NOTICE OF SHORELINE TASK FORCE REGULAR MEETING
CITY OF SOUTH PADRE ISLAND

TUESDAY, OCTOBER 25, 2022

3:00 PM 4601 PADRE BOULEVARD SOUTH PADRE ISLAND, TX 78597

1.Call to Order

2.Pledge of Allegiance

3.Public Comments and Announcements

This is an opportunity for citizens to speak to the board relating to agenda or non-agenda items. Speakers are required to address the board at the podium and give their name before addressing their concerns. [Note: State law will not permit the Shoreline Task Force to discuss, debate or consider items that are not on the agenda. Citizen comments may be referred to City Staff or may be placed on the agenda of a future Shoreline Task Force meeting]

4.Regular Agenda

4.1. Discussion and action to approve the minutes from the regular meeting on September 27th, 2022. (Hughston)

4.2. Discussion and action on preliminary design and the draft technical report presented by HDR Engineering Inc. for the Laguna Madre Living Shoreline project. (Boburka, Hughston)

5.Adjourn

NOTE:

One or more members of the City of South Padre Island City Council may attend this meeting; if so, this statement satisfies the requirements of the OPEN MEETINGS ACT.

DATED THIS THE 21ST OF OCTOBER 2022

Angelique Soto, City Secretary

I, THE UNDERSIGNED AUTHORITY, DO HEREBY CERTIFY THAT THE ABOVE NOTICE OF MEETING OF THE SHORELINE TASK FORCE OF THE CITY OF SOUTH PADRE ISLAND, TEXAS IS A TRUE AND CORRECT COPY OF SAID NOTICE AND THAT I POSTED A TRUE AND CORRECT COPY OF SAID NOTICE ON THE BULLETIN BOARD AT CITY HALL/MUNICIPAL BUILDING ON **THIS THE 21ST OF OCTOBER 2022**, AT/OR BEFORE 4:00 PM AND REMAINED SO POSTED CONTINUOUSLY FOR AT LEAST 72 HOURS PRECEDING THE SCHEDULED TIME OF SAID MEETING.

Angelique Soto, City Secretary

THIS FACILITY IS WHEELCHAIR ACCESSIBLE, AND ACCESSIBLE PARKING SPACES ARE AVAILABLE. REQUESTS FOR ACCOMMODATIONS OR INTERPRETIVE SERVICES MUST BE MADE 48 HOURS PRIOR TO THIS MEETING. PLEASE CONTACT BUILDING OFFICIAL, GEORGE MARTINEZ AT (956)761-8103.

CITY OF SOUTH PADRE ISLAND

CITY OF SOUTH PADRE ISLAND
SHORELINE TASK FORCE
AGENDA REQUEST FORM

MEETING DATE: October 25, 2022

NAME & TITLE: Erika Hughston, Shoreline Grants and Special Projects Administrator

DEPARTMENT: Shoreline Department

ITEM
Discussion and action to approve the minutes from the regular meeting on September 27th, 2022. (Hughston)

ITEM BACKGROUND
Meeting minutes from September 27th, 2022.

BUDGET/FINANCIAL SUMMARY
N/A

COMPREHENSIVE PLAN GOAL
N/A

LEGAL REVIEW
Sent to Legal:
Approved by Legal:

RECOMMENDATIONS/COMMENTS:

MINUTES OF REGULAR MEETING
CITY OF SOUTH PADRE ISLAND
SHORELINE TASK FORCE

Wednesday, September 27th, 2022

I. CALL TO ORDER.

The Shoreline Task Force of the City of South Padre Island, Texas, held a regular meeting on Tuesday, September 27th, 2022, at the Municipal Complex Building, 2nd Floor, 4601 Padre Boulevard, South Padre Island, Texas. Chairman Robert Nixon called the meeting to order at 3:00 p.m. A quorum was present with Chairman Robert Nixon, Task Force Vice Chairman Stormy Wall, Task Force Members Abbie Mahan, Todd Williams, Norma Trevino, and Michael Sularz. Excused absence for Task Force Member Carol Bolstad.

City Council present included: Ken Medders and Kerry Schwartz. City staff present included: City Secretary Angelique Soto, Shoreline Director Kristina Boburka, and Coastal Coordinator Erika Hughston.

II. PLEDGE OF ALLEGIANCE.

Chairman Robert Nixon led the Pledge of Allegiance.

III. PUBLIC COMMENTS AND ANNOUNCEMENTS:

No public comments were given at this time.

IV. REGULAR AGENDA

I. DISCUSSION AND ACTION TO APPROVE THE MINUTES FROM THE REGULAR MEETING ON SEPTEMBER 21ST, 2022. (HUGHSTON)

Task Force Member Mahan made a motion to approve the minutes, seconded by Task Force Member Williams. Motion carried unanimously.

II. UPDATE ON DEPARTMENT PROJECTS. (BOBURKA, HUGHSTON)

- **COASTAL MANAGEMENT PROGRAM (CMP) CYCLE 24**
- **CMP CYCLE 25**

−**CMP CYCLE 26**
−**CMP CYCLE 27**
−**MARISOL BOAT RAMP**
−**BAYSIDE LIVING SHORELINE**

Shoreline Director Boburka and Coastal Coordinator Hughston gave project updates.

V. ADJOURNMENT.

There being no further business, Chairman Nixon adjourned the meeting at 3:13 p.m.

______________________________ Erika Hughston, Coastal Coordinator

______________________________ Robert Nixon, Chairman

Item No. 4.2

CITY OF SOUTH PADRE ISLAND
SHORELINE TASK FORCE
AGENDA REQUEST FORM

MEETING DATE: October 25, 2022

NAME & TITLE: Erika Hughston, Shoreline Grants and Special Projects Administrator

DEPARTMENT: Shoreline Department

ITEM
Discussion and action on preliminary design and the draft technical report presented by HDR Engineering Inc. for the Laguna Madre Living Shoreline project.

ITEM BACKGROUND
The presentation and review of the Laguna Madre Living Shoreline project preliminary designs and technical report.

