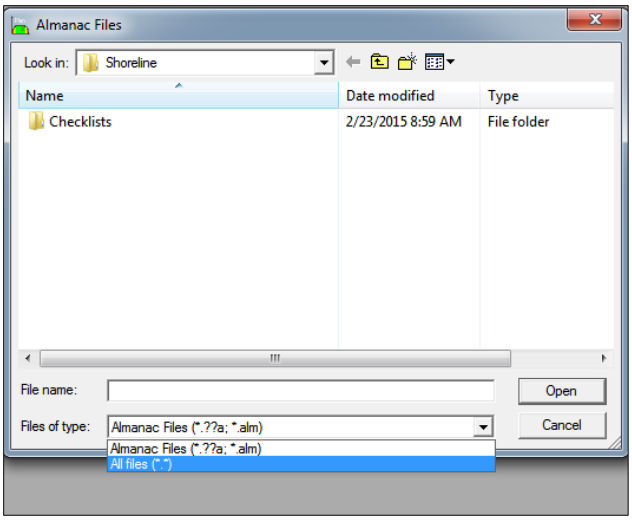

Figure 6. Screenshot of 'Almanac Files' window where the type of file displayed is being changed.

iii. Select the almanac .txt file previously saved (Figure 7).

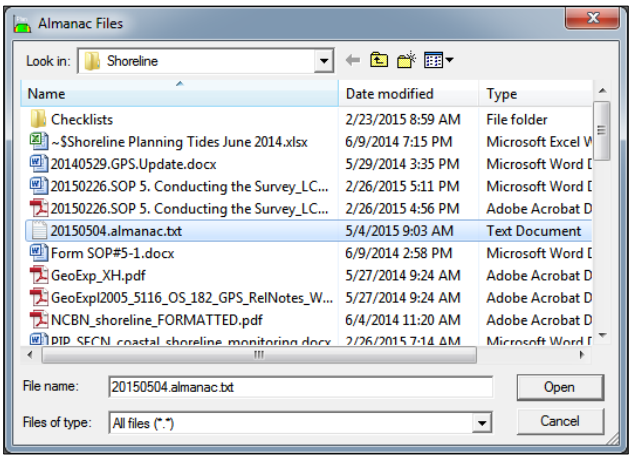

Figure 7. Screenshot of 'Almanac Files' window showing all files in the folder.

iv. Click 'Open.'

v. A confirmation window will appear informing how many satellites were imported (Figure 8). Click 'OK.'

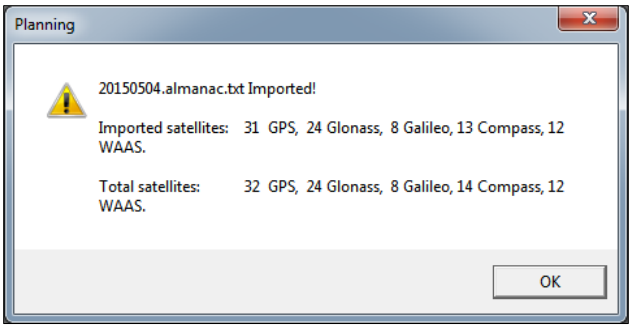

Figure 8. Screenshot of the 'Planning' information window displaying the almanac file imported.

d. Plot the DOP by choosing Graphs → DOP → DOP - Position.

i. A DOP position window will open displaying the DOP over the selected time period (Figure 9).

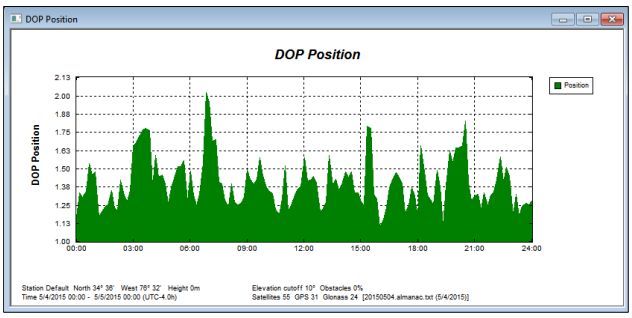

Figure 9. Screenshot of the 'DOP Position' window displaying the DOP.

ii. Verify that PDOP is between zero and six for at least the majority of the survey day. If the PDOP frequently exceeds six, the survey will need to be rescheduled for the next day when the PDOP is below six.

4. Repeat steps above as needed until an adequate survey window is found.

Evaluation of a Storm Event within the Survey Window

The purpose of the shoreline monitoring protocol is to collect data denoting long-term changes. Therefore, data influenced by recent storm events would skew the shoreline change by introducing short-term changes. A storm event is defined as an event that produces a tide level greater than 1 foot (0.3 m) above the predicted high tide (Figure 10). Storm surge, generated by a storm event, can create wave run-up and displace the position of the high tide swash line. It generally takes up to a week for a beach to recover from storm surge. Therefore, shoreline surveys should not be conducted if a storm event has occurred one week prior to the survey date.

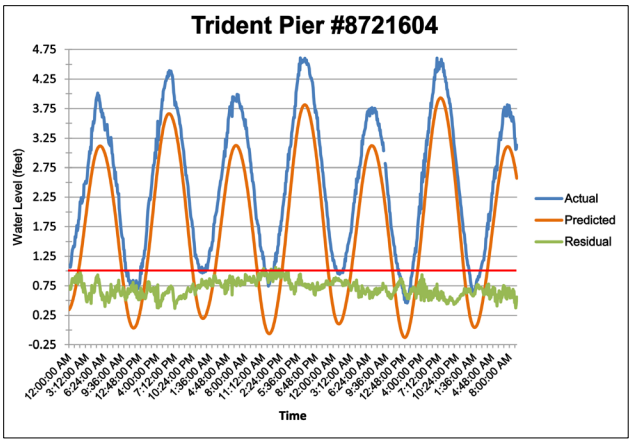

Figure 10. Plot of predicted, actual, and residual water levels for Trident Pier tide gage from 1–4 May 2015. The residual value is calculated from the actual minus the predicted. The red line represents one foot residual value. Where the residuals are greater than the red line at high tide, storm surge is influencing the high tide swash line, and therefore surveying needs to be postponed. In this plot the residuals are not exceeding one foot during high tide.

