

South Beach Design Alternatives

Preliminary Design Report

City of Key West

July 16, 2018

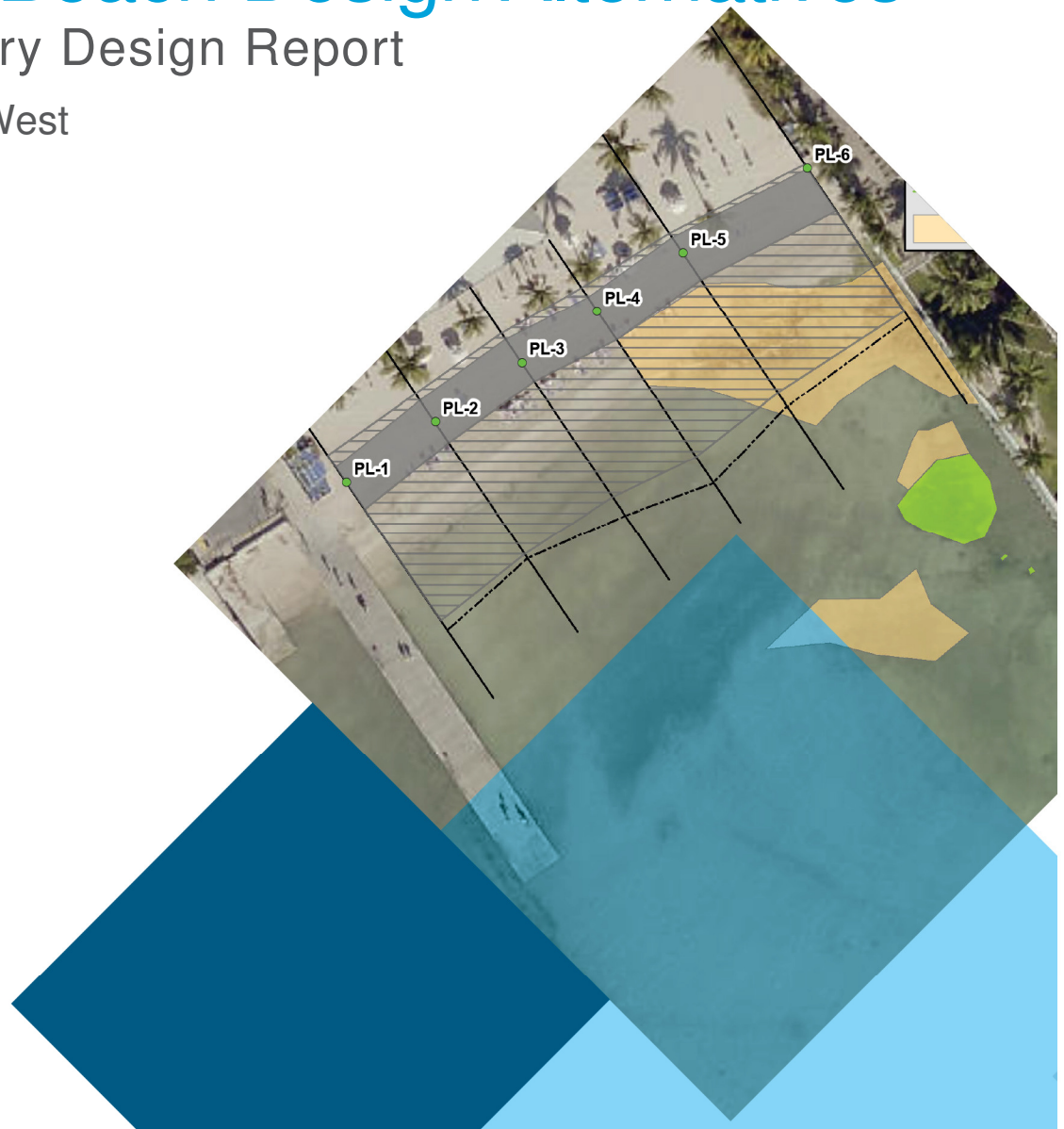


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1. Introduction

1.1. Project Background

The City of Key West (City) manages many public beaches along its shoreline, South Beach being one of them. South Beach is located at the southern end of Duval Street on the Atlantic Ocean coast of Key West island (see Figure 1 below). Over the past few years, the approximately 240-foot long beach has experienced erosional forces resulting in a severe loss of sand and a receding of the shoreline. The City desires to nourish South Beach to add more beach width for use by residents and tourists, and to protect the restaurant structure behind it.



Figure 1 – Location of South Beach within Key West

The City has requested Atkins North America, Inc. (Atkins) provide professional engineering services to prepare design alternatives for South Beach. After discussion with the City and evaluation of the alternatives, one of these template alternatives will be chosen as the preferred design for South Beach and will be utilized in obtaining permits from the Florida Department of Environmental Protection (FDEP) and the U.S. Army Corps of Engineers (USACE) for the nourishment of the severely eroded shoreline through the Joint Coastal Permit (JCP) approval process. The following is the preliminary design report detailing alternatives for the nourishment of South Beach.

1.2. Site Characteristics

South Beach is a small public beach located at the southern end of Duval Street on the Atlantic Ocean coast of Key West (Latitude 24° 32' 48.73" N, Longitude 81° 47' 44.00" W). The beach is approximately 240 feet in length and located between the South Beach Pier at the southern end of Duval Street and the seawall on the western side of the Southernmost on the Beach Hotel. Other than the adjacent South Beach Pier and the seawall on the western side of the Southernmost on the Beach Hotel, there are no manmade structures in place below the mean high water (MHW) line at South Beach to protect the beach from wave and storm impacts.

Seaward of the MHW line, the site is characterized by sand, areas of rocky substrate and a small isolated patch of seagrass supporting some marine life. The small seagrass patch was located nearshore and was separated from the more extensive offshore seagrass meadows offshore. Above the MHW line is a sandy beach, with some areas of rocky substrate, followed by upland development; including a restaurant and resorts.

To the east of South Beach is the Southernmost on the Beach Hotel, with a surrounding seawall. To the west of South Beach is the South Beach Pier, followed by seawalls protecting the southern end of Duval Street and the Southernmost House. There is also another small pier between Duval Street and the Southernmost House.

1.3. Project Purpose

The Florida Department of Environmental Protection has designated nearly the entire south coast of the island of Key West as critically eroded, including South Beach, which provides recreational, economic and shoreline protection benefits to the City of Key West. Currently, there is an exposed cap rock area towards the eastern end of South Beach, which the City would like to have buried for increased usable beach area, as it is a traditional recreational area that has been used by Key West residents and tourists for many years.

South Beach is subject to coastal erosion which is exacerbated by storm events. Multiple hurricane and storm events have affected Key West over the past 25 years including: Hurricane Opal (October 1995), the Groundhog Day storm (February 1998), Hurricane Georges (September 1998), Hurricane Irene (October 1999), Hurricane Charley (August 2004), Hurricanes Dennis, Katrina, Rita, and Wilma (July through October 2005), and Hurricane Irma (September 2017).

The creation of a sand berm as proposed in this preliminary design report would add erosion protection for the shoreline and upland development at South Beach for future storm events. The nourishment of South Beach would also provide a wider beach to support recreation and tourism at this popular pocket beach on Key West.

2. Technical Approach

At the request of the City, Atkins prepared four preliminary beach designs for South Beach. These beach template alternatives were based on the 2008 GM Selby berm template and variations of that template. The following sections provide the technical objectives and methods employed to develop and evaluate the preliminary beach fill design alternatives.

2.1. Analysis Methods

The equilibrium toe of fill (ETOF) was calculated for each alternative to determine if material from the four proposed beach fill templates is anticipated to impact nearshore resources or hardbottom once the sediment had equilibrated. Empirical calculations were utilized to predict the cross-shore location of the ETOF, as defined by Dean (1990) for six profiles along the South Beach shoreline. These calculations include the determination of the shape of the offshore equilibrium profile using the grain size data for the proposed borrow source material, and the displacement of the origin of the equilibrium beach profile curve at MHW (Δy) from the fill template using the volume difference between the existing condition survey and the fill template, the berm height and the depth of closure. To determine the intersection of the equilibrium profile with the berm crest, a line was extrapolated up to the berm crest of the fill template from the origin of the equilibrium curve at MHW.

2.2. Input Data

The November 2017 post-Irma topographic and bathymetric survey data collected by Florida Keys Land Surveying was used as the existing condition survey for calculation of the ETOF, while the fill template alternatives were based on the 2008 GM Selby berm template design for South Beach and variations of that template. Since the survey used as the existing condition was a post-storm survey, the calculation of the ETOF location may not be an accurate prediction, as the existing condition survey may not reflect the natural equilibrated state of the nearshore conditions at South Beach. Before nourishment occurs, a pre-construction survey should be conducted to verify ETOF calculations and placement volumes and the survey should be compared to available historical surveys. At the direction of the City, sediment characteristics of the proposed fill material were assumed to be the same as that of the Smathers Beach nourishment project, for which material was obtained from reports of material at the quarry. The effective grain size data was determined to be approximately 0.23 mm (D50) from the E.R. Jahna QC Report of the Ortona Sand Mine in June-July of 2011, which was used for fill material for the 2011 Smathers Beach nourishment project.

2.3. Field Data

Based on the most recent survey being a post-storm survey, comparing the ETOF locations to the most recent survey is not a reliable comparison. The ETOF profile was compared to the November 2012 monitoring survey to verify prediction of the cross-shore location of the ETOF, which showed that the nearshore bathymetry was deeper at the time of the November 2012 survey than at the time of the November 2017 survey. Based on this comparison, a pre-construction survey should be completed to verify calculations, placement volumes, and the ETOF location prior to nourishment of the South Beach shoreline.

Atkins conducted a benthic habitat assessment of the project area on May 8, 2018 to document the nearshore biological communities to assist with future management decisions on selecting a preliminary beach nourishment design template. The assessment area extended approximately 240 feet along the shoreline of South Beach, plus an additional 190 feet to the west in front of the adjacent Southernmost House property, and 390 feet offshore, representing a total area of approximately 167,700 square feet. Seaward of the MHW line, the site was characterized by sand, areas of rocky substrate and a small isolated patch of seagrass in the nearshore area (See plan view template alternatives in Appendix A.).

2.4. Model Calibration/Verification

The empirical ETOF calculations as defined by Dean (1990) were performed using MATLAB and the results were translated to ArcGIS for the presentation of the alternative beach fill templates. Profile plots including the ETOF results were developed for each proposed alternative, along with the November 2017 post-Irma survey, which was included on the profiles to show the variation of the proposed alternatives. Based on the differences in nearshore depth when comparing the November 2012 and November 2017 (post-Irma) surveys to verify prediction of the cross-shore location of the ETOF, a pre-construction survey should be completed to verify calculations, placement volumes, and the ETOF location prior to nourishment of the South Beach shoreline. Once an alternative is selected and calculations are verified based on a pre-construction survey, the results will be translated to AutoCAD for plotting the predicted location of the ETOF.

Based on the monitoring of Smathers Beach and some Gulf Coast beaches, the ETOF calculation is a conservative estimate of seaward migration of fill. Generally, physical monitoring surveys have shown that the actual seaward adjustment for the beach profile post-construction ETOF is less than the ETOF prediction. However, since the post-Irma survey was used as the existing conditions, this may not accurately capture the natural equilibrated bathymetry of the beach. For this reason, a pre-construction survey is recommended for verification of the ETOF and placement volumes before nourishment occurs.

2.5. Engineering Alternatives

For the alternatives analysis and preliminary design report, the proposed beach fill template alternatives were based on the 2008 GM Selby berm design and three variations of that design to evaluate which template provides the most added beach width, while avoiding impacts to submerged aquatic resources. The sediment source was previously determined to be the same source as was used for the Smathers Beach nourishment project and the November 2017 post-Irma survey was used as the existing condition.

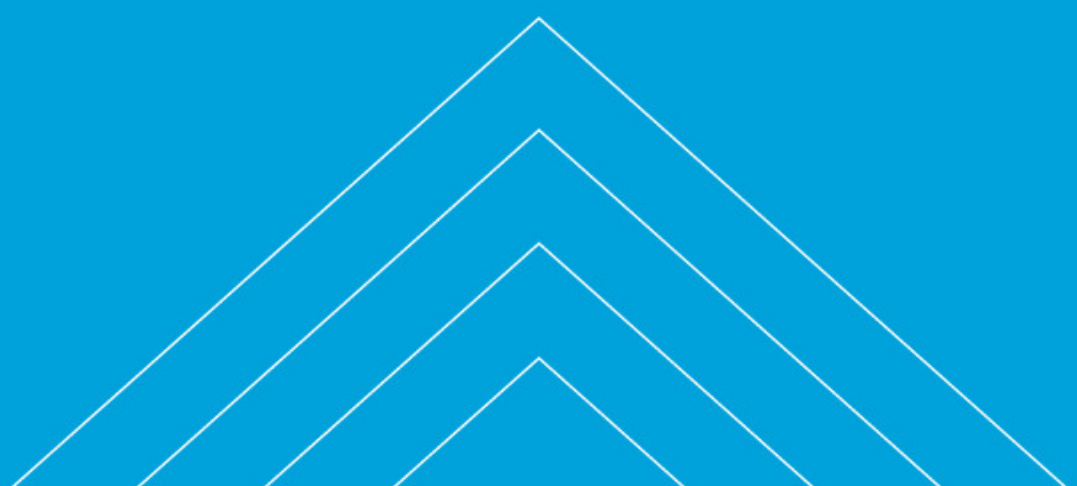
Design calculations, including the approximate ETOF location based on the November 2017 survey, were completed for the 2008 GM Selby berm template (Alternative 1) and three other alternatives, as detailed in Table 1 below.