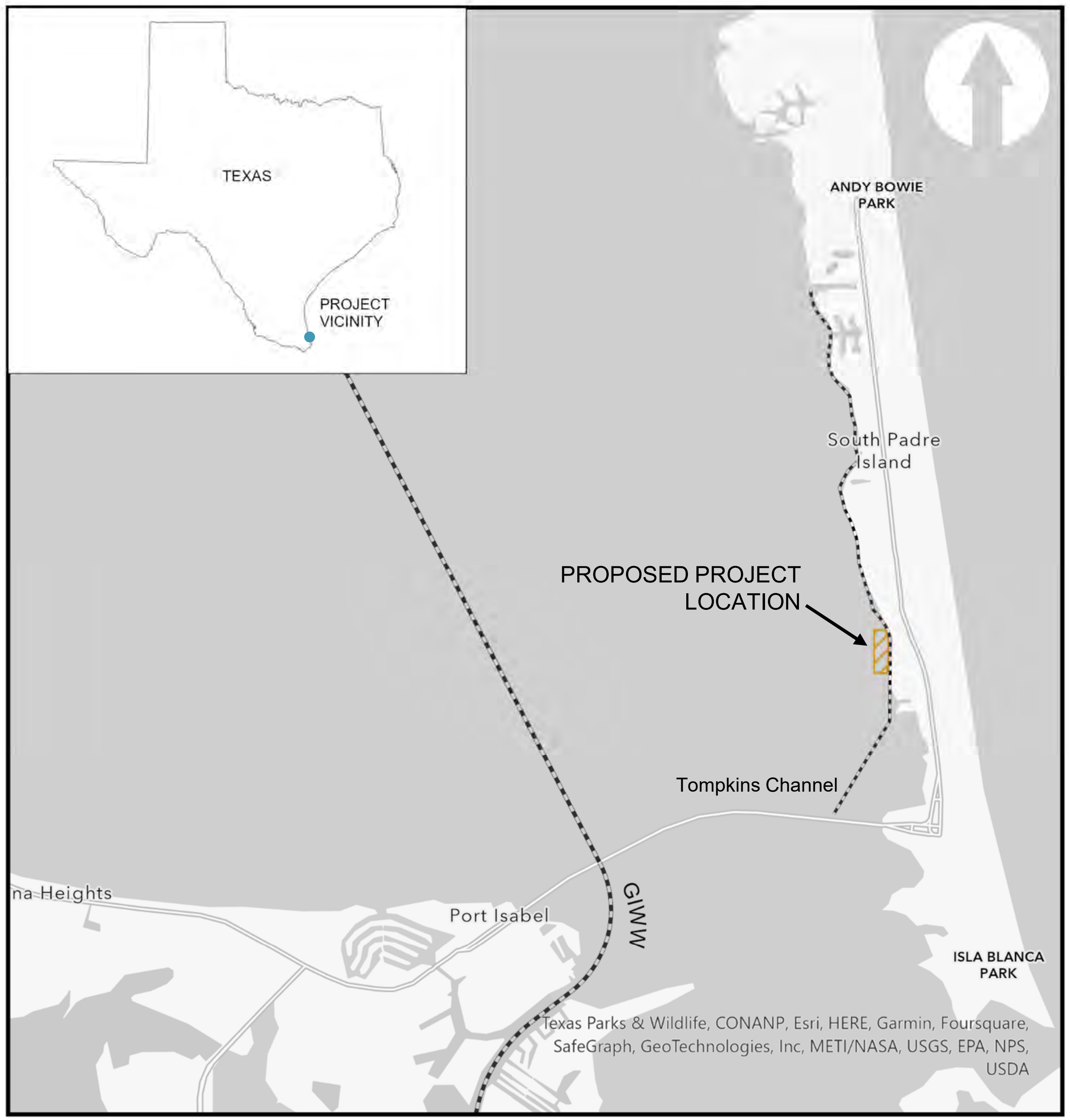
BUDGET/FINANCIAL SUMMARY
N/A

COMPREHENSIVE PLAN GOAL
Chapter 9: Shoreline

LEGAL REVIEW
Sent to Legal:
Approved by Legal:

RECOMMENDATIONS/COMMENTS:

PROJECT SPONSER



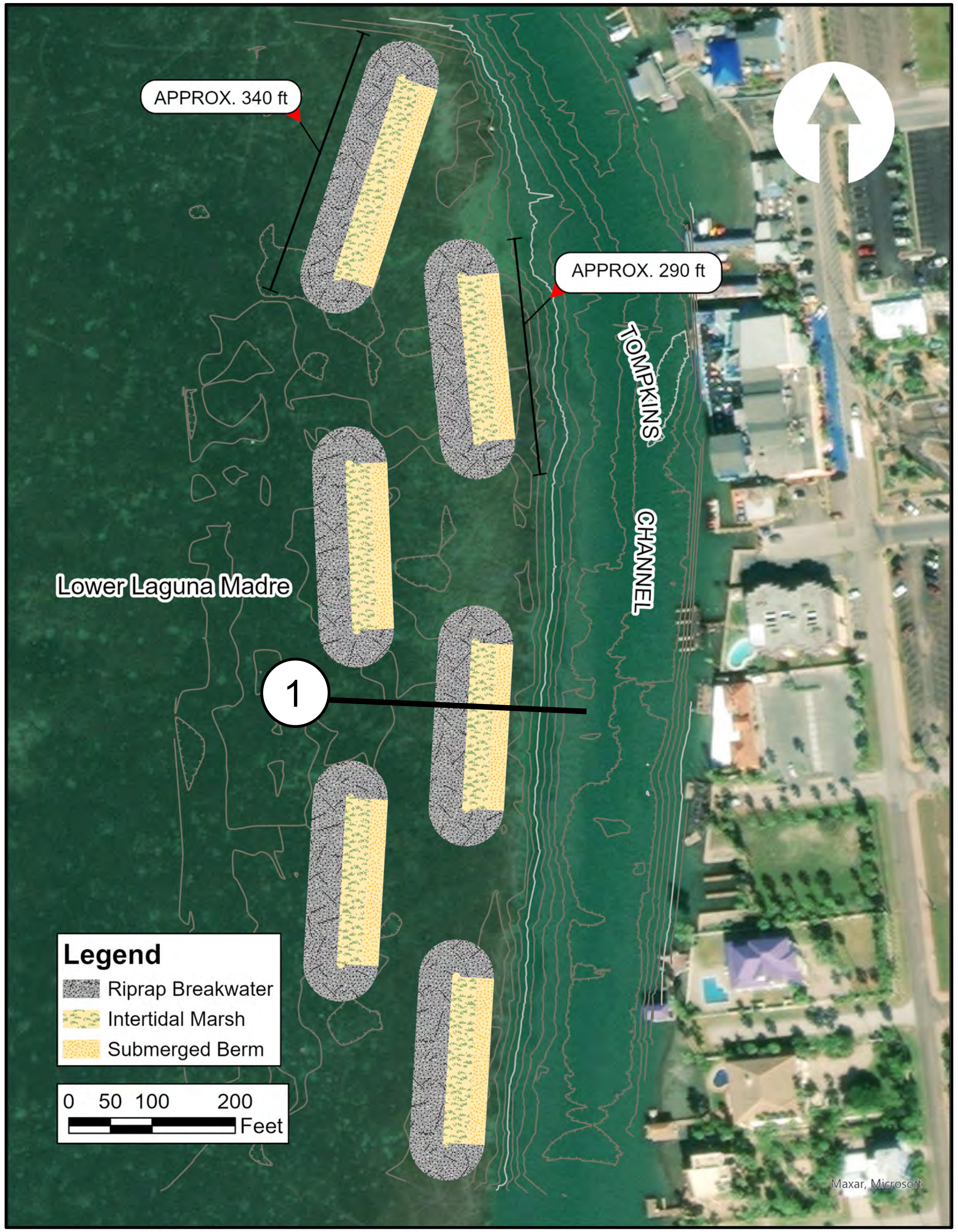
Exhibits for

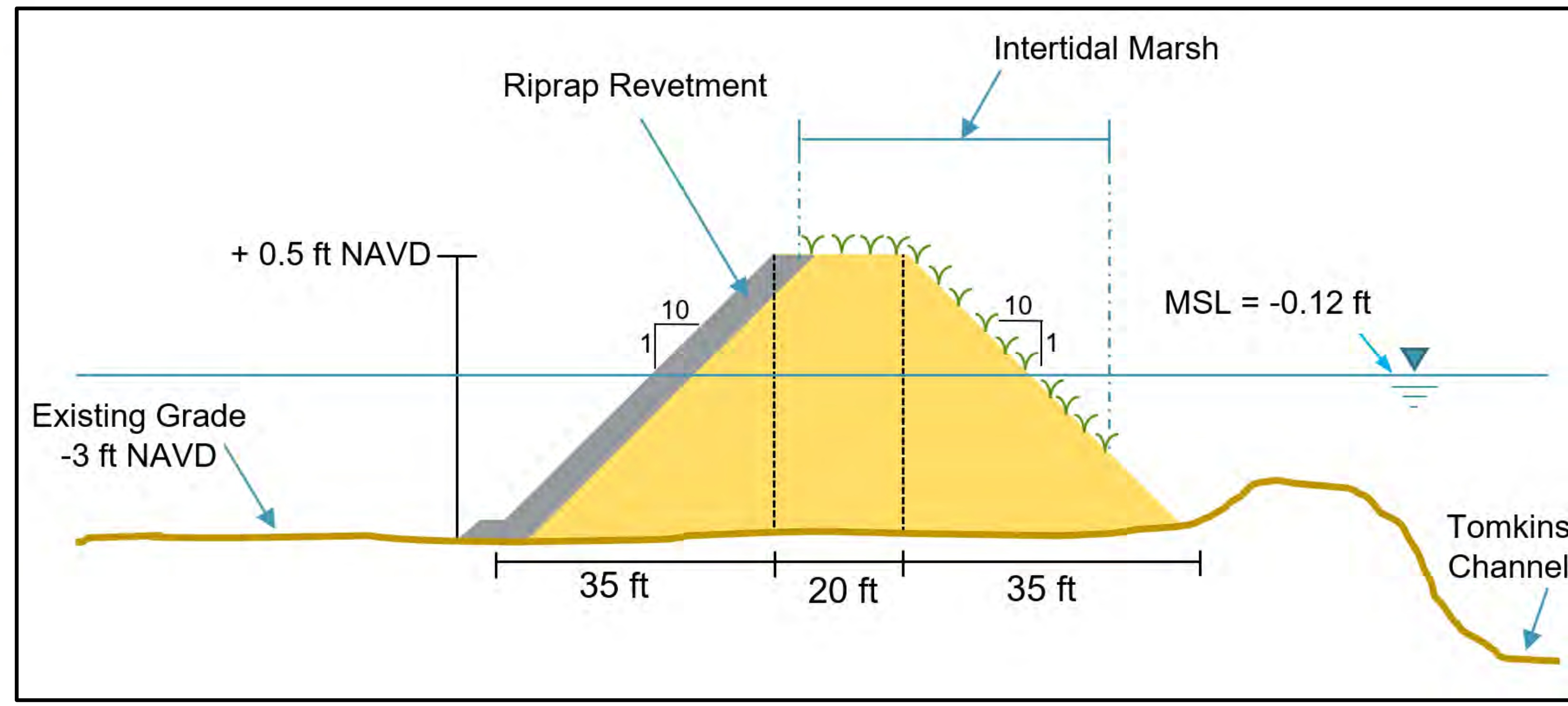
CITY OF SOUTH PADRE

LAGUNA MADRE LIVING SHORELINE

HDR Project No. 10333313

SOUTH PADRE ISLAND
SEPTEMBER 2022





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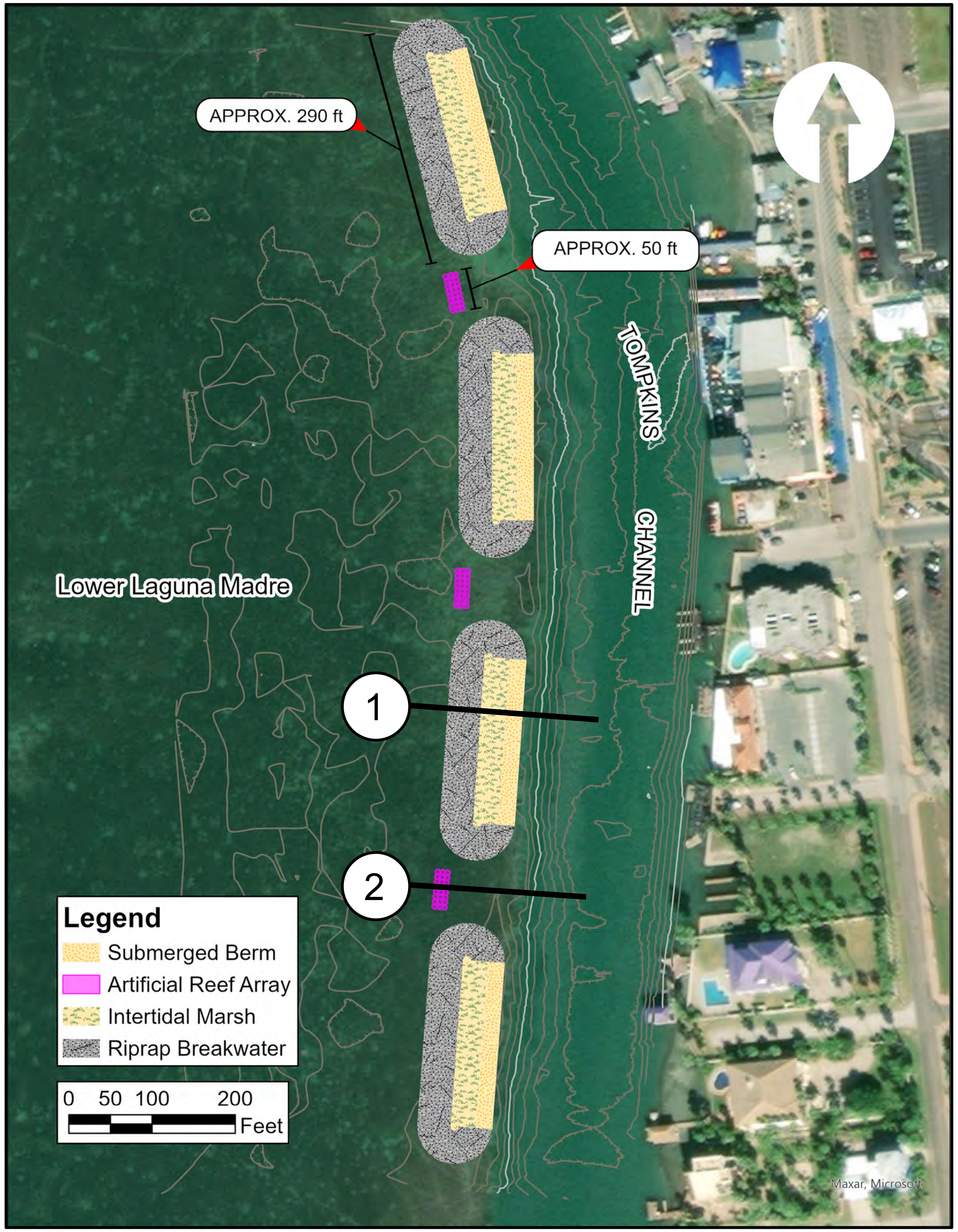