Storm surge is determined by calculating the residual water level from the actual and predicted tides of a NOAA tide gauge closest to each shoreline survey location. The residual (difference between the actual and predicted tides) represents the change in elevation of the water due to local conditions, referred to as storm surge. To determine if a storm event is influencing the water levels for an upcoming shoreline survey, follow the steps below.

Beginning seven days prior to the planned survey day:

1. Access the NOAA tide gages through the CO-OPS website.
2. Select the tide station corresponding to the park unit (See Table 1).
3. A plot of the predicted (blue line) and actual (red line) water level data will appear (Figure 11):

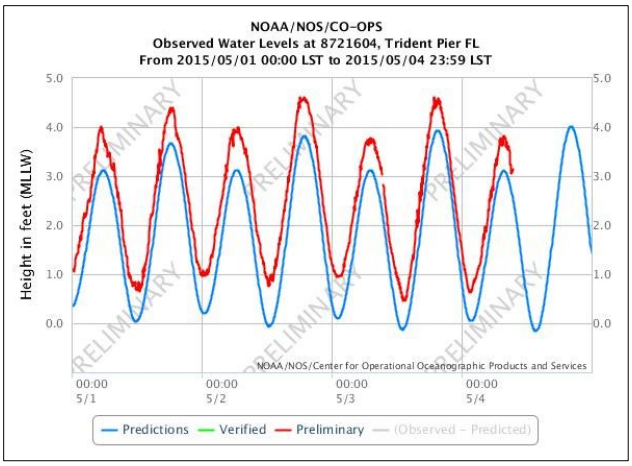

Figure 11. Plot of predicted (blue) and actual (red) water level data. This plot is an example of what the surveyor will see when checking the tides prior to collecting a survey. The data have not been verified; therefore, the verified data (green) does not appear and the residual (observed-predicted) is greyed out.

4. The data can also be viewed in tabular form by clicking the "Show Data Listing" button on the left side of the screen, below the "Options" of the plot. These data can also be exported as a .csv file by clicking the 'Export .CSV' button on the right side of the screen.

5. The residual is the storm surge. To calculate the residual, subtract the predicted from the actual water level. If the residual is greater than 1 foot (0.3 m) at high tide during the week prior to when the shoreline survey is conducted, the shoreline survey has to be rescheduled for a time period not influenced by storm surge.

6. Steps 1–5 are repeated daily during the week prior to the survey in addition to the morning of the survey to assure that storm surge is not affecting the high tide swash line that will be surveyed.

Ideally, shoreline monitoring data is not to be collected until 7 days after a storm tide has occurred. However, due to storm frequency during the shoreline mapping window, shoreline monitoring data will not be collected *during* a storm tide, but will be collected regardless of recent storm tide conditions. When a storm tide has occurred within the past 7 days, additional information in the field notes (Site notes) should be included describing a post-storm data collection event. This information may be used to exclude anomalous data.

- Minimizing impact to Park Resources

There are times when portions of the beach face are not accessible due to a variety of resource related issues, including scheduled events or the presence of rare, threatened, or endangered species. In order to make sure the proposed shoreline-mapping window will allow surveyor access, it is imperative to work with resource management staff at the survey location.

In some instances, resource management staff may need to assist or escort the surveyor to minimize damage to an area, such as nesting bird habitat or sea turtle nests. These more sensitive areas may

need to be walked and thus need additional time to complete surveying. Contact the park's natural resource staff to ensure the surveyor is briefed on and can anticipate resource related issues that may need to be considered.

Points of Contact

Resource and other related issues may require cooperation between multiple agencies and divisions within the shoreline survey area. A contact list should be kept up-to-date and stored in the project folder on the shared drive, similar to Table 2.

Table 2. Example of SECN park contact list for parks where shoreline change monitoring data collection is conducted.

Park	Staff Position	Staff Name
TIMU	Superintendent	Chris Hughes
TIMU	Resource Management	Steve Kidd
CANA	Superintendent	Myrna Palfrey-Perez
CANA	Resource Management	Kristen Kneifl
CALO	Superintendent	Pat Kenney
CALO	Biologist	Jon Altman
CAHA	Superintendent	Dave Hallac
CAHA	Resource Management	Tracy DeYoung
CAHA	Biological Technician	Will Thompson
CAHA	Biological Technician	Paul Doshkov
FOMA	Superintendent	Gordon Wilson
FOMA	Resource Management	Kurt Foote
CUIS	Superintendent	Gary Ingram
CUIS	Resource Management	Michael Seibert

Literature Cited

Psuty, N. P., M. Duffy, J. F. Pace, D. E. Skidds, and T. M. Silveira. 2010. Northeast Coastal and Barrier Network geomorphological monitoring protocol: part I—ocean shoreline position. Natural Resource Report NPS/NCBN/NRR—2010/185. National Park Service. Fort Collins, Colorado. Available at: https://irma.nps.gov/DataStore/Reference/Profile/664308 (last accessed July 2018).

Trimble, 2007. Getting Started Guide GeExplorer 2005 Series. Version 1.10. Revision A. Available at: https://gis14.uwec.edu/GeoSpatialResources/Manuals/GeoExplorer/GeoExpl2005GettingStartedGuide.pdf (last accessed August 2017).