Table 1 - South Beach Template Alternatives

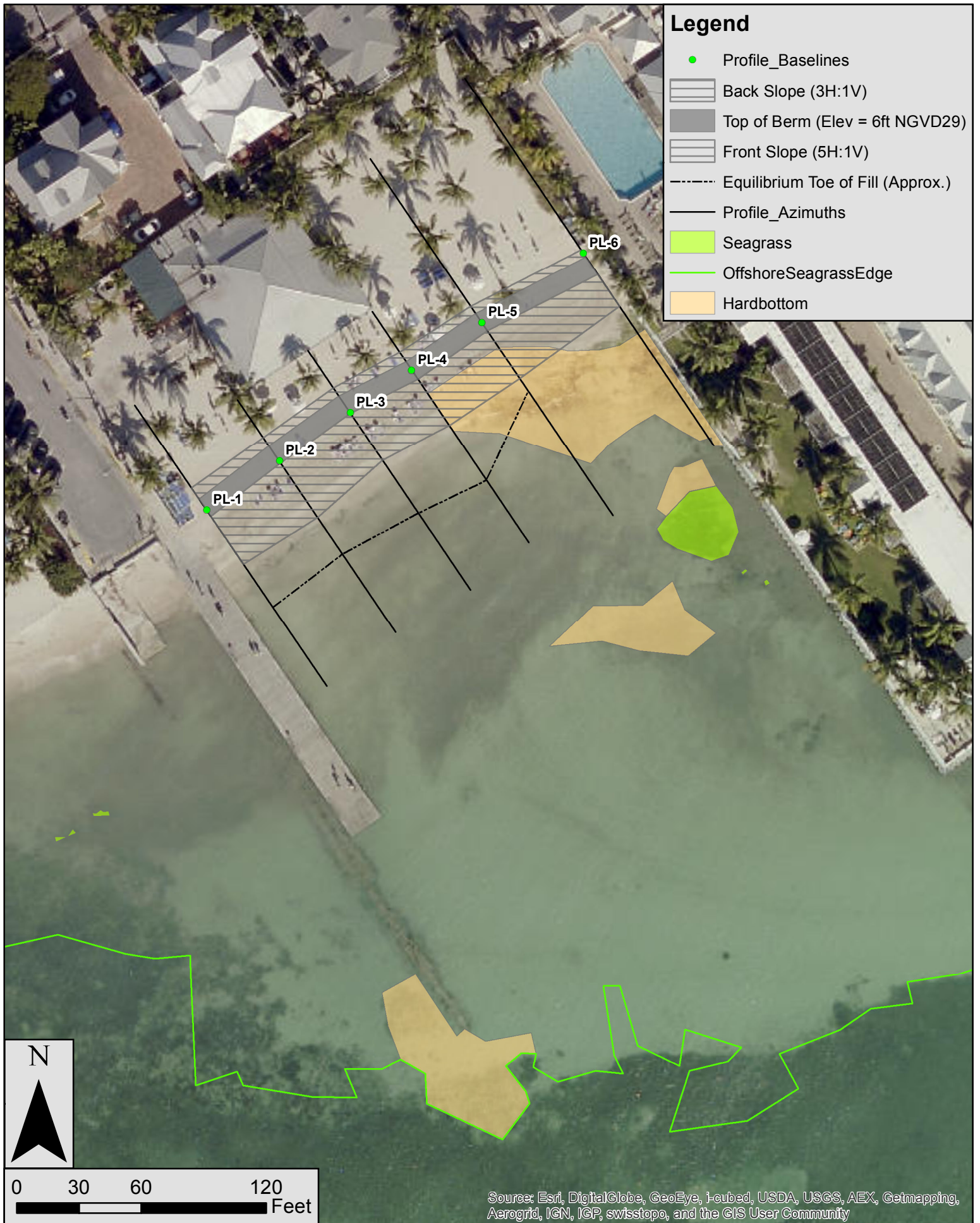
Alternative Number	Backslope (V:H)	Berm Elevation (feet NGVD29)	Berm Width (feet)	Seaward Slope (V:H)	Approximate Fill Volume (feet ³)
1	1:3	6	10	1:5	17,025
2	1:5	6	10	1:10	41,927
3	1:5	5	20	1:10	32,064
4	1:5	6	20	1:10	57,436

The ETOF calculations using the November 2017 post-Irma survey and the Spring 2018 biological assessment indicate that none of the four proposed alternatives are anticipated to impact submerged aquatic vegetation. Based on the shoreline of South Beach being bounded by a seawall on the eastern end and the South Beach Pier on the western end, which includes open culverts, minimal littoral transport along the shoreline is anticipated for material placed on South Beach. Plan view figures and profiles depicting each of the four proposed beach fill alternative templates are included as Appendix A of this preliminary design report.

Appendices



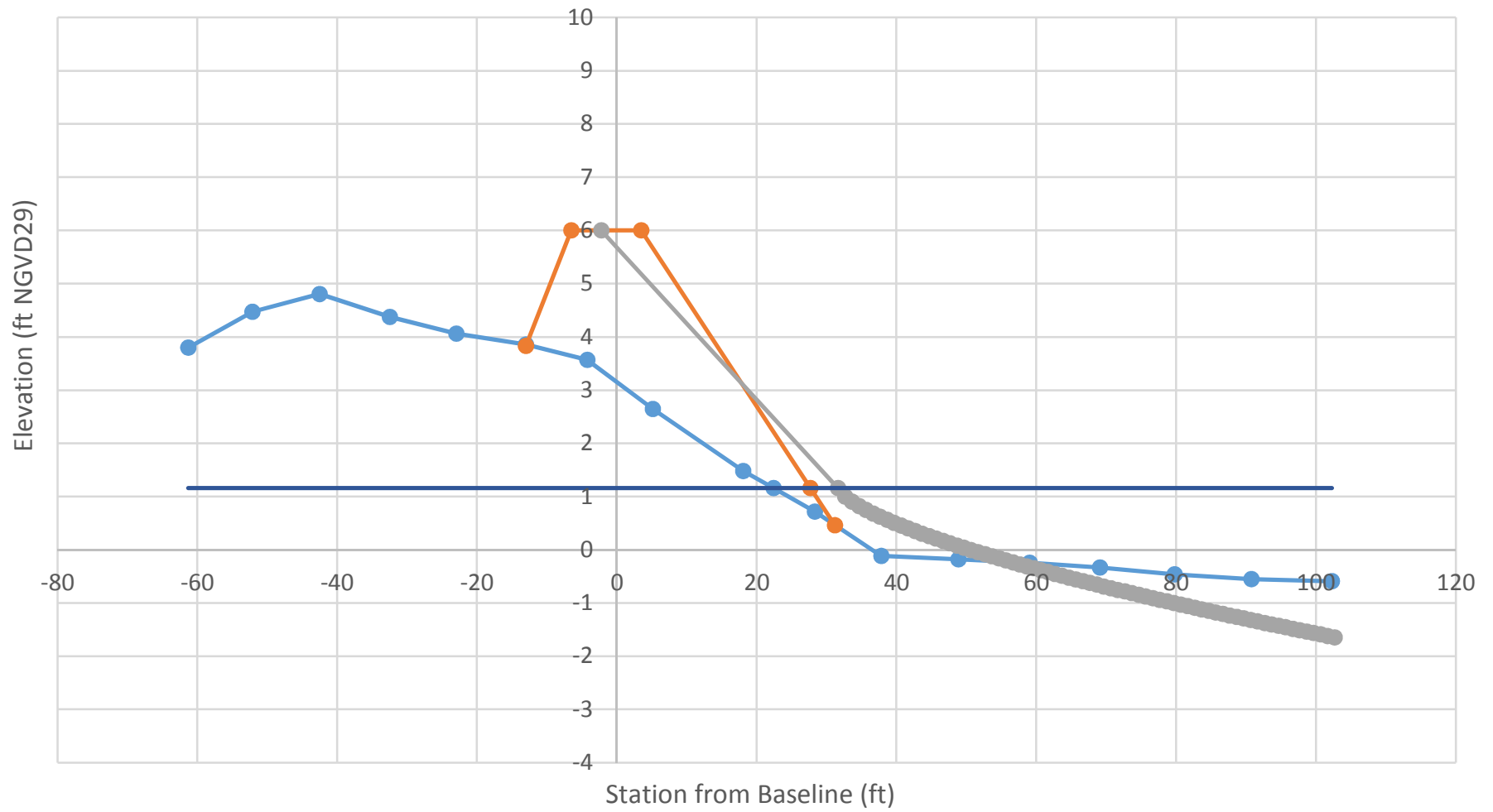
Appendix A. South Beach Fill Template Alternatives