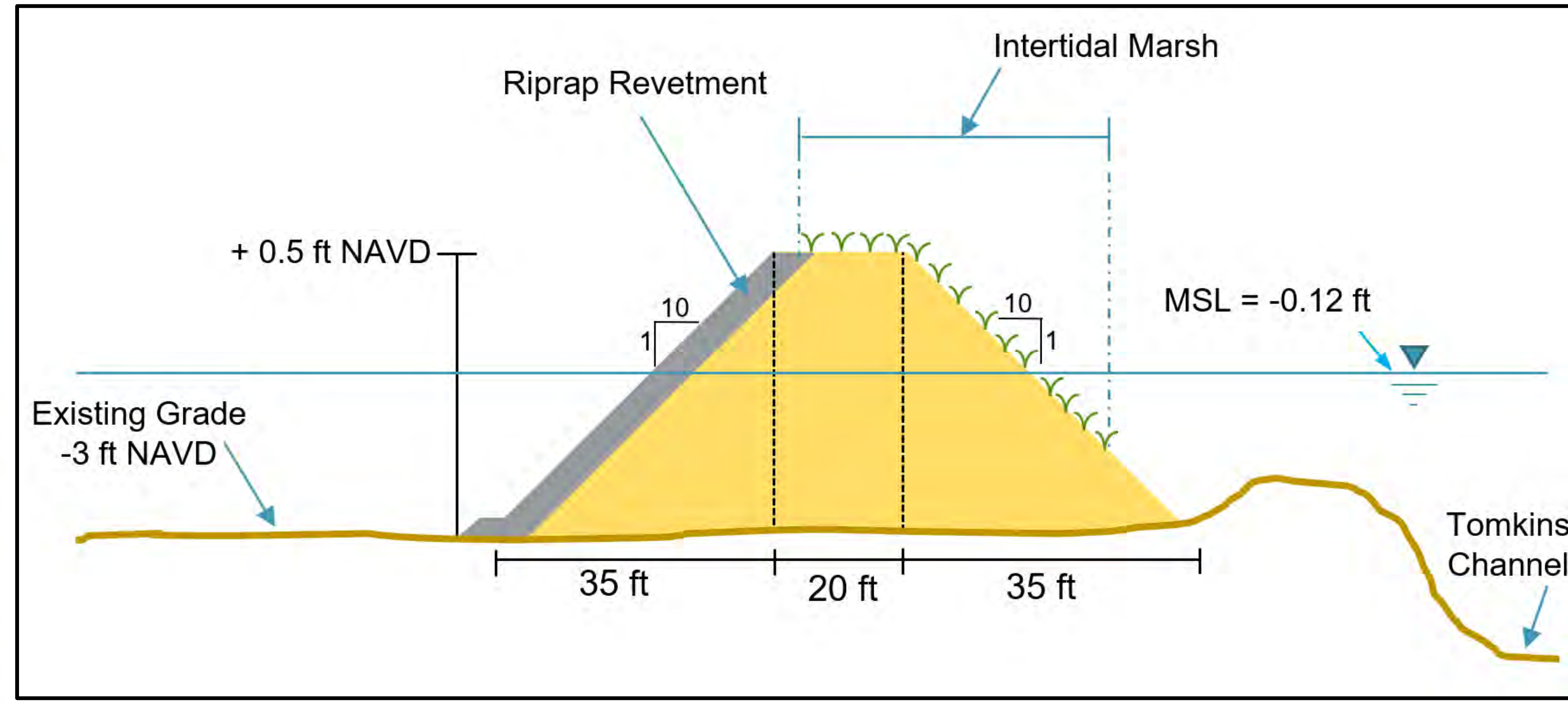

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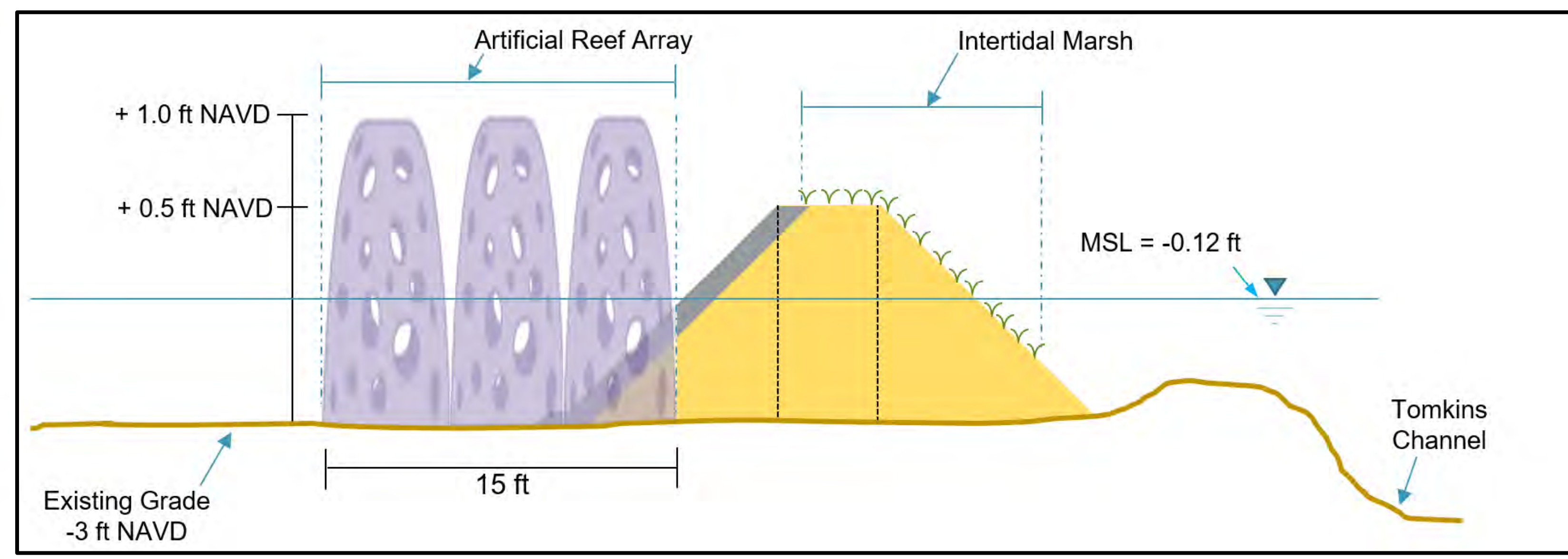
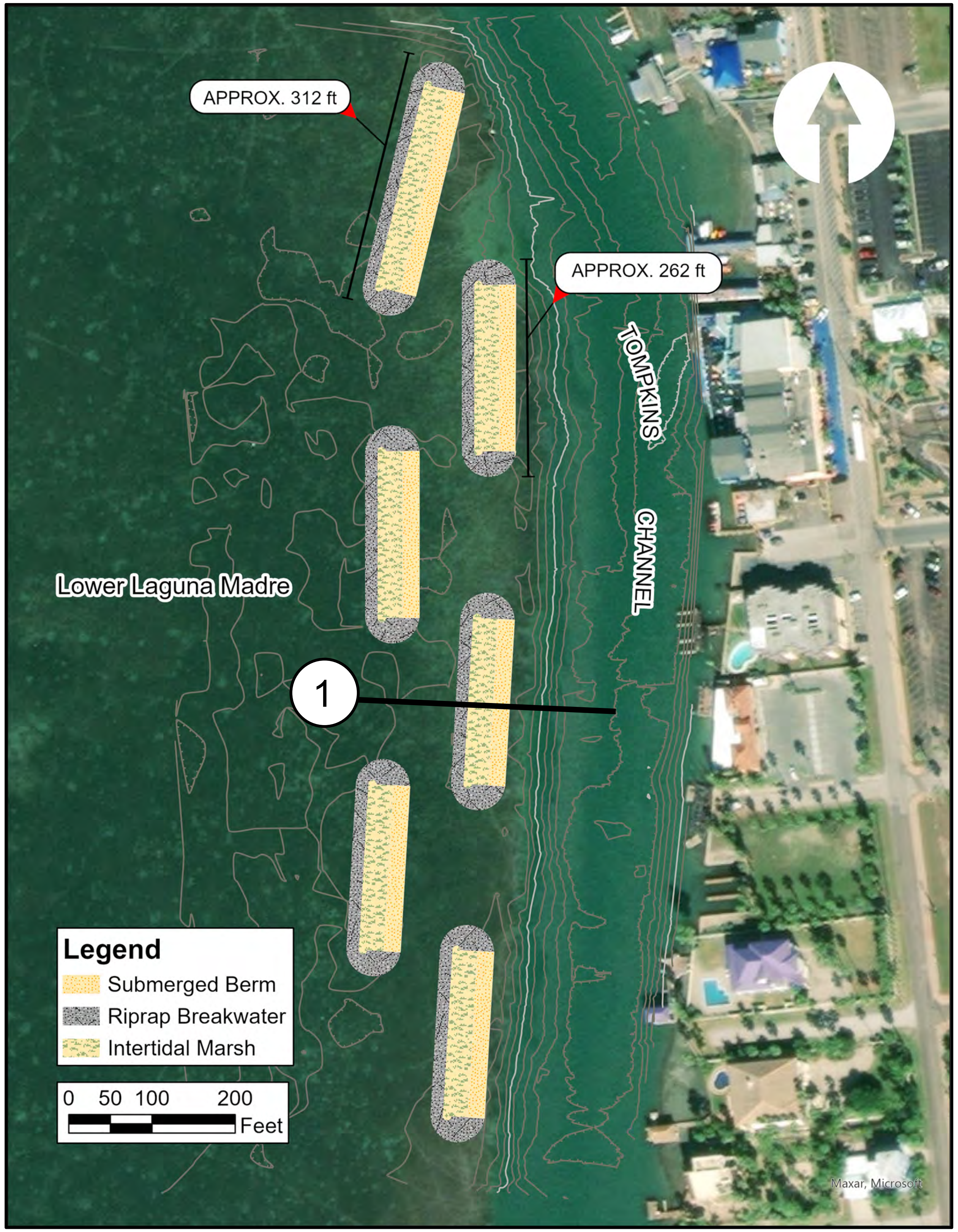


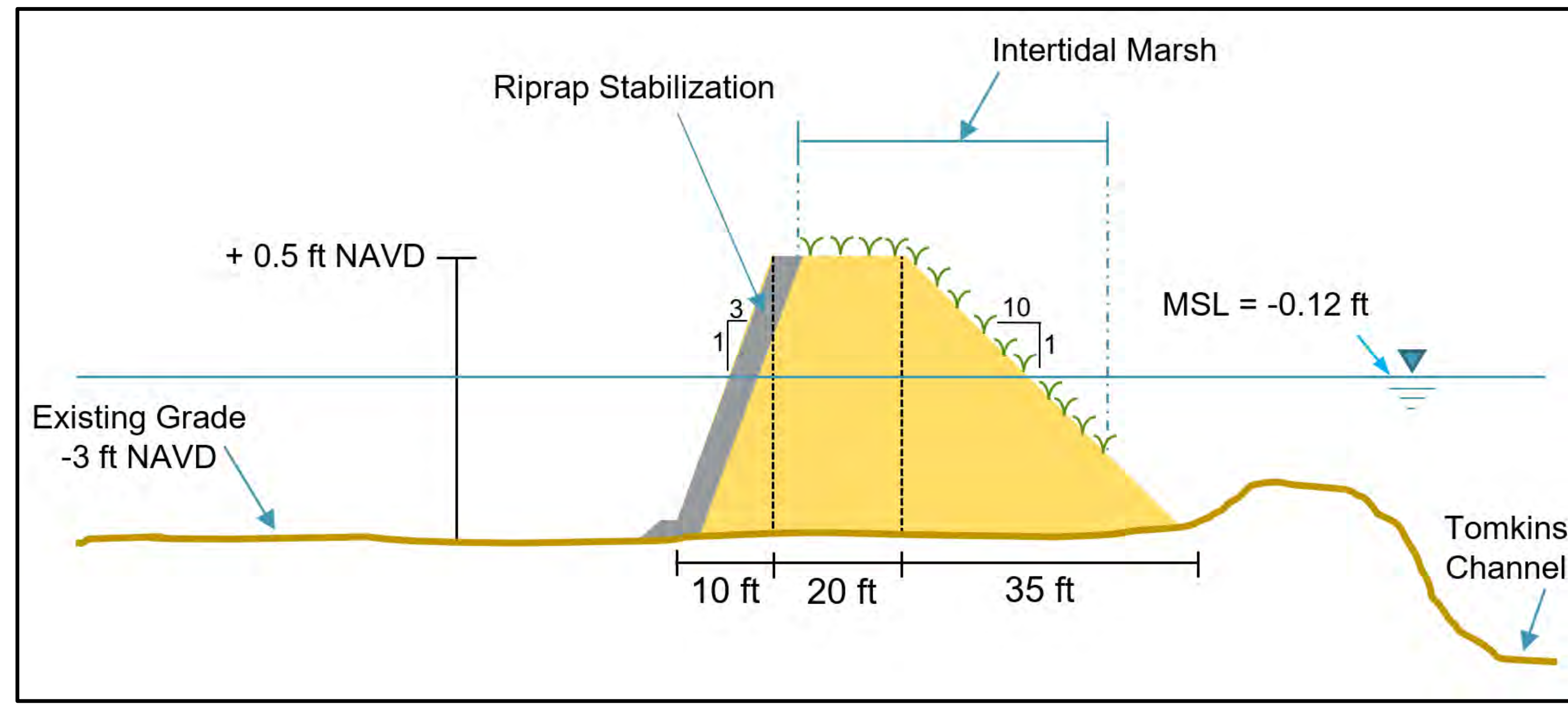
2 TYPICAL SECTION – ARTIFICIAL REEF ARRAY BETWEEN BERMS

LAGUNA MADRE LIVING SHORELINE

INTERTIDAL BERM ALTERNATIVE - 1 ROW OF 10H:1V BERMS WITH ARTIFICIAL REEF ARRAYS

EXHIBIT 2





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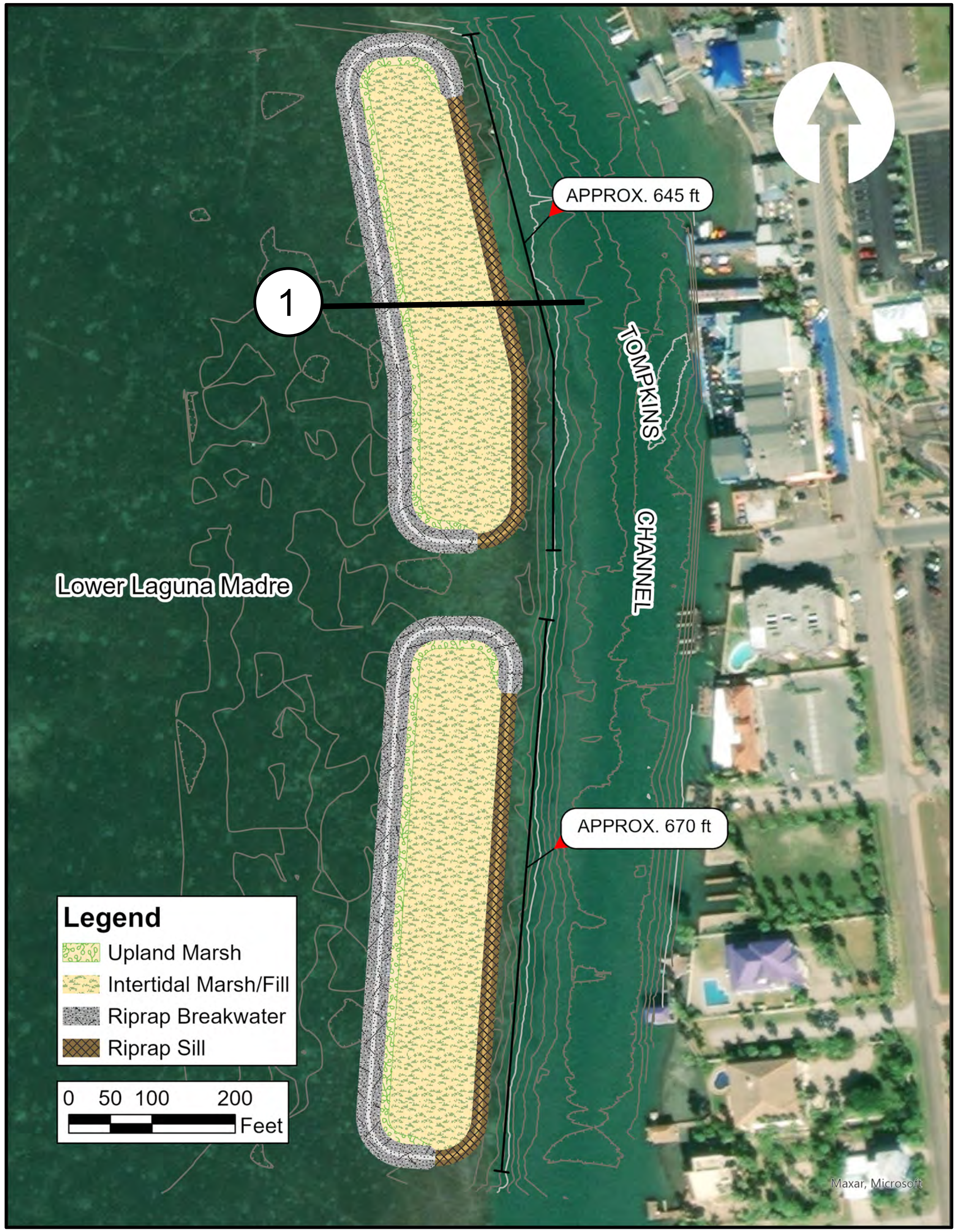

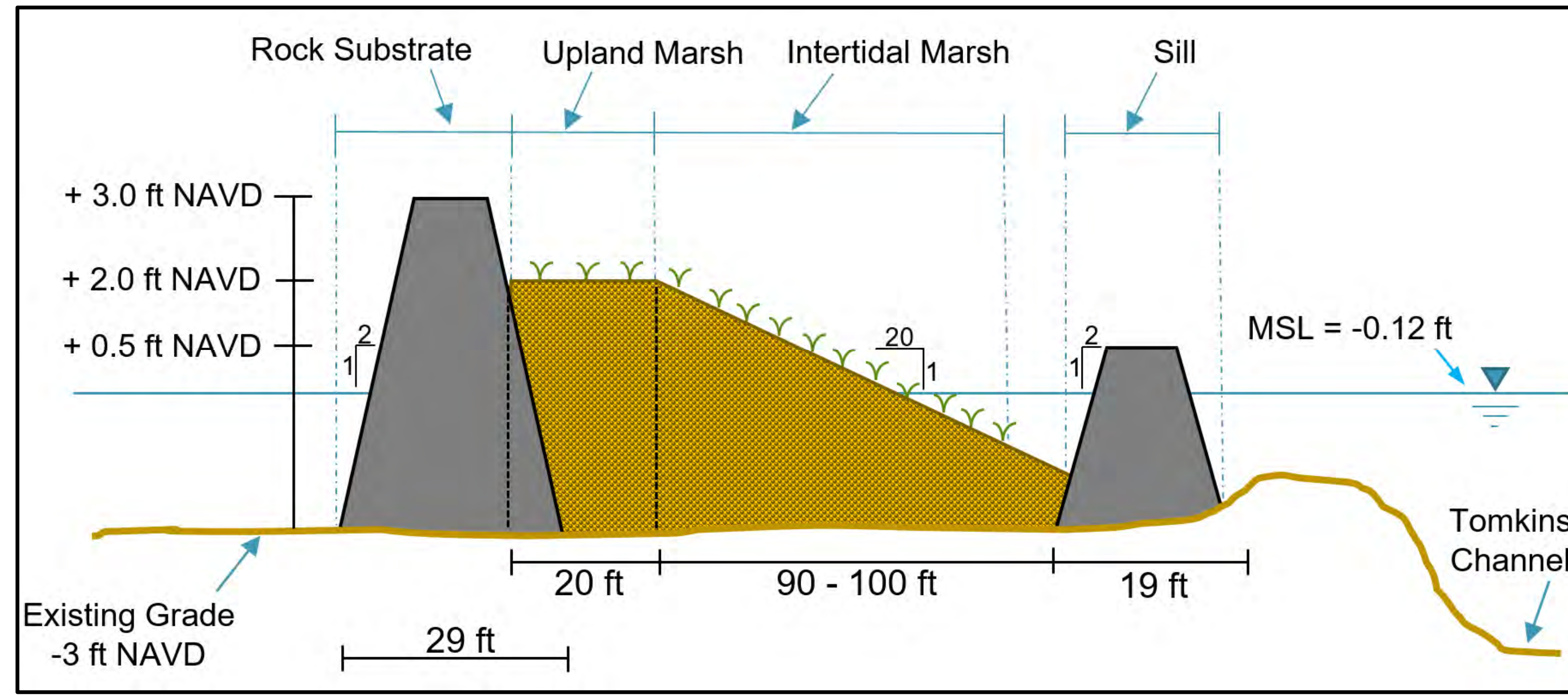

1 TYPICAL SECTION – LIVING BREAKWATER WITH MARSH PLANTING

-DRAFT-
Technical Report

Laguna Madre
Living Shoreline Project

South Padre Island, TX

September 30, 2022

PRELIMINARY

THIS DOCUMENT IS RELEASED FOR THE PURPOSE OF INTERIM REVIEW AND IS NOT INTENDED TO BE USED FOR CONSTRUCTION, BIDDING, OR PERMIT PURPOSES.