**South Beach Fill Templates
Alternative 1**

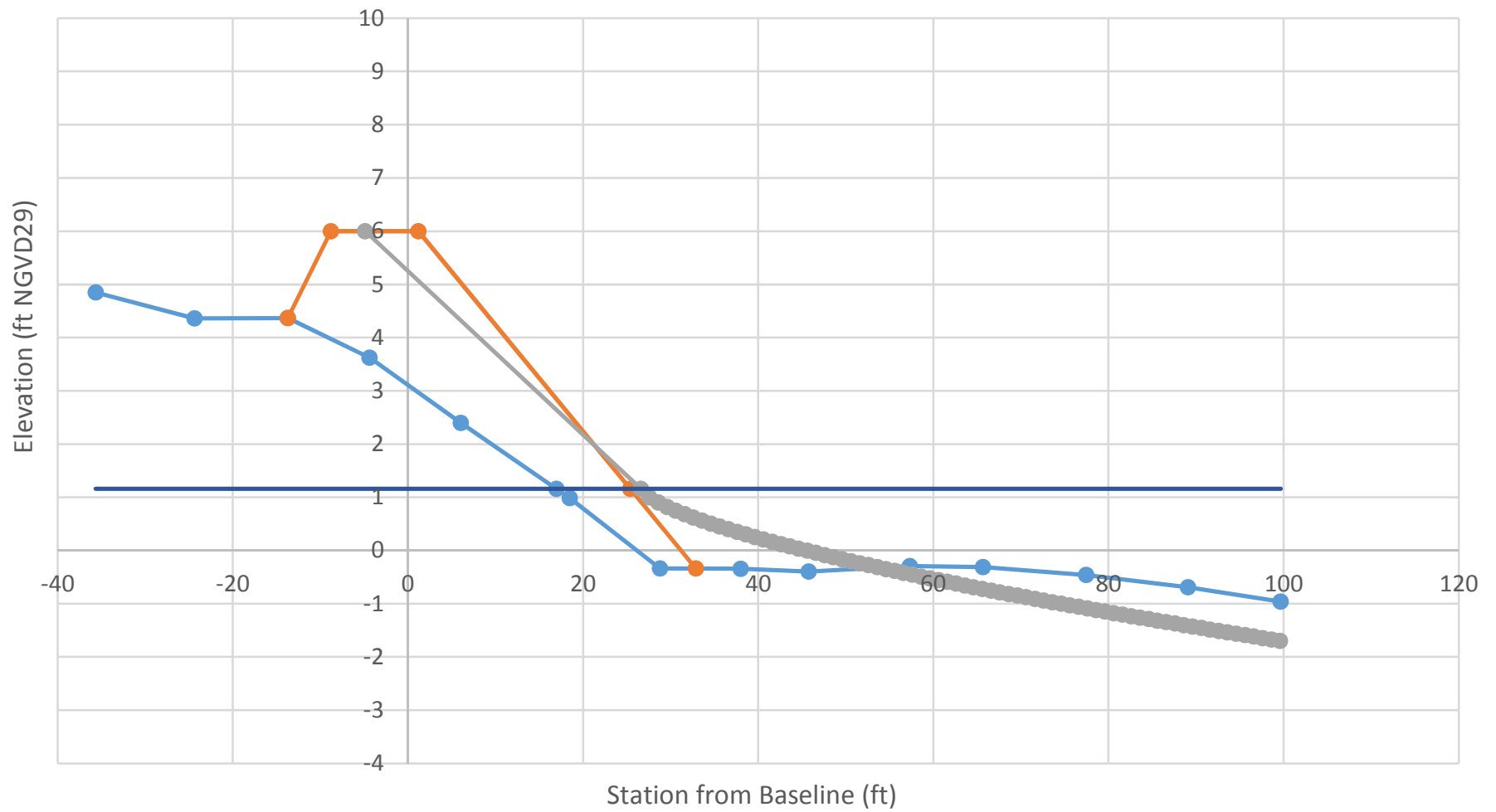
South Beach_PL-1

● Post-Irma Survey (11.2017) ● Alternative 1 Template ● ETOF Curve — MHW



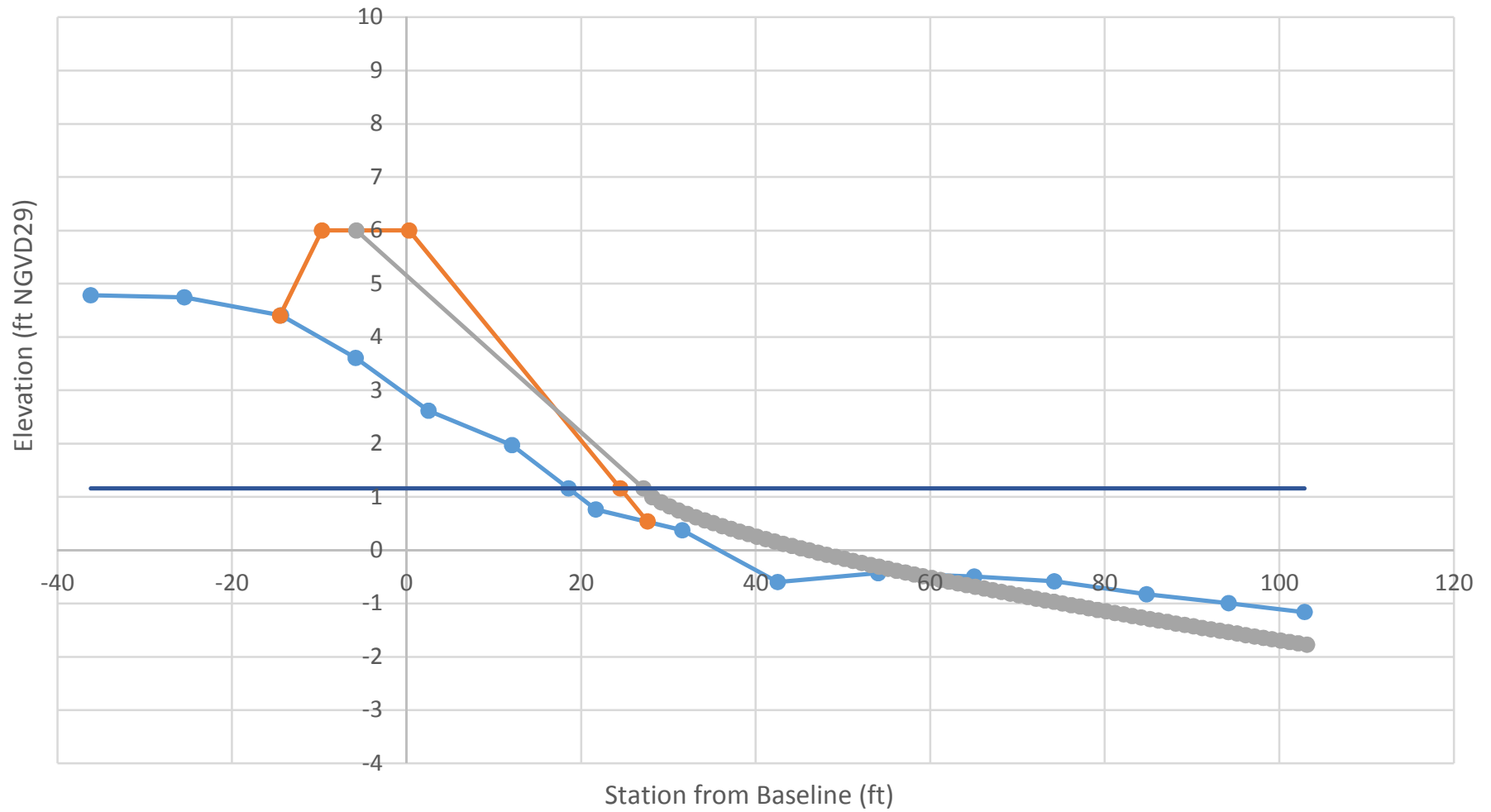
South Beach_PL-2

Post-Irma Survey (11.2017) Alternative 1 Template ETOF Curve MHW



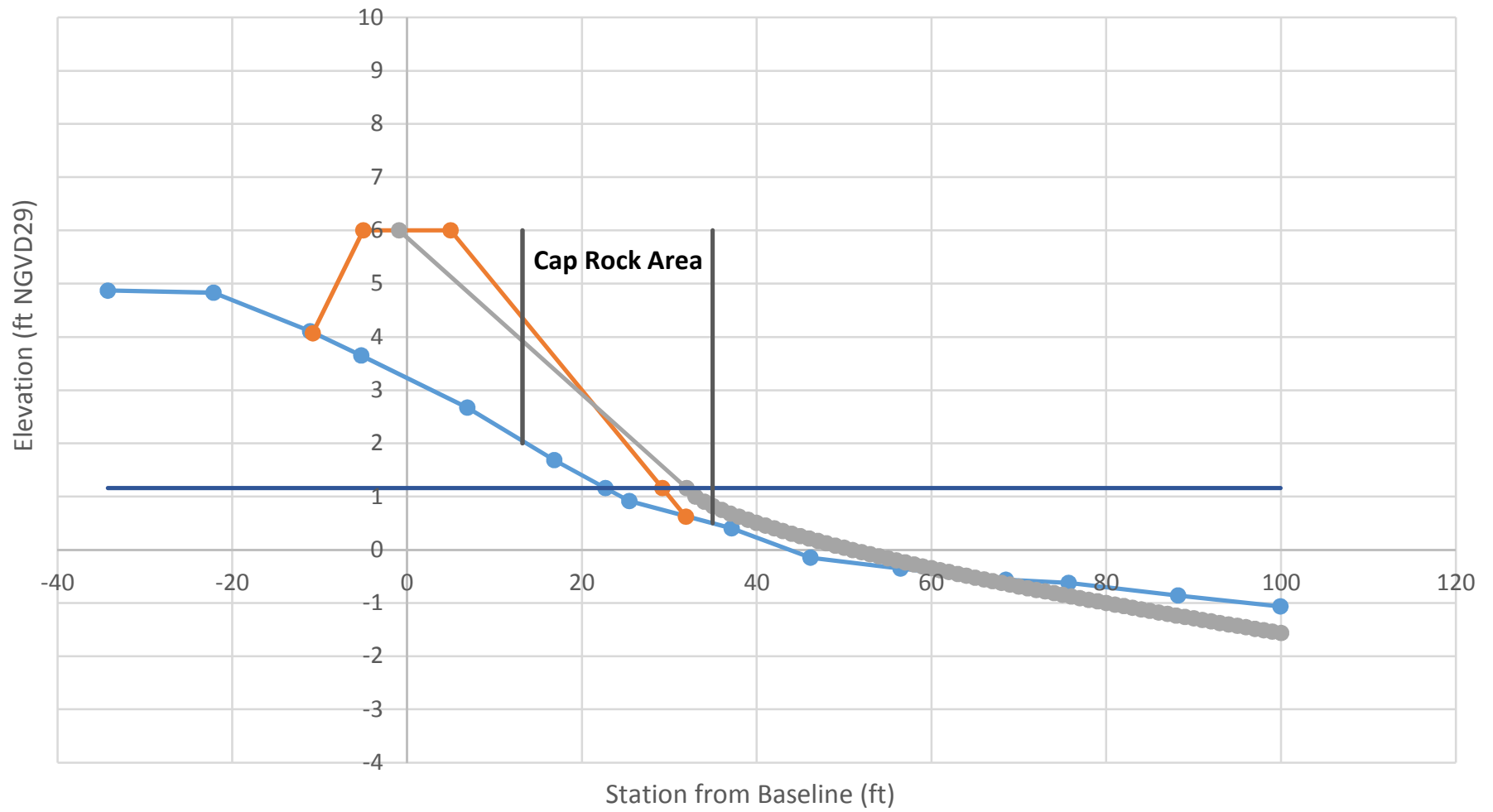
South Beach_PL-3

Post-Irma Survey (11.2017) Alternative 1 Template ETOF Curve MHW



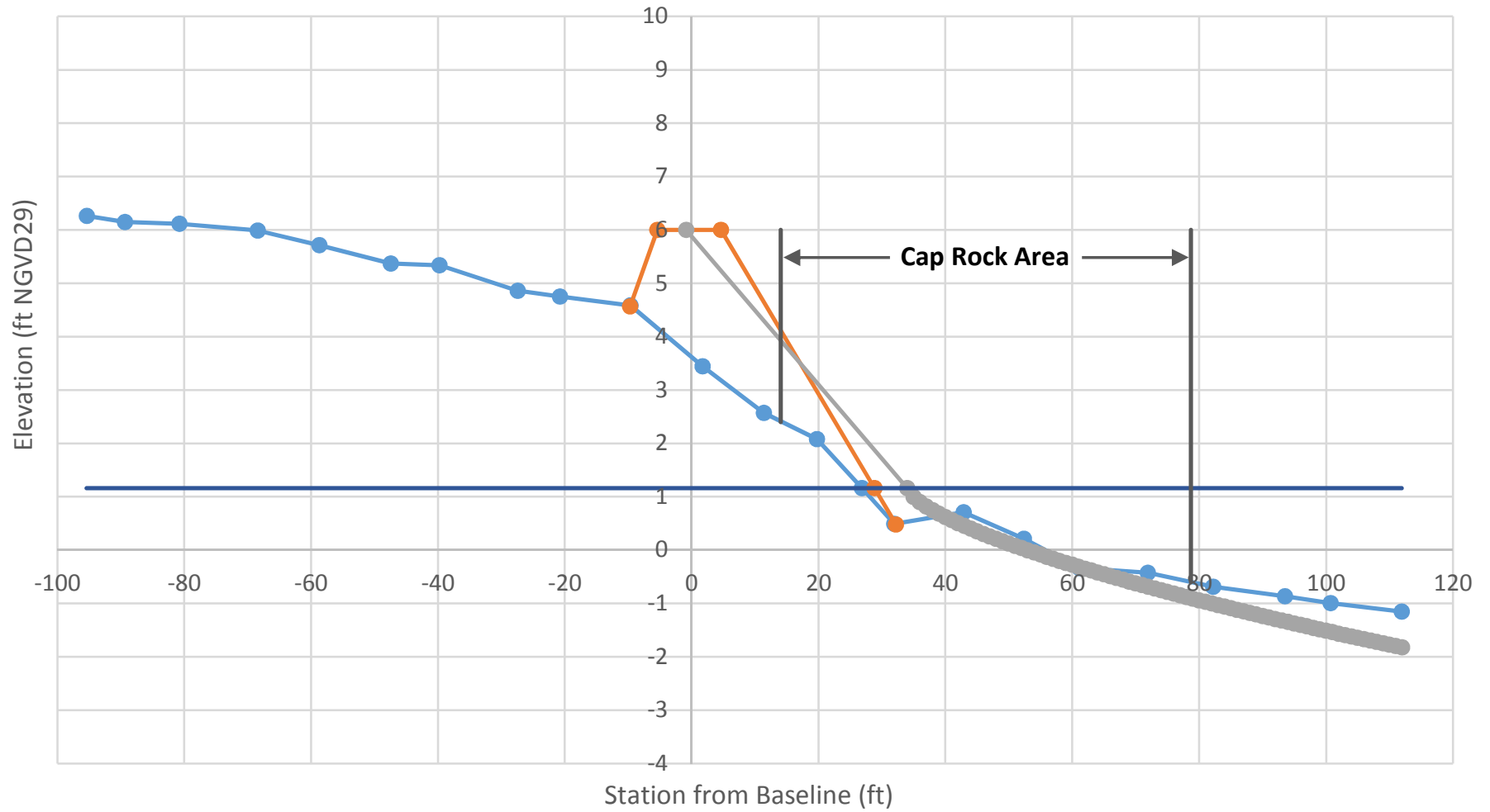
South Beach_PL-4

Post-Irma Survey (11.2017) Alternative 1 Template ETOF Curve MHW



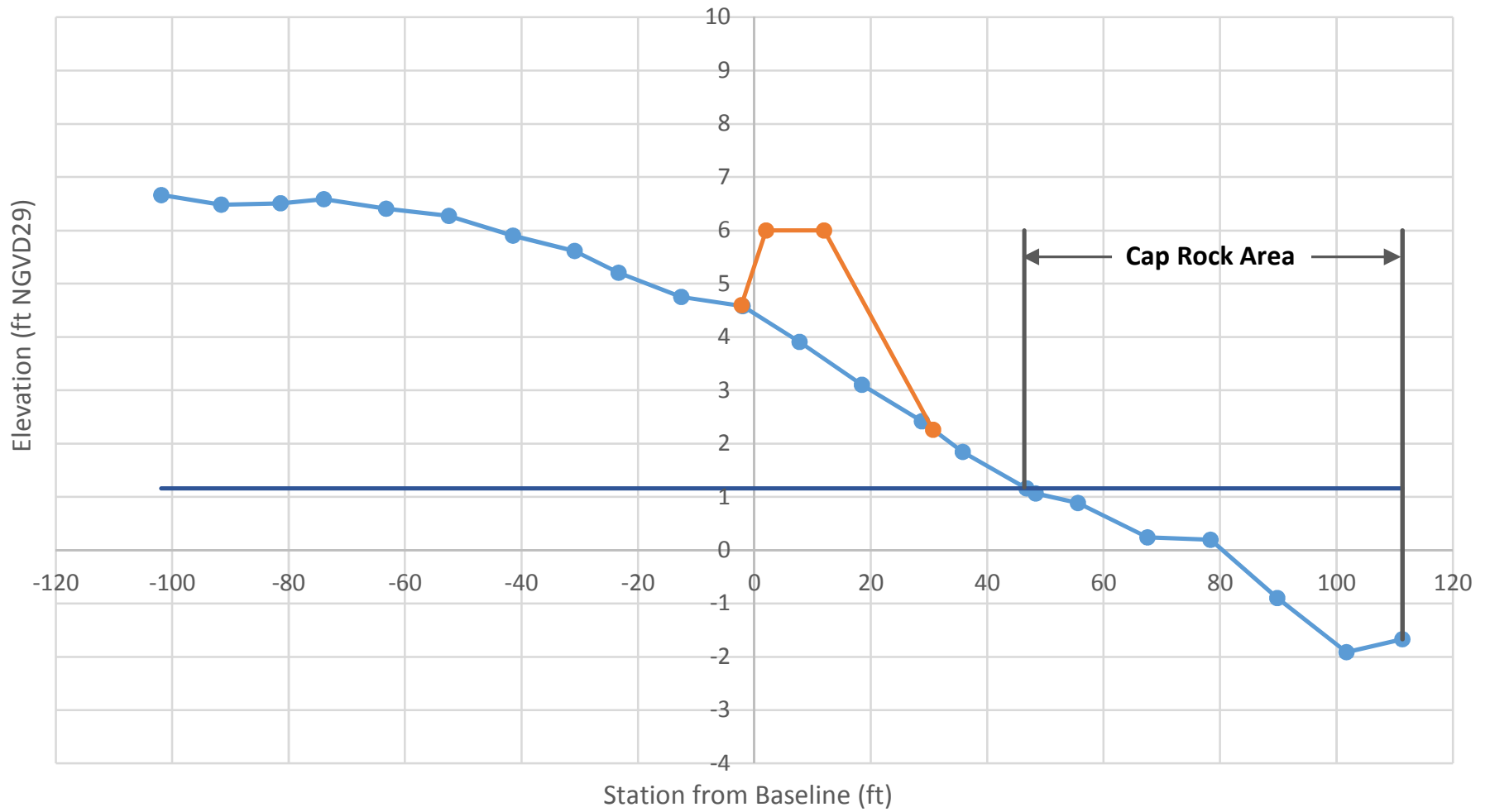
South Beach_PL-5

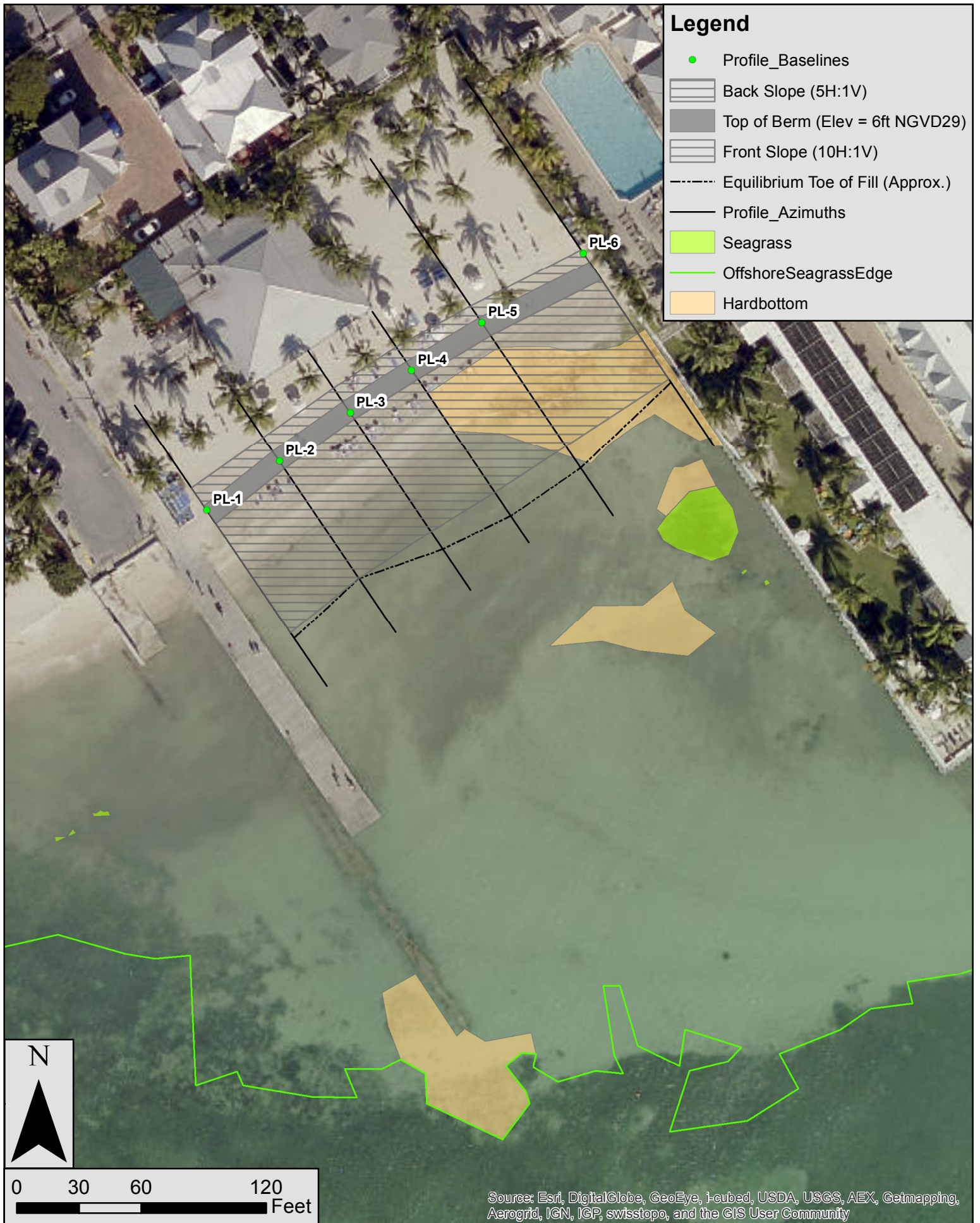
● Post-Irma Survey (11.2017) ● Alternative 1 Template ● ETOF Curve — MHW



South Beach_PL-6

● Post-Irma Survey (11.2017) ● Alternative 1 Template — MHW

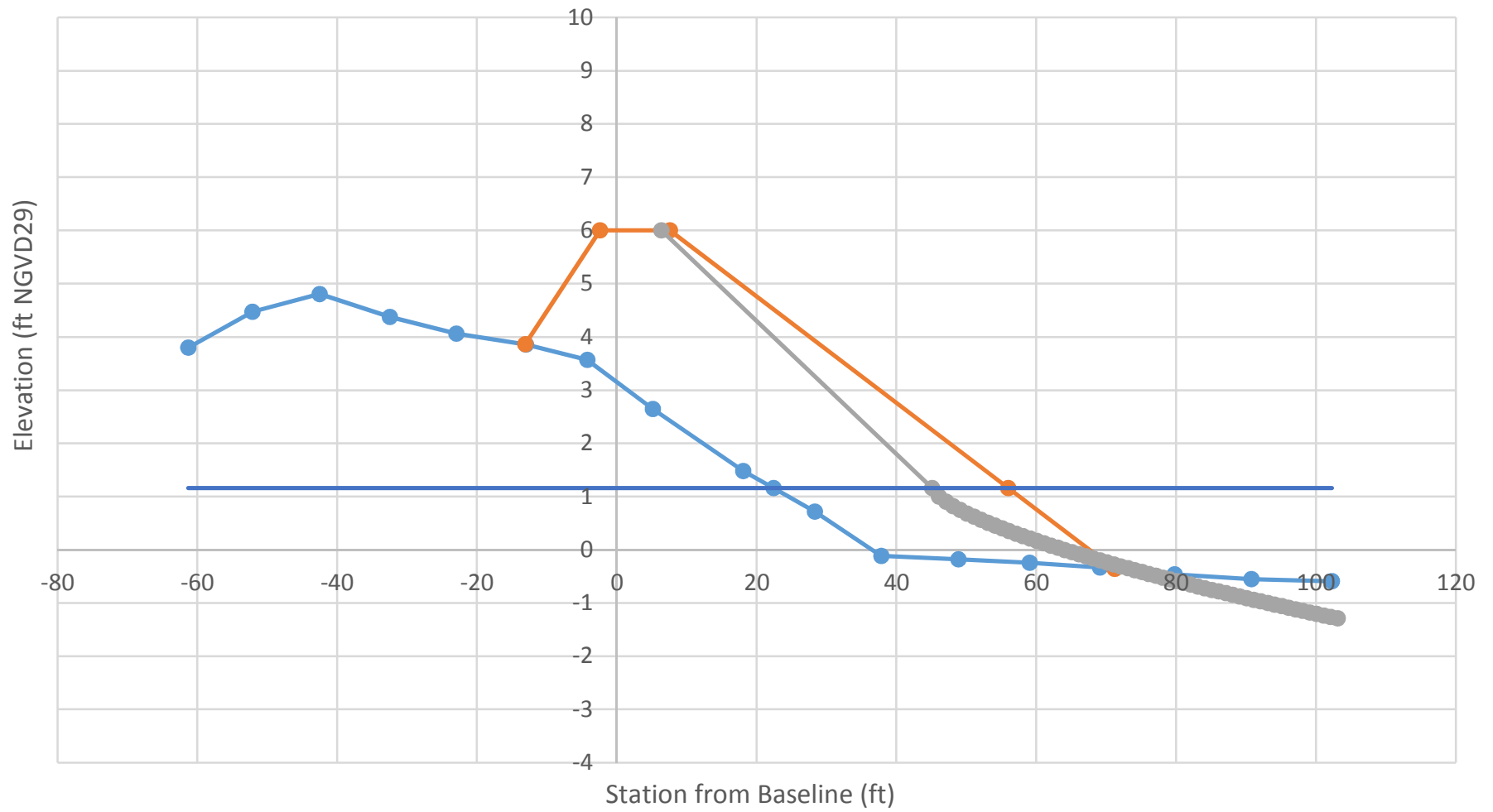




**South Beach Fill Templates
Alternative 2**

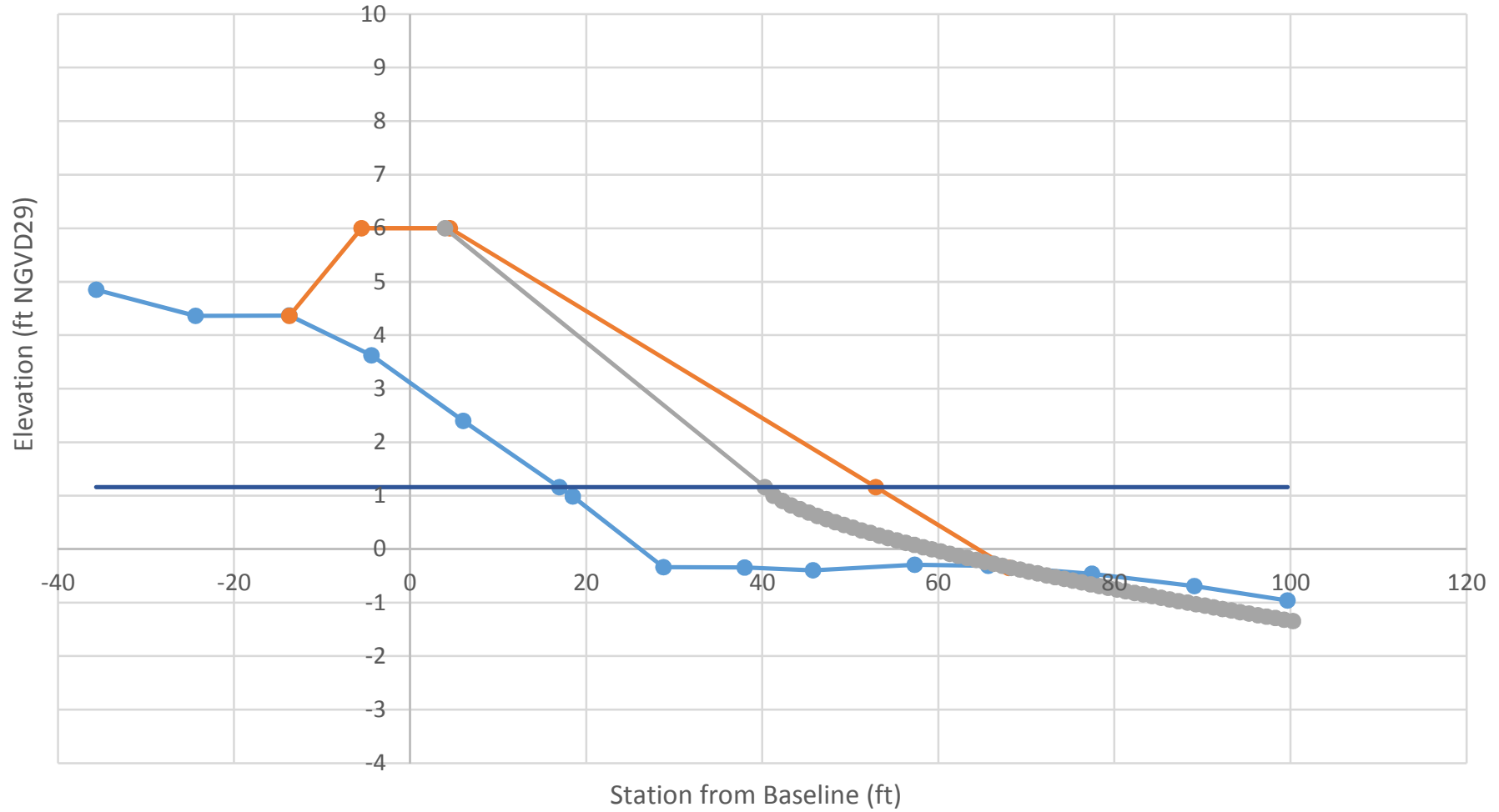
South Beach_PL-1

Post-Irma Survey (11.2017) Alternative 2 Template ETOF Curve MHW

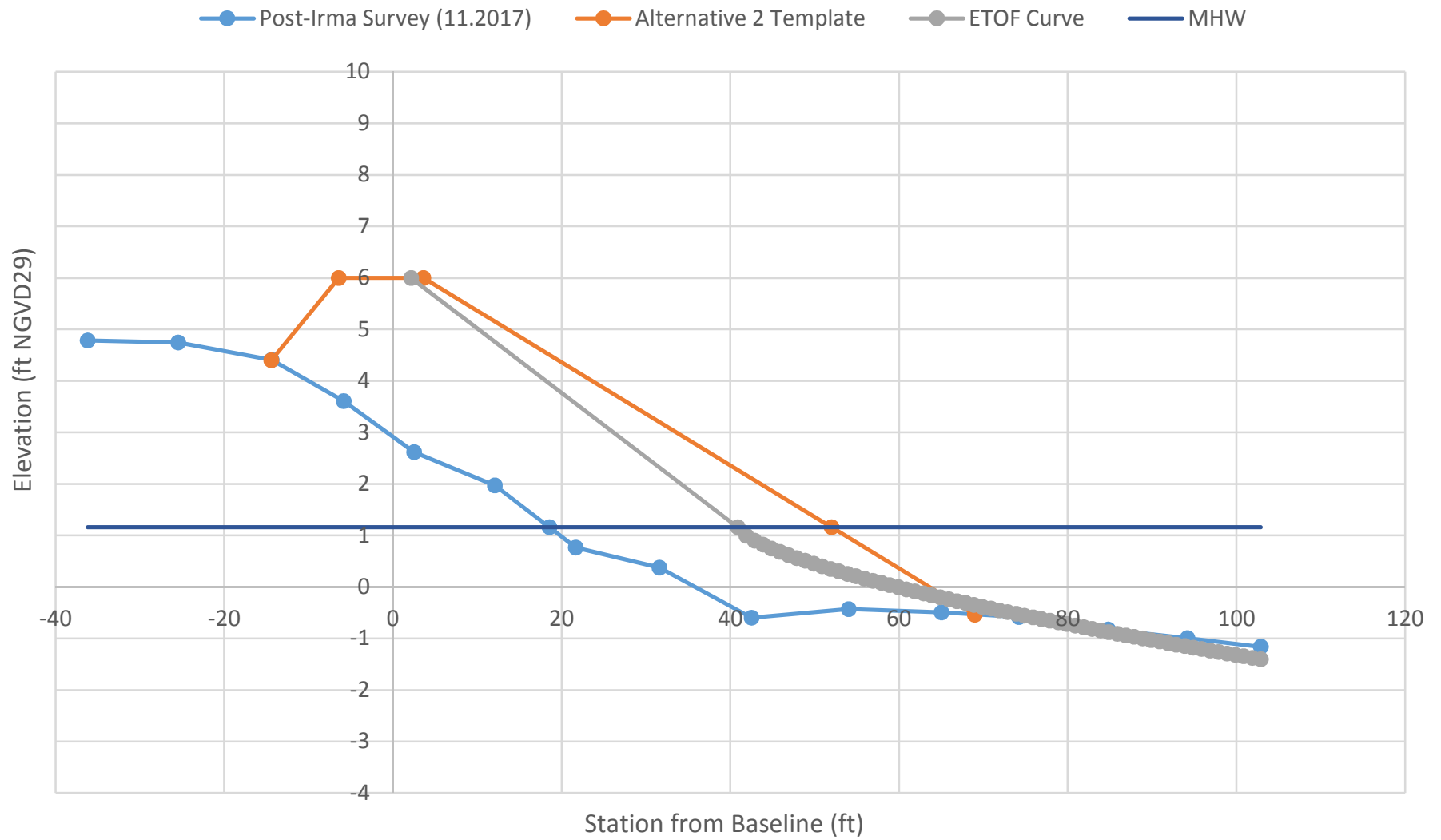


South Beach_PL-2