ENGINEER	REGISTRATION NO.
Cameron Perry, P.E.	94056

DATE: 09-30-2022

HDR Engineering, Inc.
TBPELS Firm Registration No. F-754

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1 Introduction

The City of South Padre Island (City) is located on a barrier island on the southern tip of the Texas coast near Brownsville, Texas. The city is known for its renowned beaches, clear water, and ecological value. These qualities have made South Padre Island (SPI) a hub for tourism and home to approximately 2,800 residents (2021 Census. In 2018 the City issued their Shoreline Master Plan developed from community stakeholder input. The plan promotes increasing coastal resiliency and protecting their natural resources.

Protecting against coastal flooding on both the gulf and bay side of the island is a key component to this master plan. The City has developed a vegetated dune system on the gulf shoreline and performs routine beach nourishments to maintain beach widths for tourism as well as flood protection for the gulf side of the island. The bayside however is mostly hardened waterfront consisting of bulkheads, docks, marinas, and other infrastructure. Flooding and wave forcing on the bay waterfront results in property damages and poses threats to community safety. As part of the Shoreline Master Plan, using living shoreline projects as applicable was proposed to help provide protection to upland infrastructure. The proposed living shoreline is intended to act as a first line of defense against waves and storm surge that currently impact the bay shoreline. The structures would also create habitat in the bay for diverse species, principally intertidal wetlands that would sustain fish populations, migratory birds and other species like shellfish. Secondary benefits of these living shorelines are envisioned as improving water quality and adding recreational value to the community.

The City has received funding from the National Coastal Resiliency Fund (NCRF) grant administered by the National Fish and Wildlife Foundation to design a pilot project for the proposed living shoreline network. The City then partnered with HDR and the United States Geographical Survey (USGS) to develop conceptual design alternatives for this pilot project. The USGS is performing various field data collection efforts, including bathymetric surveying within the study area, biological surveys, and water level and wave measurements. HDR services include supplementing the field work with a desktop level study to gather available data on the project area and prepare conceptual living shoreline alternatives based on the collected data and collaboration with the City. This Technical Report summarizes the collected data from USGS and HDR, descriptions of the conceptual design alternatives, and the results of the Joint Evaluation Meeting (JEM) held on <##>, November 2022.

1.1 Project Location

The pilot project site is located on the bay side of SPI along the Lower Laguna Madre (LLM), north of Port Isabel (see Figure 1). Located along the Gulf of Mexico, this region is exposed to the relatively active Atlantic Hurricane Season. It is important to note that the position of the project site within the bay shelters the site from offshore swells from the Gulf. Instead, local wave climates are dominated by locally generated wind waves within the LLM.

Figure 1. Project Location

The proposed project site (or potential protection location) is on the west side of Tompkins channel in the vicinity of Pike St. and Pompano St. as shown in Figure 2. This region is part of a relatively shallow, nearshore region that supports a substantial seagrass habitat within the LLM. The developed shoreline on the bayside of the SPI barrier island consist mainly of commercial and residential properties with docks extending into the bay. As a result, boat traffic near the project site will consist primarily recreational vessels.

Figure 2. Study area and site access

1.2 Historical Imagery.

Prior to development of the barrier island, the bay side of South Padre Island typically consisted of sandy shoreline along with intertidal marsh and flats along the shoreline. Following the development of the island, in particular the creation of Tompkins Channel adjacent to the island, much of the shoreline became hardened with bulkheads and docks. As a result, for the past few decades, there hasn't been significant recession of the bayside shoreline based on a review of available images provided by Google Earth and the Texas Natural Resource Information System (TNRIS).

2 Data Collection and Analysis

HDR gathered available information on historic shoreline positions, bathymetry and topography, water levels at the site, meteorological information, oil and gas infrastructure, and environmental conditions in the project vicinity. The USGS collected environmental, bathymetric, and meteorological data within the project area. An analysis of these data was performed to guide the conceptual level design of the living shoreline alternatives.

The following sections will describe the data collected for this phase of the project. All data references the North American Datum of 1983 (NAD83) State Plane Texas South 4205 horizontal datum in US feet and the North American Vertical Datum of 1988 (NAVD88) vertical datum in US feet.

2.1 Bathymetric and Topographic Data

Topographic and bathymetric data was used to assess wave and hydrodynamic conditions in the project area as well as accessibility to the site. HDR gathered bathymetric and topographic data comes from a Continuously Updated Digital Elevation Model (CUDEM) of the U.S. coast found in the NOAA Bathymetry Viewer (CIRES, 2021). Figure 3 shows the contour lines of the approximate bathymetric data near the study area.

Figure 3. NOAA CUDEM Bathymetric and Topographic Contours

The USGS performed a bathymetry survey in July 2021 of the entire proposed project site as well as part of Tompkins channel. This survey was conducted by wading and also taking measurements from a boat using a rod-mounted Global Navigation Satellite Systems (GNSS). Survey data are shown in Figure 4 with a cross-section taken from the shoreline at Marlin St. that extends nearly perpendicular to shore. The section shows the Tompkins Channel section as well as the relatively flat nearshore region with an approximate depth of -3.0 ft NAVD (Ockerman, D. J., 2022).