Post-Irma Survey (11.2017) Alternative 2 Template ETOF Curve MHW

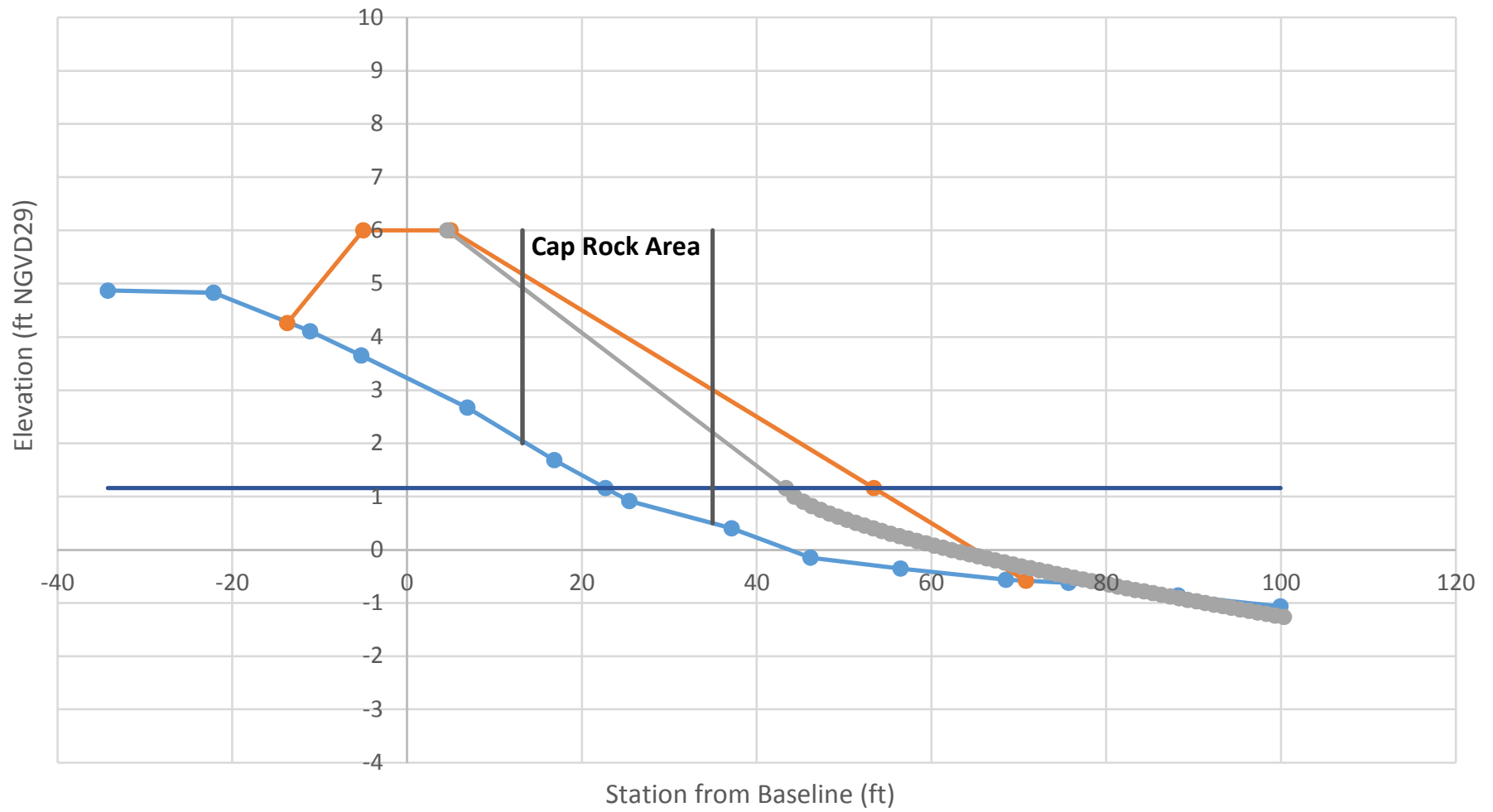


South Beach_PL-3



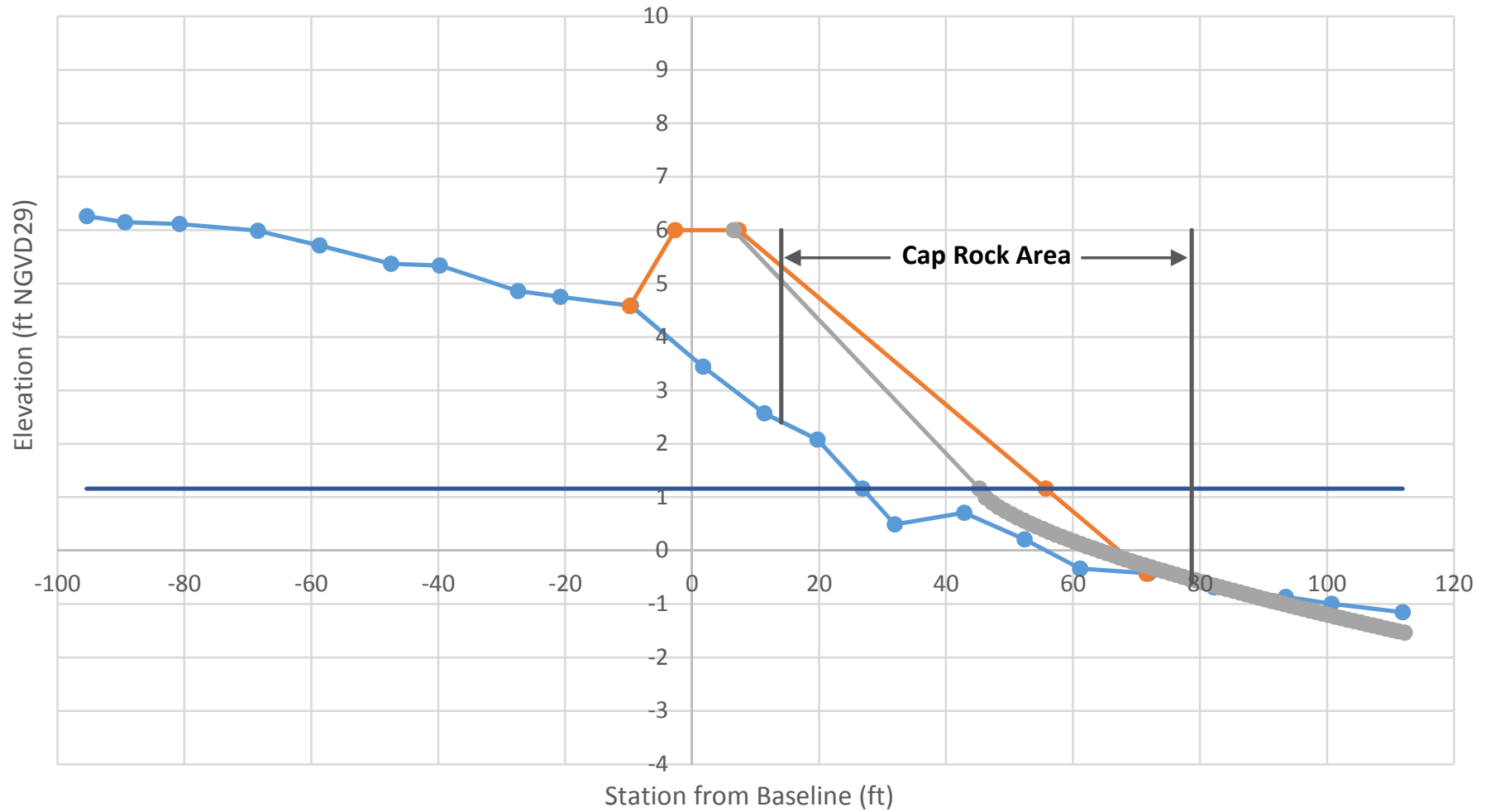
South Beach_PL-4

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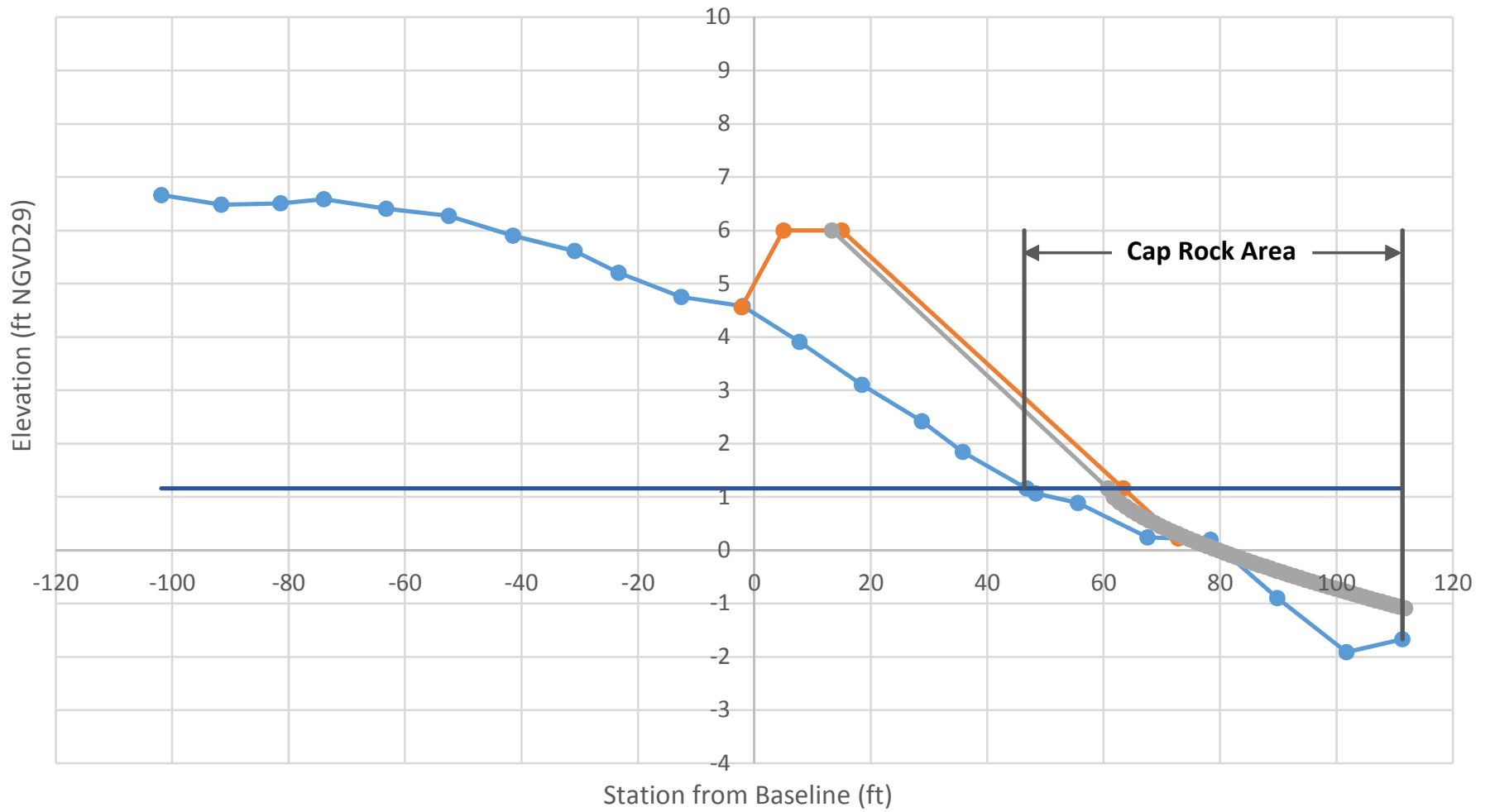
South Beach_PL-5

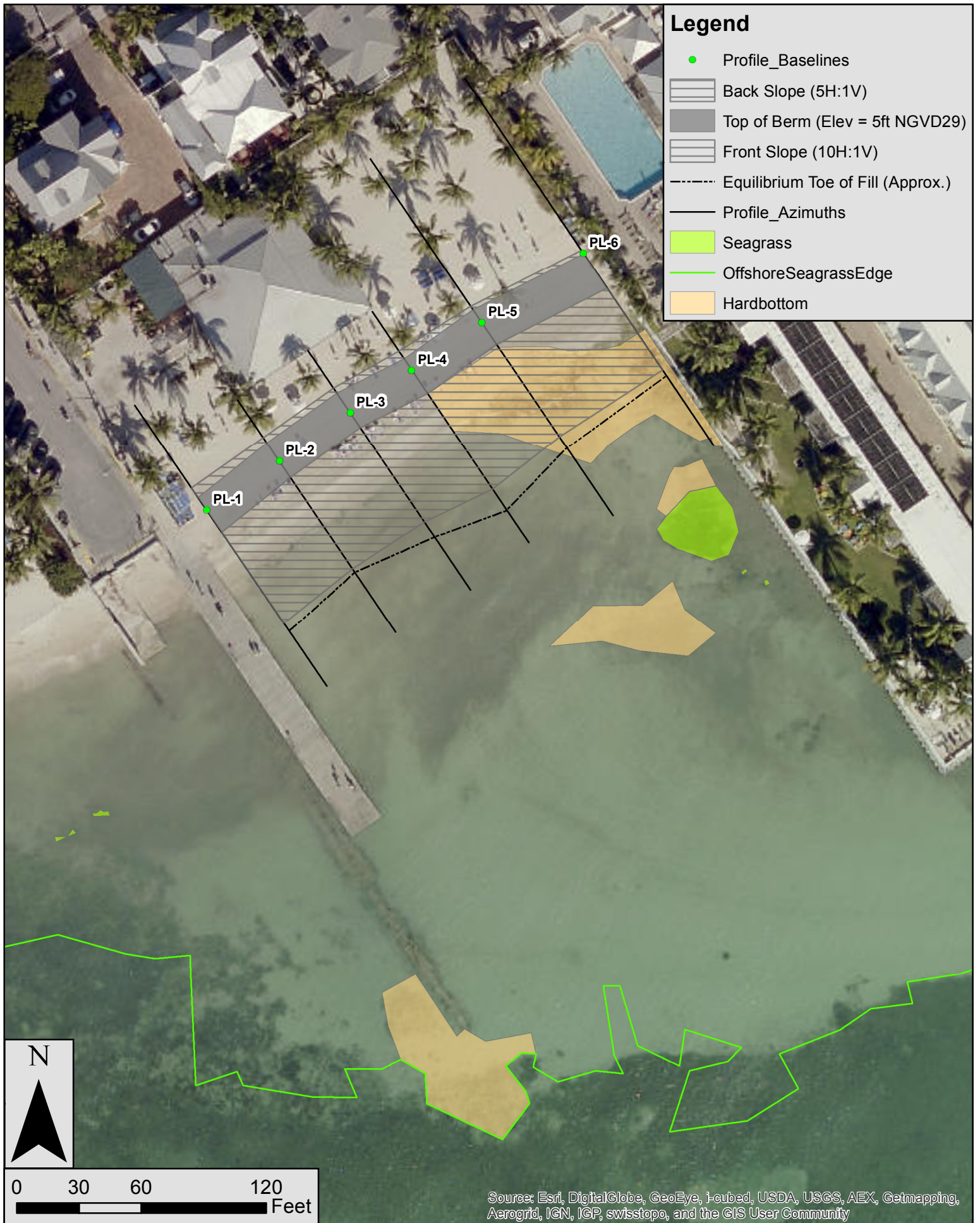
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South Beach_PL-6

● Post-Irma Survey (11.2017) ● Alternative 2 Template ● ETOF Curve — MHW

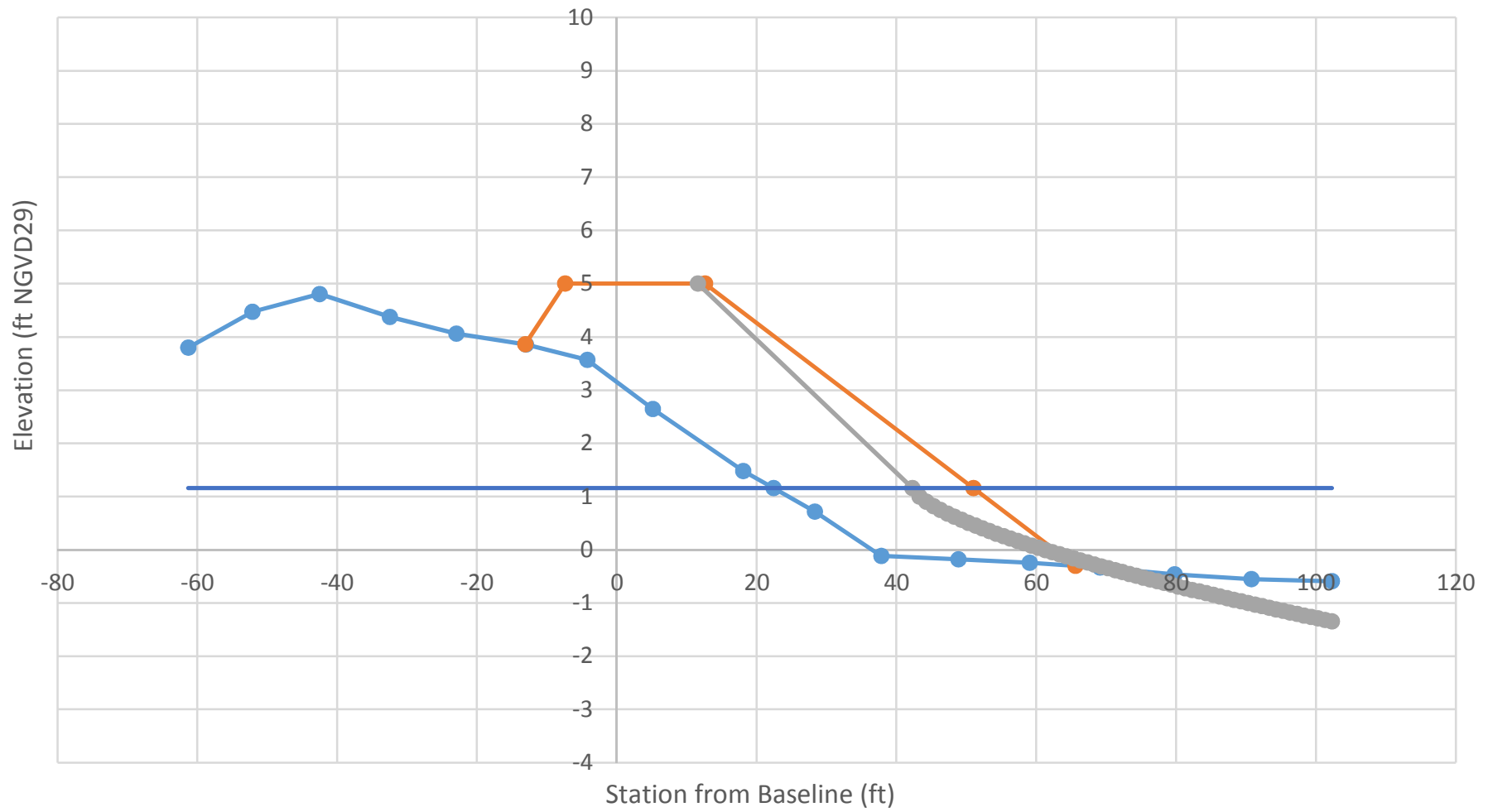




**South Beach Fill Templates
Alternative 3**

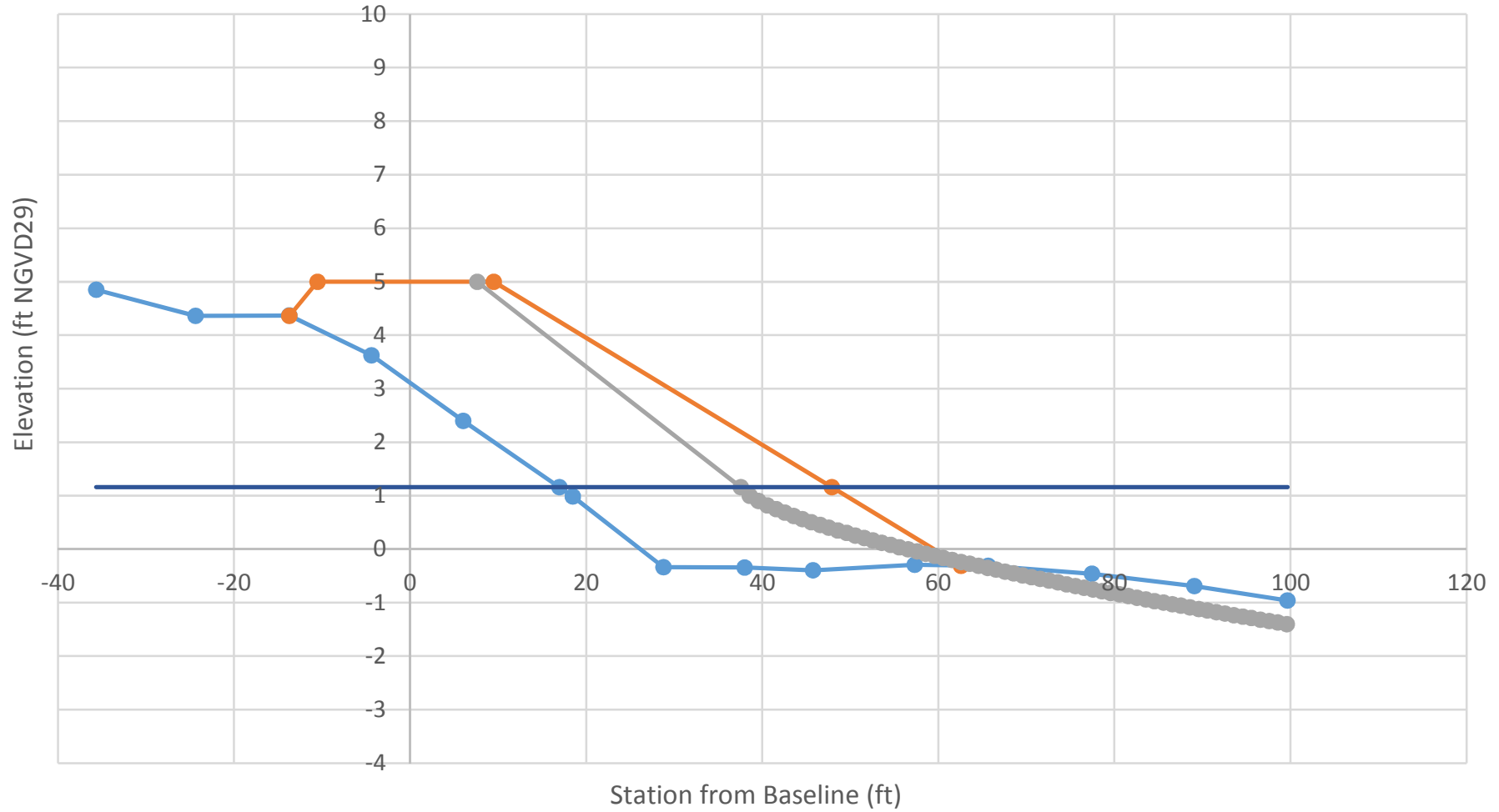
South Beach_PL-1

● Post-Irma Survey (11.2017) ● Alternative 3 Template ● ETOF Curve — MHW



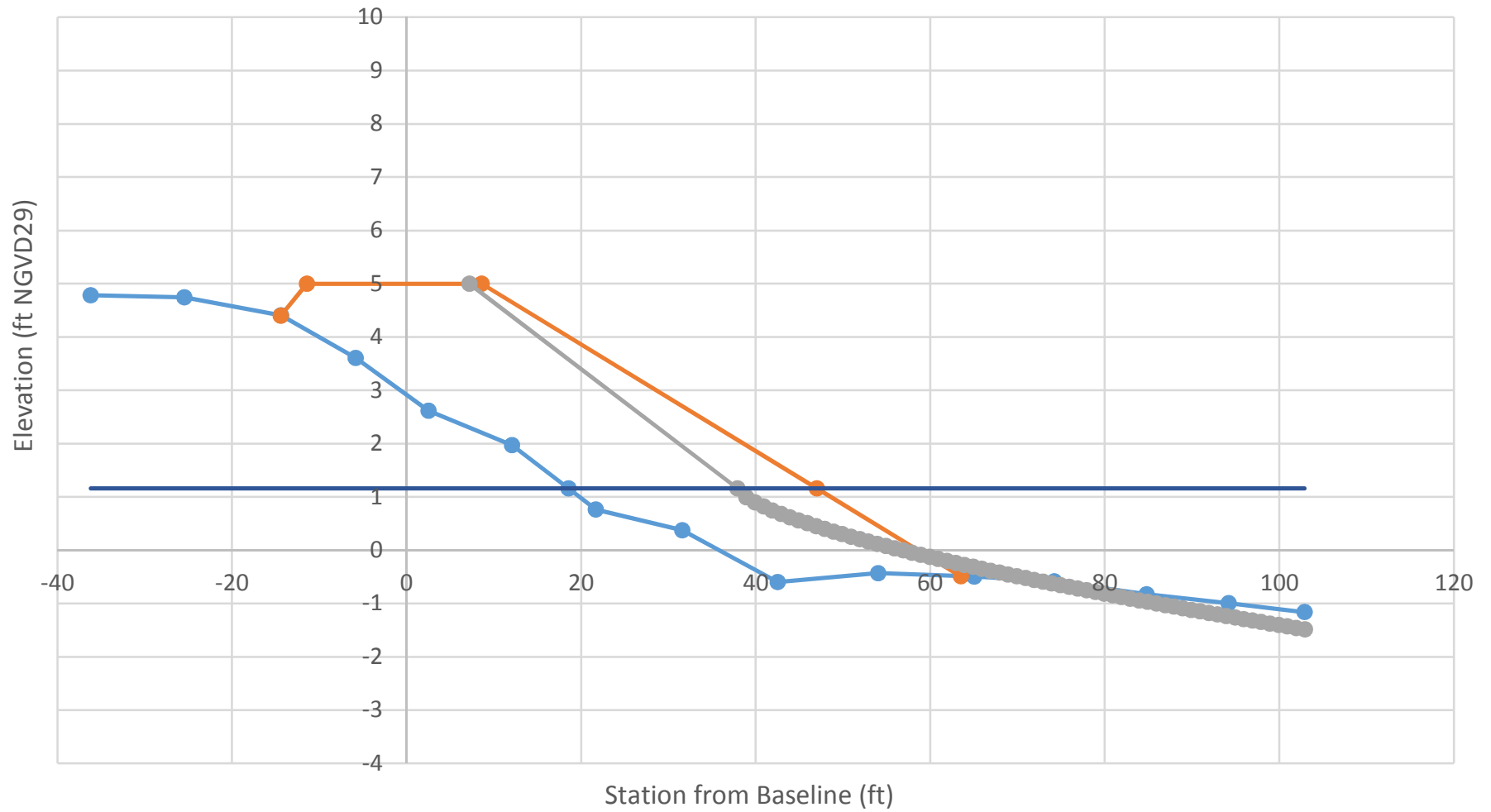
South Beach_PL-2

Post-Irma Survey (11.2017) Alternative 3 Template ETOF Curve MHW