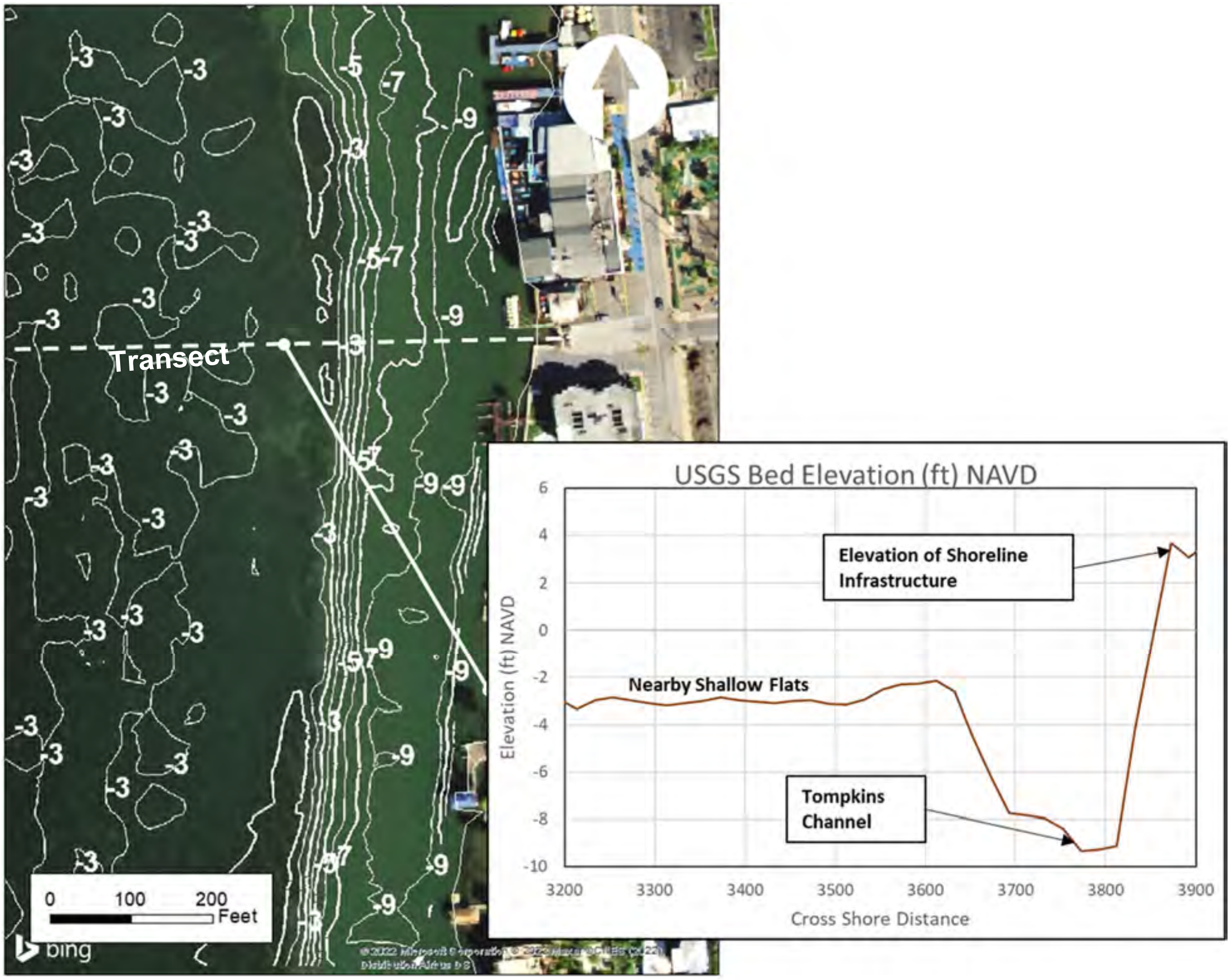

Figure 4. USGS Bathymetric Survey

2.2 Environmental Data

Environmental data of the project area was studied to guide conceptual design efforts. Seagrass coverage and oyster habitat maps are readily available for the LLM. The USGS collected data on the seagrass beds, benthic invertebrate populations, and water quality in the project area. Information regarding seagrass habitat, essential fish habitat, endangered species, and other environmental items will be referenced in future phases of the project as it pertains to regulatory permits of proposed design options.

2.2.1 Seagrass

Seagrass mapping of the LLM was obtained from the Texas Parks & Wildlife (TPWD) ArcGIS Seagrass online tool which encompasses data gathered from NOAA Coastal Services Center based on photointerpretation, digitization, and computer image processing of digital imagery methodologies (TPWD, 2022). The TPWD shapefile of the extent of seagrass coverage in and around the project area is shown in Figure 5. Seagrass observed on the aerial photograph outside of the TPWD shapefile may be due to recent changes in seagrass habitat or variations in satellite imagery used for mapping.

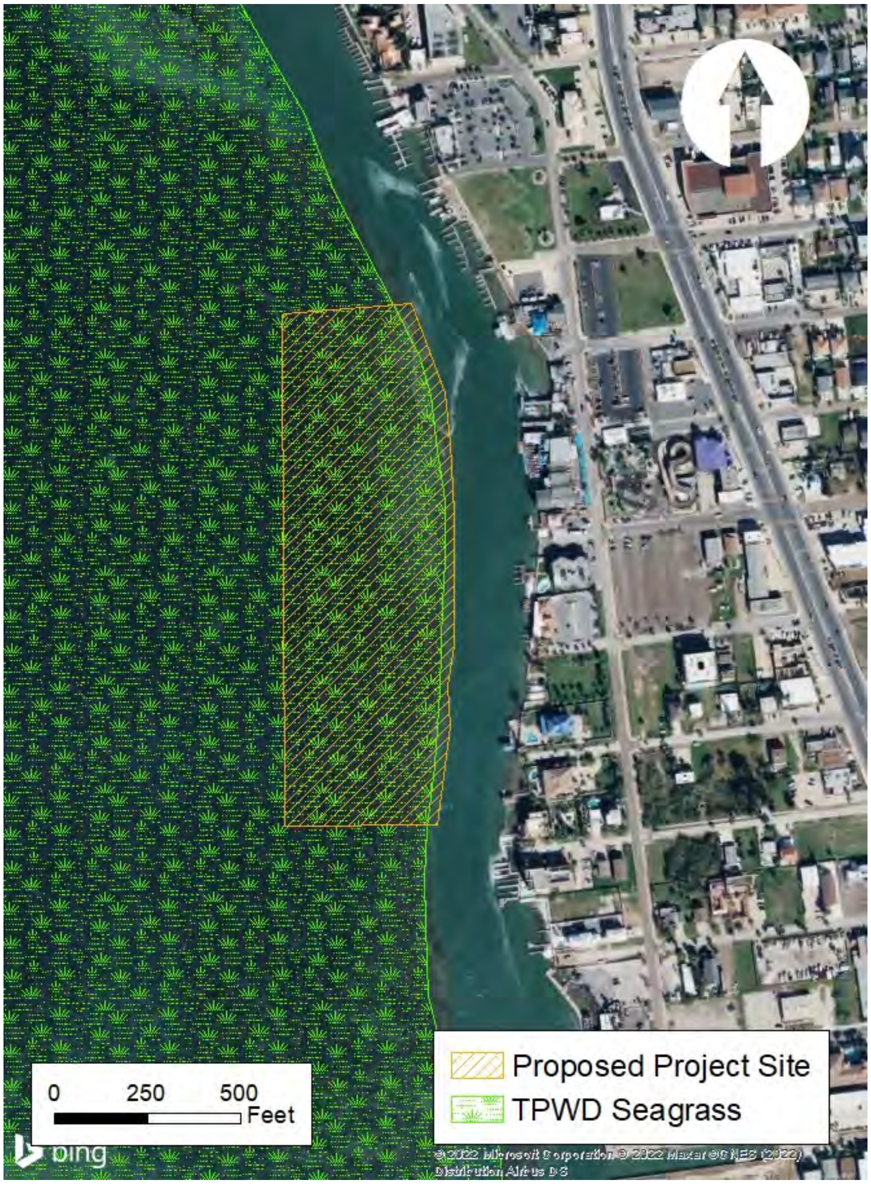

Figure 5. Seagrass extent from TPWD records

In July 2021, the USGS surveyed the project area to measure seagrass coverage, benthic invertebrate abundance and water quality. These data were collected along eight transects within the project area with three samples taken at each transect. The seagrass data collected showed almost complete coverage in the surveyed locations within the project area with varying levels of density (measured by shoot count) and seagrass species dominance (Opsahl, S.P. et al., 2022). The sample locations and summary of these findings are provided in Figure 6. The symbology used in Figure 6, represents the measured shoot count by the size of the pie chart and the number to the top right whereas the shading of each pie chart symbolizes the proportion of different seagrass species that were observed at the survey locations.