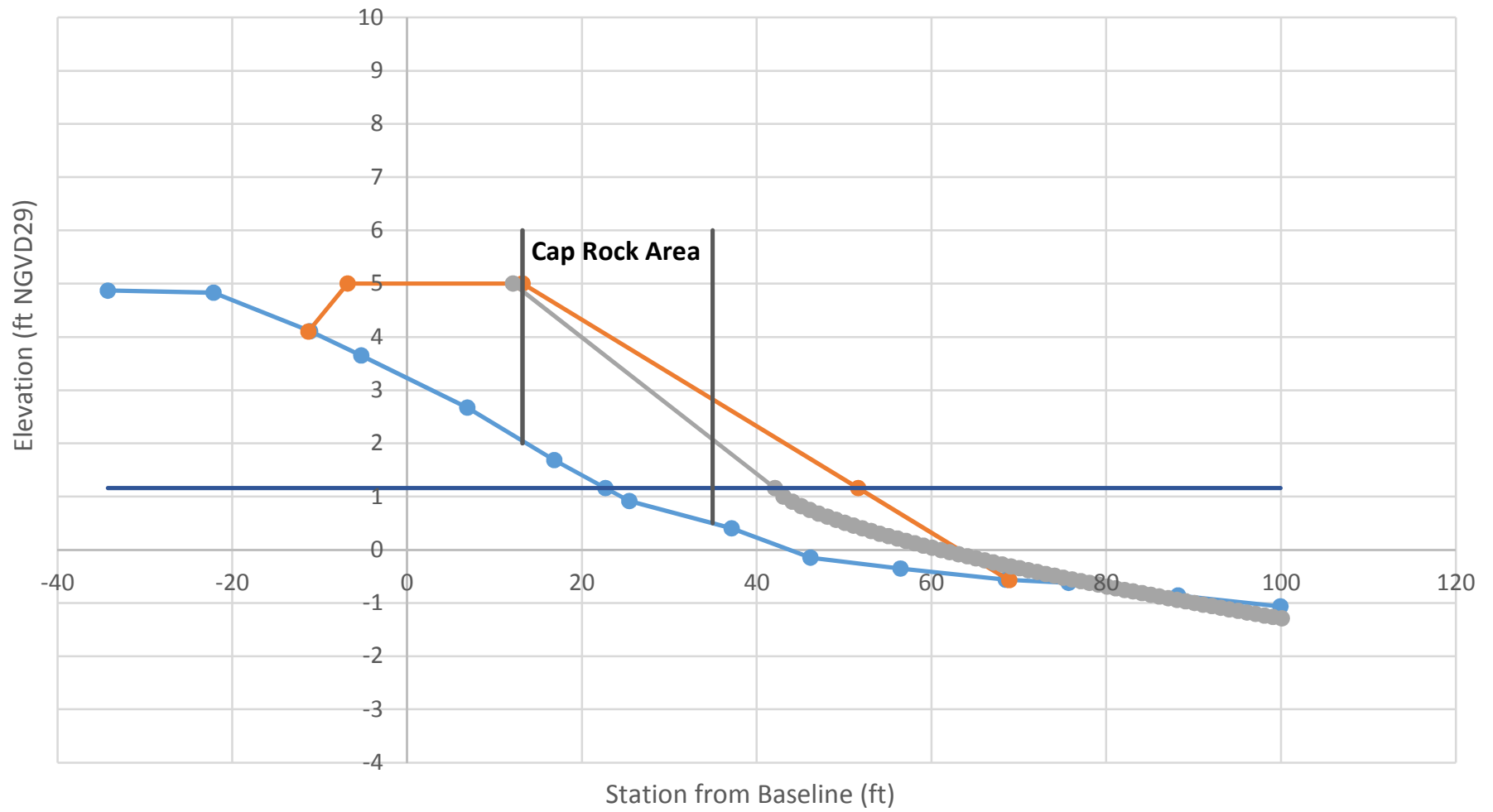
South Beach_PL-3

Post-Irma Survey (11.2017) Alternative 3 Template ETOF Curve MHW



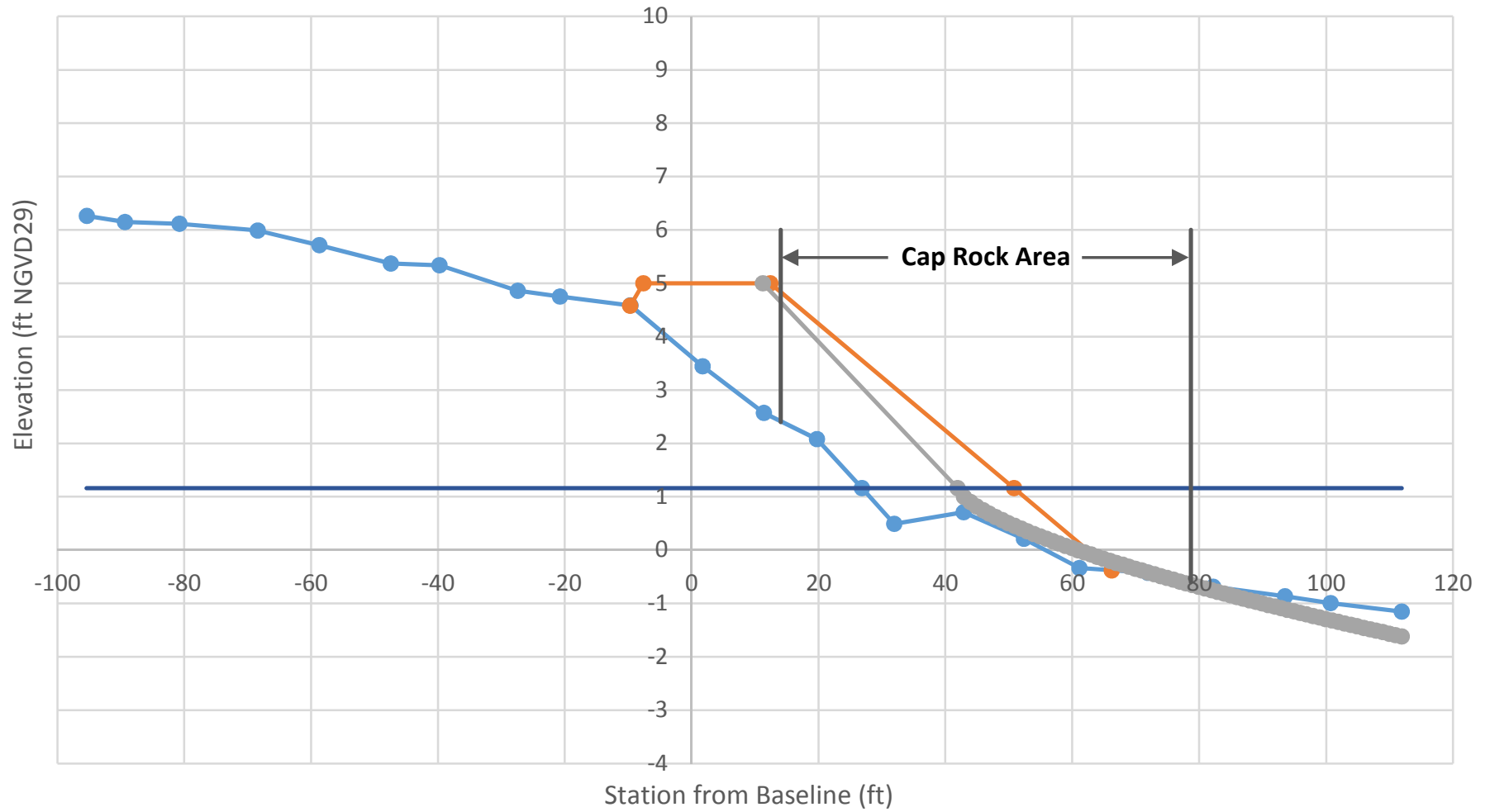
South Beach_PL-4

● Post-Irma Survey (11.2017) ● Alternative 3 Template ● ETOF Curve — MHW



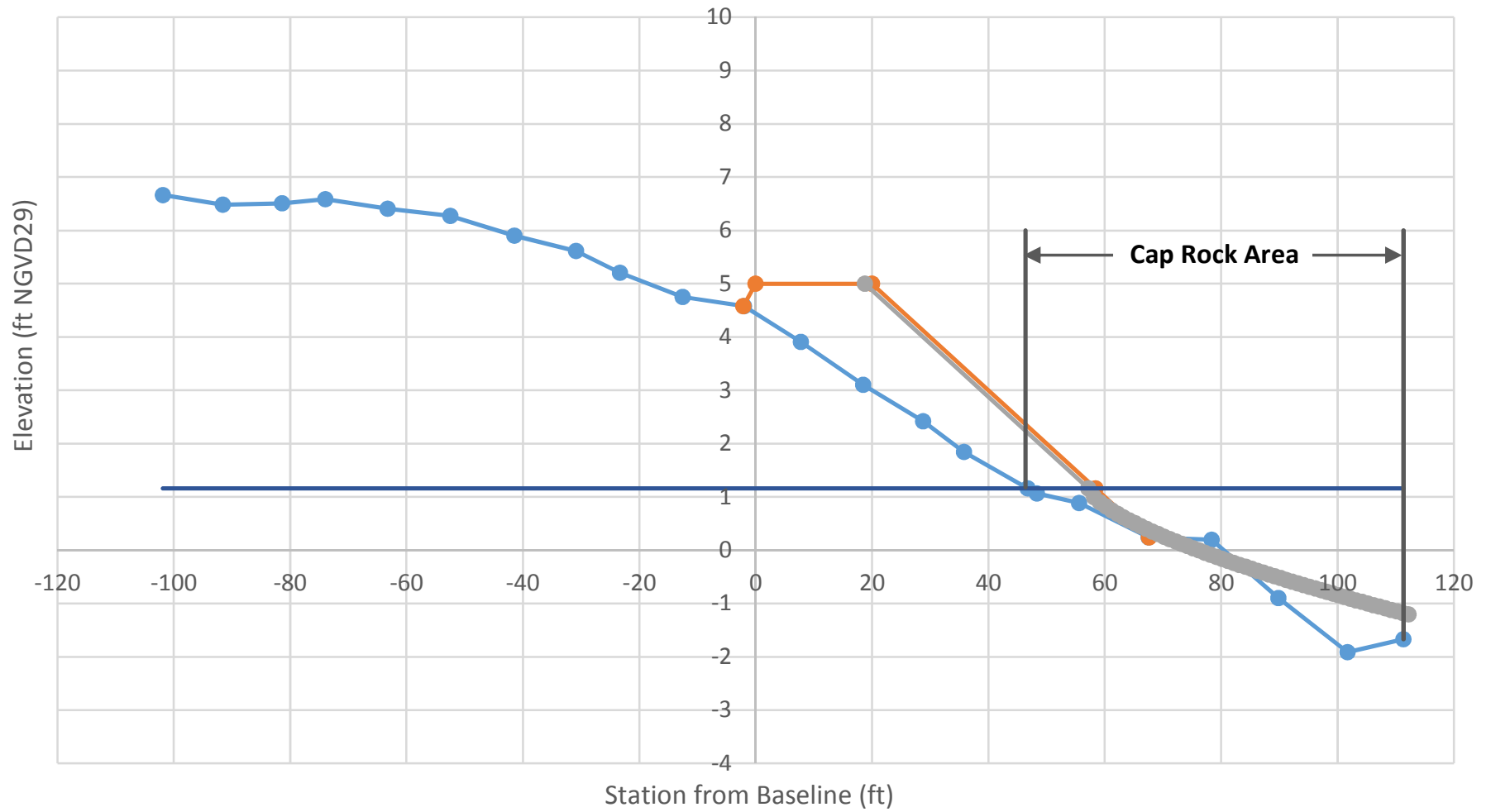
South Beach_PL-5

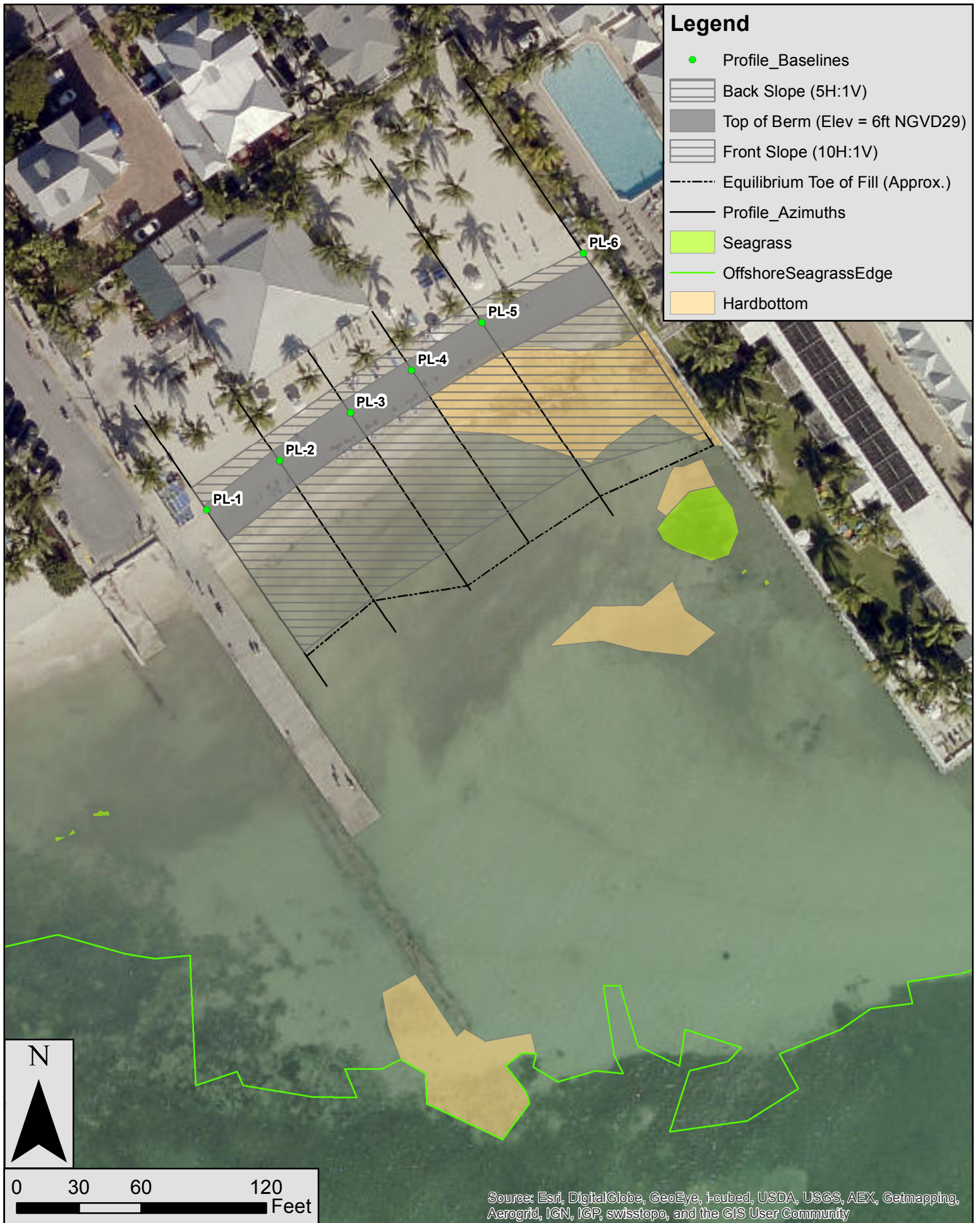
● Post-Irma Survey (11.2017) ● Alternative 3 Template ● ETOF Curve — MHW



South Beach_PL-6

● Post-Irma Survey (11.2017) ● Alternative 3 Template ● ETOF Curve — MHW

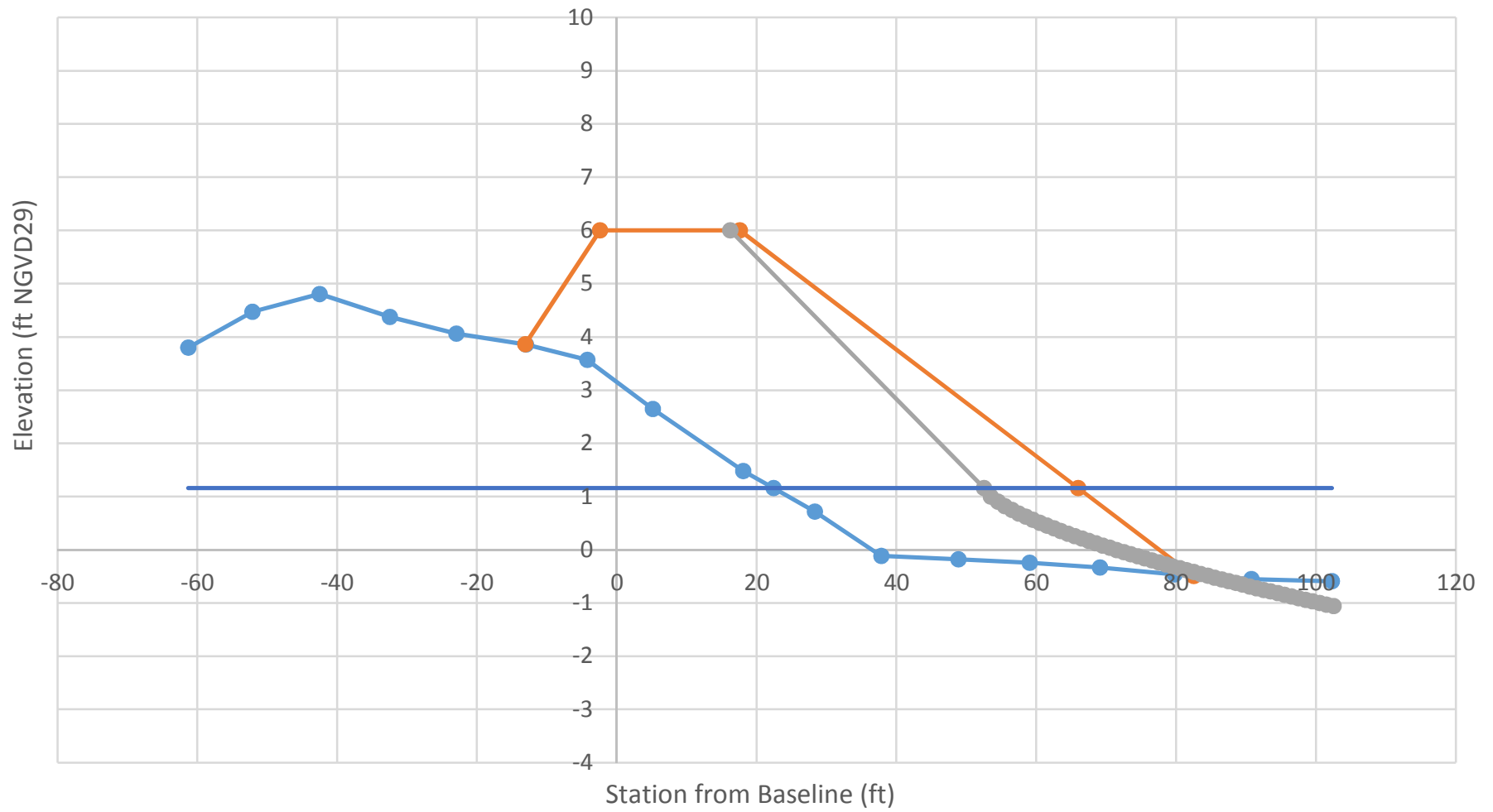




**South Beach Fill Templates
Alternative 4**

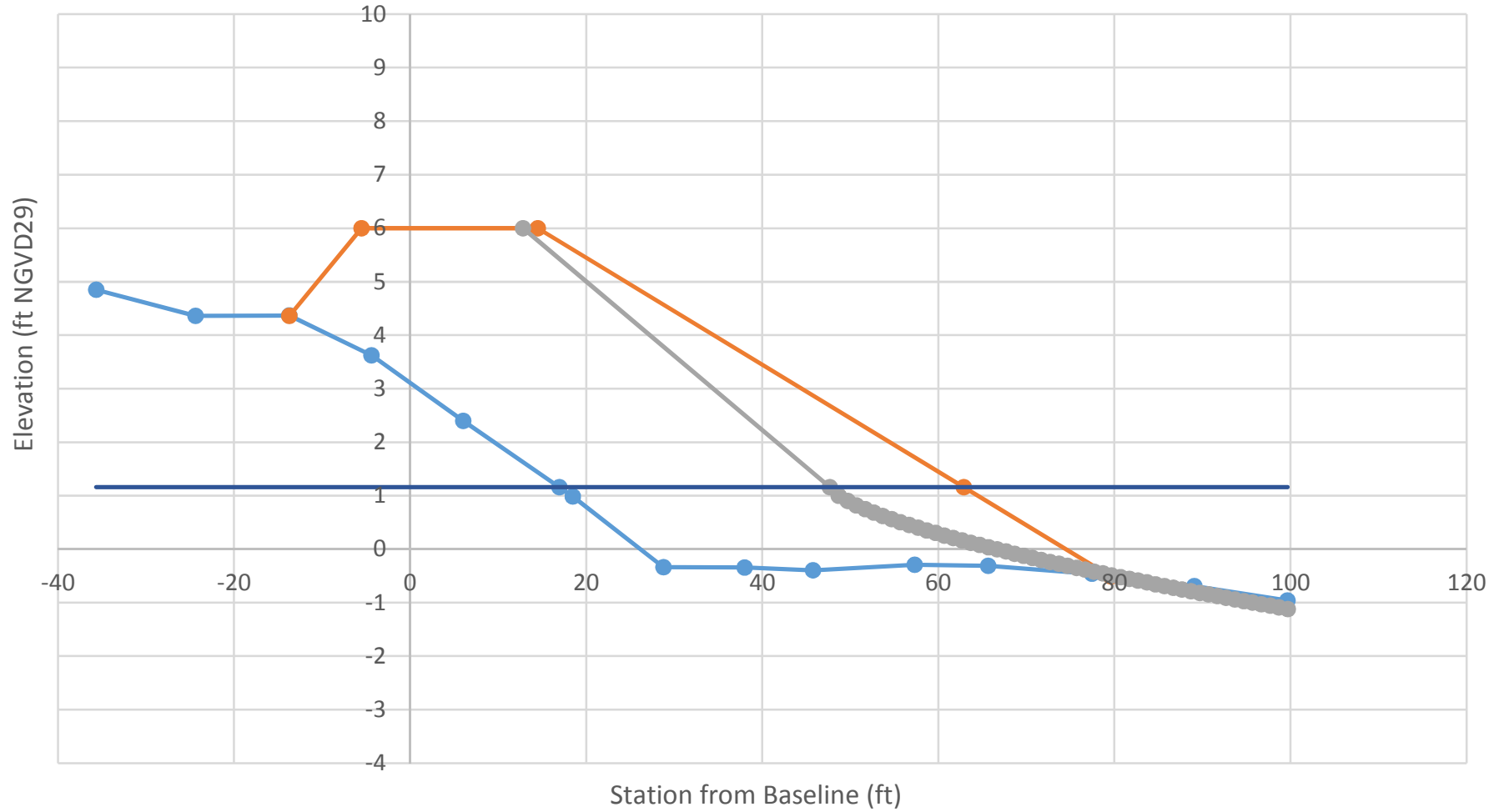
South Beach_PL-1

Post-Irma Survey (11.2017) Alternative 4 Template ETOF Curve MHW



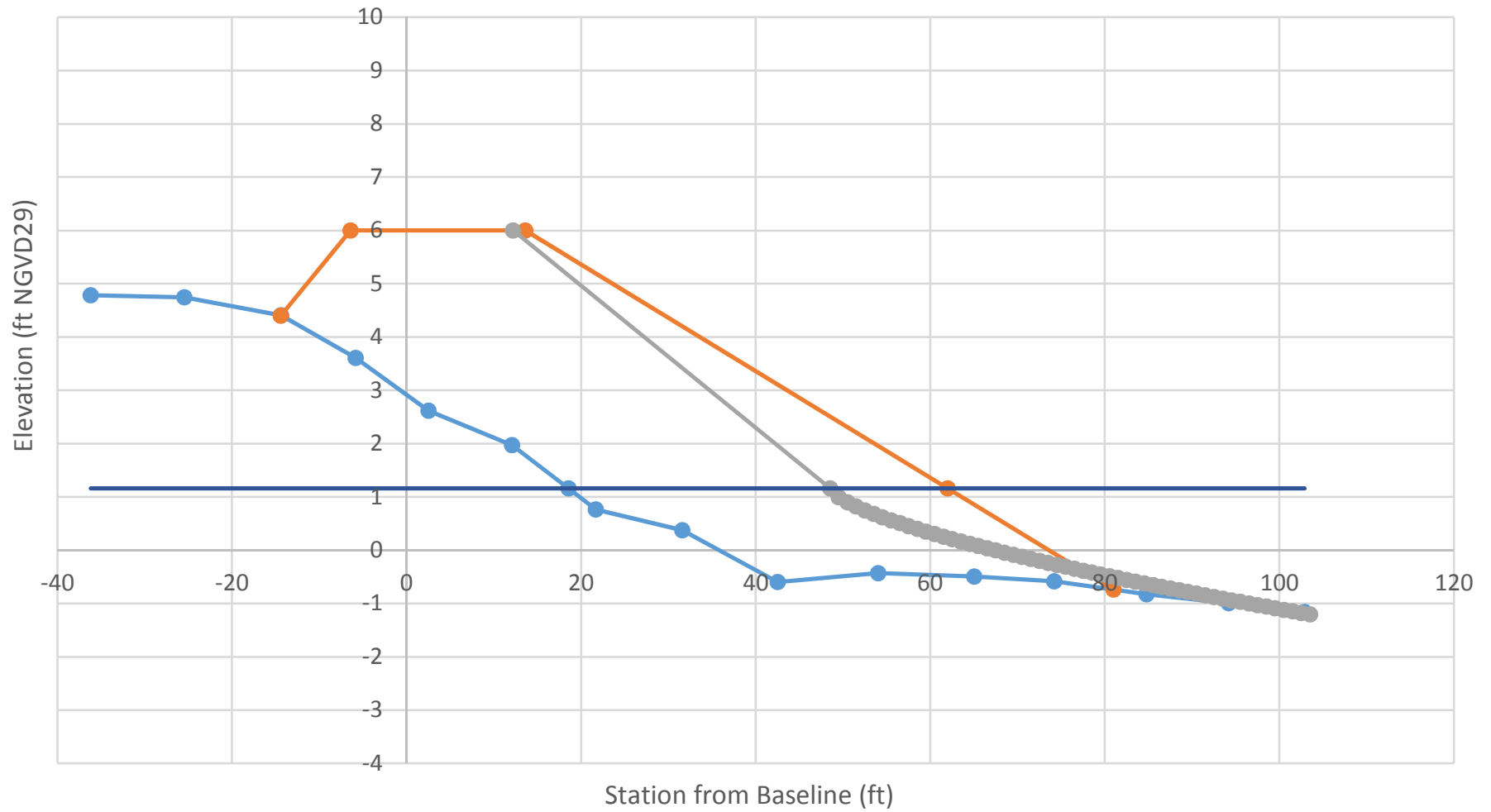
South Beach_PL-2

● Post-Irma Survey (11.2017) ● Alternative 4 Template ● ETOF Curve — MHW

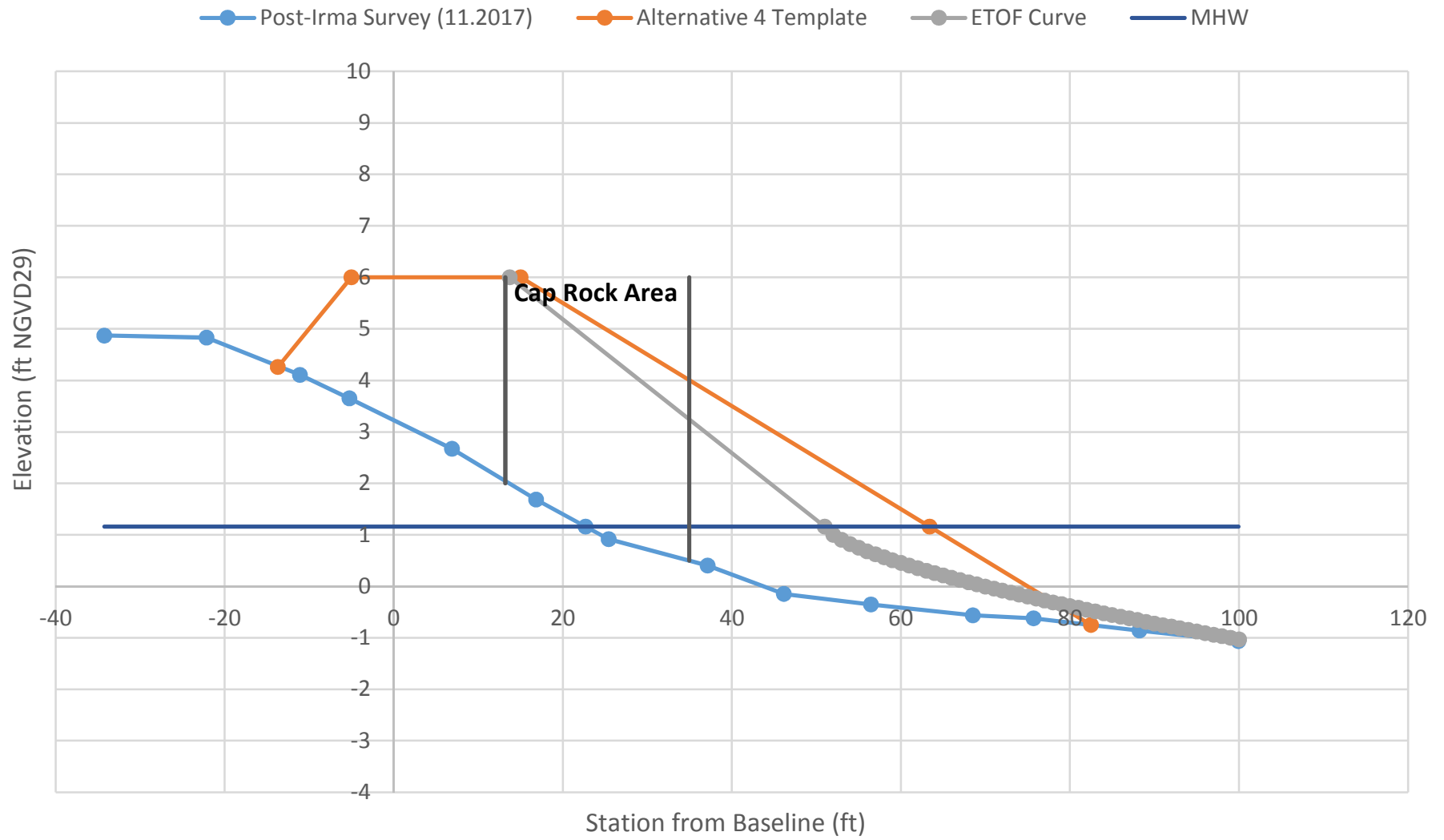


South Beach_PL-3

Post-Irma Survey (11.2017) Alternative 4 Template ETOF Curve MHW

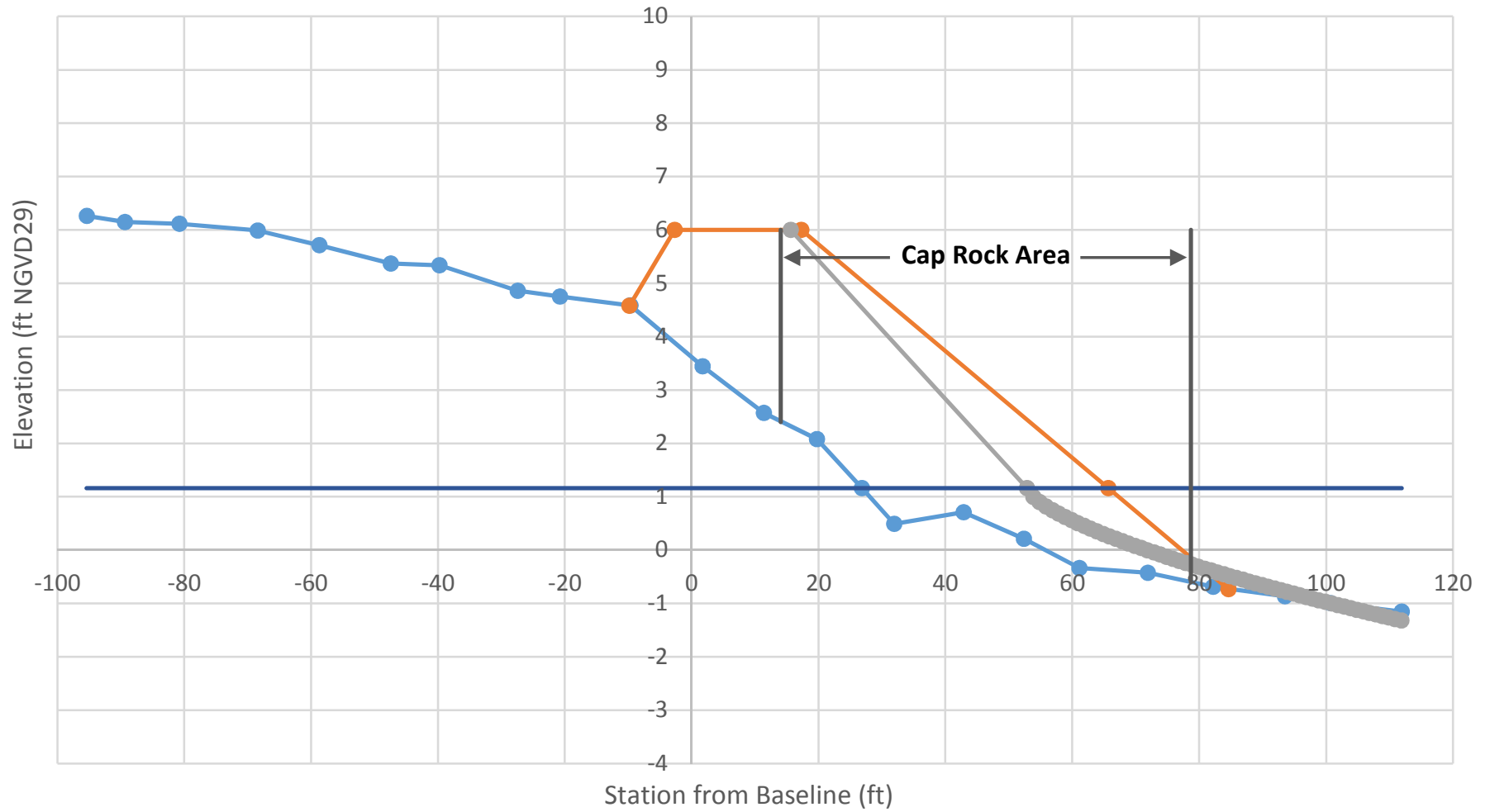


South Beach_PL-4



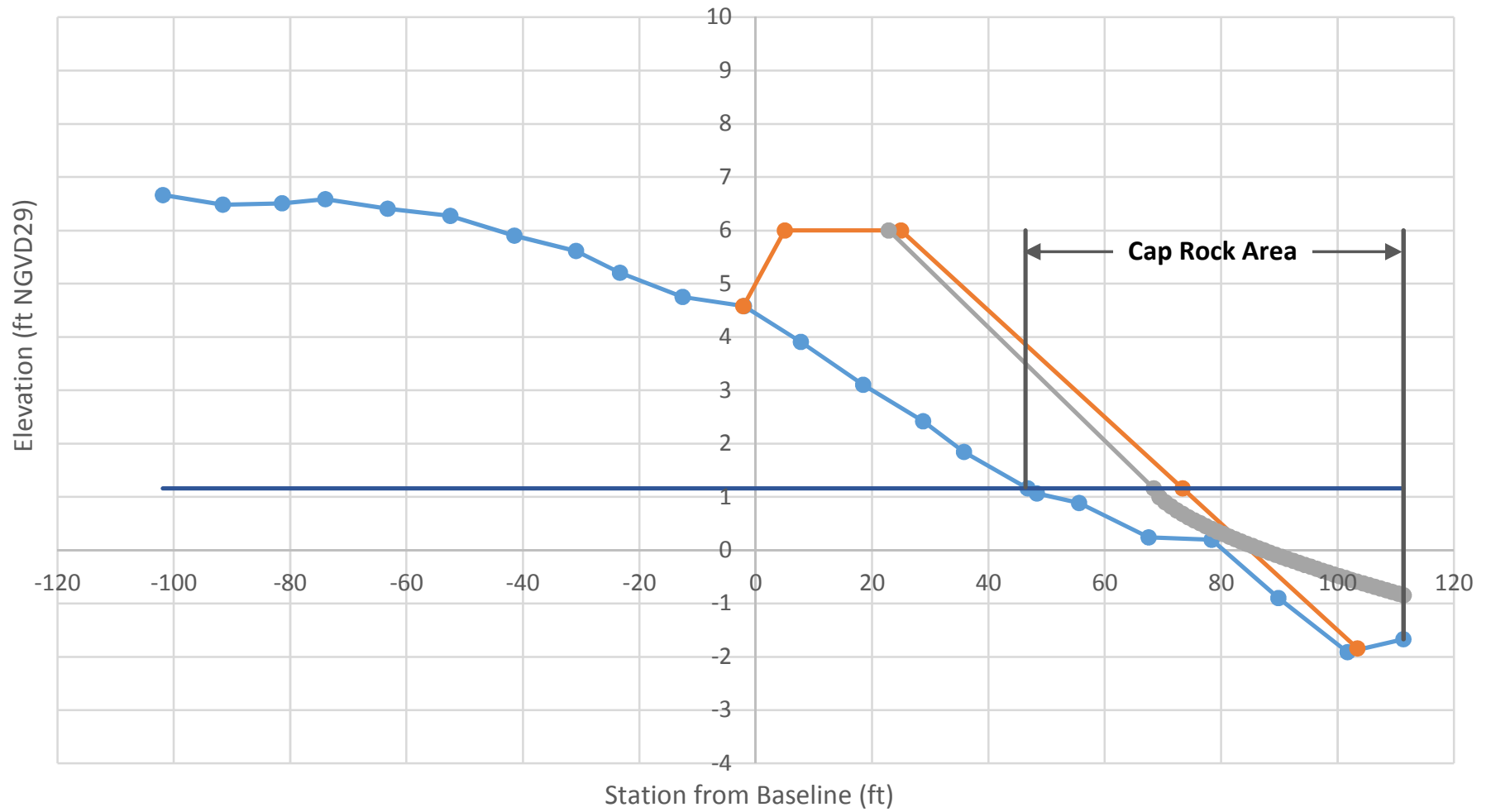
South Beach_PL-5

● Post-Irma Survey (11.2017) ● Alternative 4 Template ● ETOF Curve — MHW



South Beach_PL-6

● Post-Irma Survey (11.2017) ● Alternative 4 Template ● ETOF Curve — MHW



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