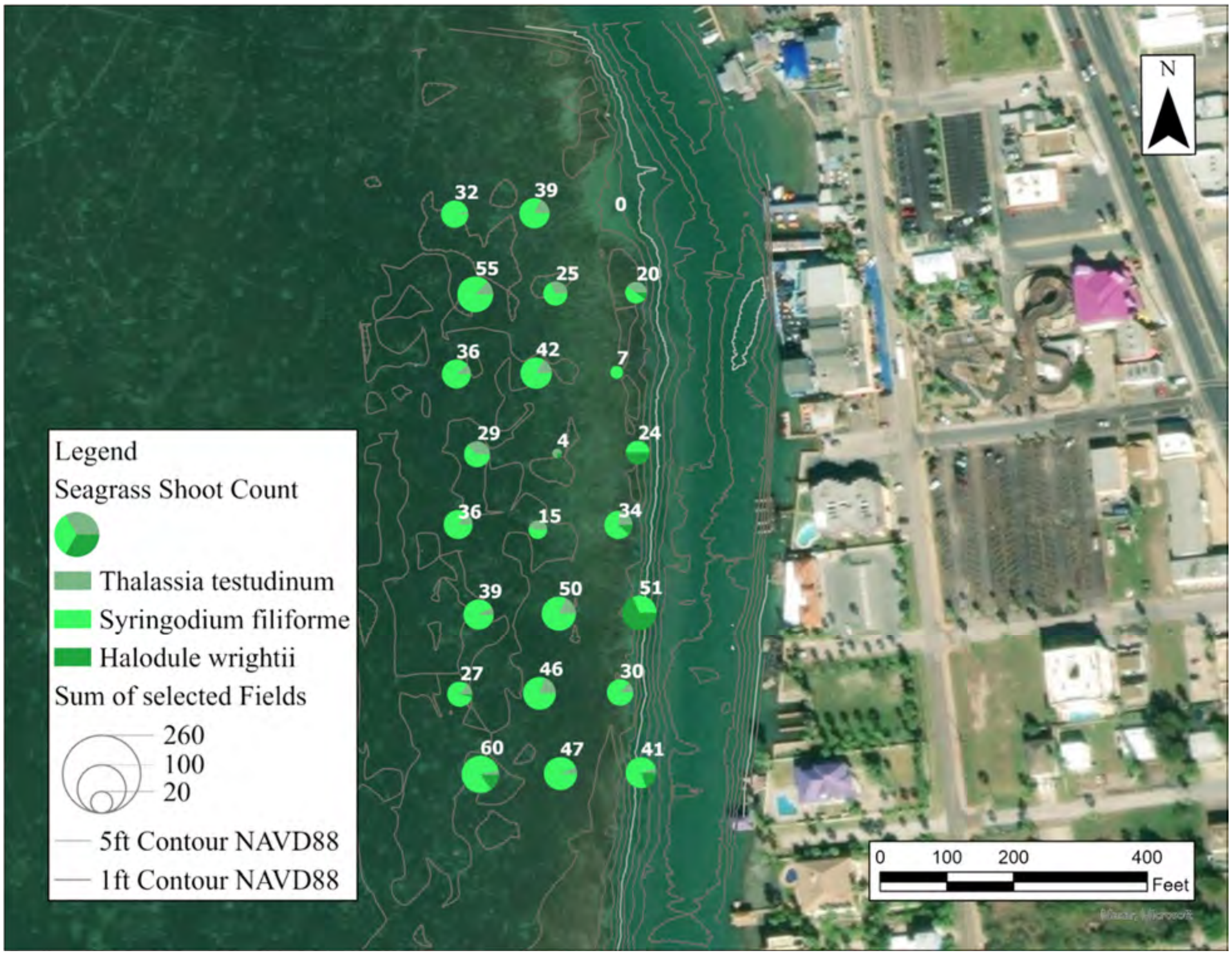

Figure 6. Summary of USGS seagrass count and species data

2.2.2 Benthic Invertebrate and Water Quality Data

Benthic invertebrate samples collected by the USGS during July 2021 as mentioned in Section 2.2.1. measured biodiversity in the project area. Specimens were sorted by hand, via sieves, and by microscopic inspection. The following online resources were used to identify individual specimens: gulfbase.org, txmarspecies.tamug.edu, gbif.org, marinespecies.org, and boldsystems.org. This analysis resulted in an inventory of the species that were observed in the project area. These results were uploaded to the Integrated Taxonomic Information System (IT IS) for the specimens that were successfully identified.

USGS made water-quality measurements before and after each sample of seagrass and benthic invertebrates were collected. The measured phenomenon were water temperature, specific conductance, dissolved oxygen, PH, and turbidity (Opsahl, S.P. et al., 2022).

HDR also gathered information on oyster populations in the LLM from the Conservation Blueways group ArcGIS online dataset (Blueways, 2022). This dataset includes historical oyster reef information up to 1975 from NOAA Coastal Services Center. The data set provided no indication of existing oyster habitat near the project site; however, oyster habitat and small shell mounds have been observed in the vicinity of the project. No habitat is expected within the proposed project are due to presence of seagrass meadows.

2.3 Oil and Gas Infrastructure

Historical wellhead and pipeline locations were extracted from the Railroad Commission (RRC) of Texas site data viewer (RRC, 2022). No oil and gas infrastructure were found near the Proposed Study Area (Figure 7). It should be noted that there is a submerged electrical transmission line to crosses the Laguna Madre and enters South Padre Island on the bay shoreline; however, this transmission line is at the north end of the island, north of the end of Tompkins Channel and is not in the vicinity of the proposed project.

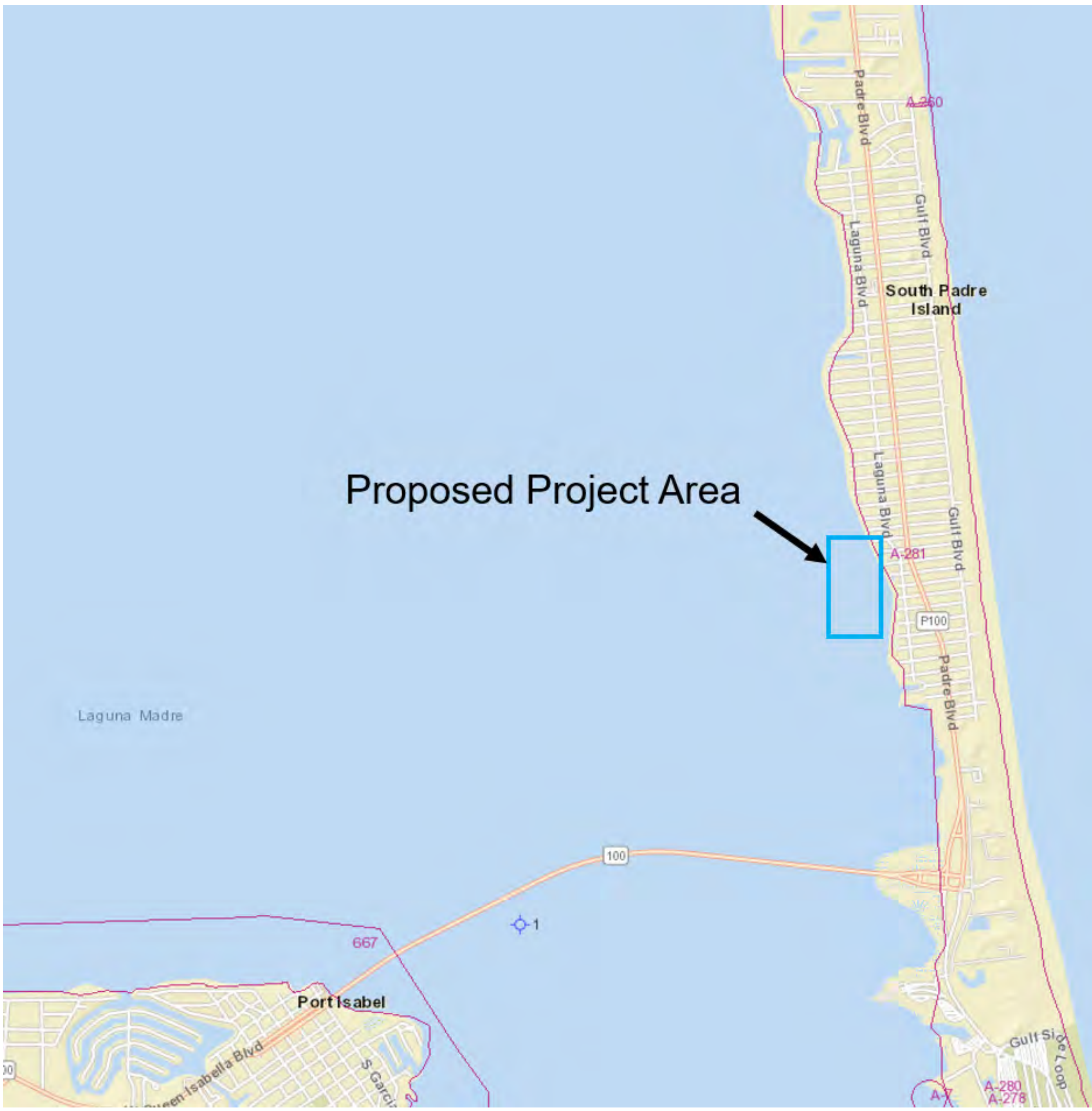

Figure 7. Texas Railroad Commission viewer data for project area

2.4 Wind Data

Wind data were gathered for the SPI Coast Guard NOAA Station 8779748 (Figure 8) from the NOAA Tides and Currents website (NOAA N. O., 2022). Using MATLAB the data was binned into direction and speed categories then processed to create the wind rose shown in Figure 9. The wind rose classifies the wind data in terms of windspeed, direction and occurrence. Combined, it helps identify the dominant wind direction and the typical origin of the fastest windspeeds. From this wind rose, the dominant wind direction is southeast, but the position of the shoreline on the bayside of a barrier island means that the project site is sheltered from wave climates generated by these winds. Therefore, the north and northwest directions are where the more critical winds that will develop waves at the project site are originating from.

Figure 8. NOAA Station Location

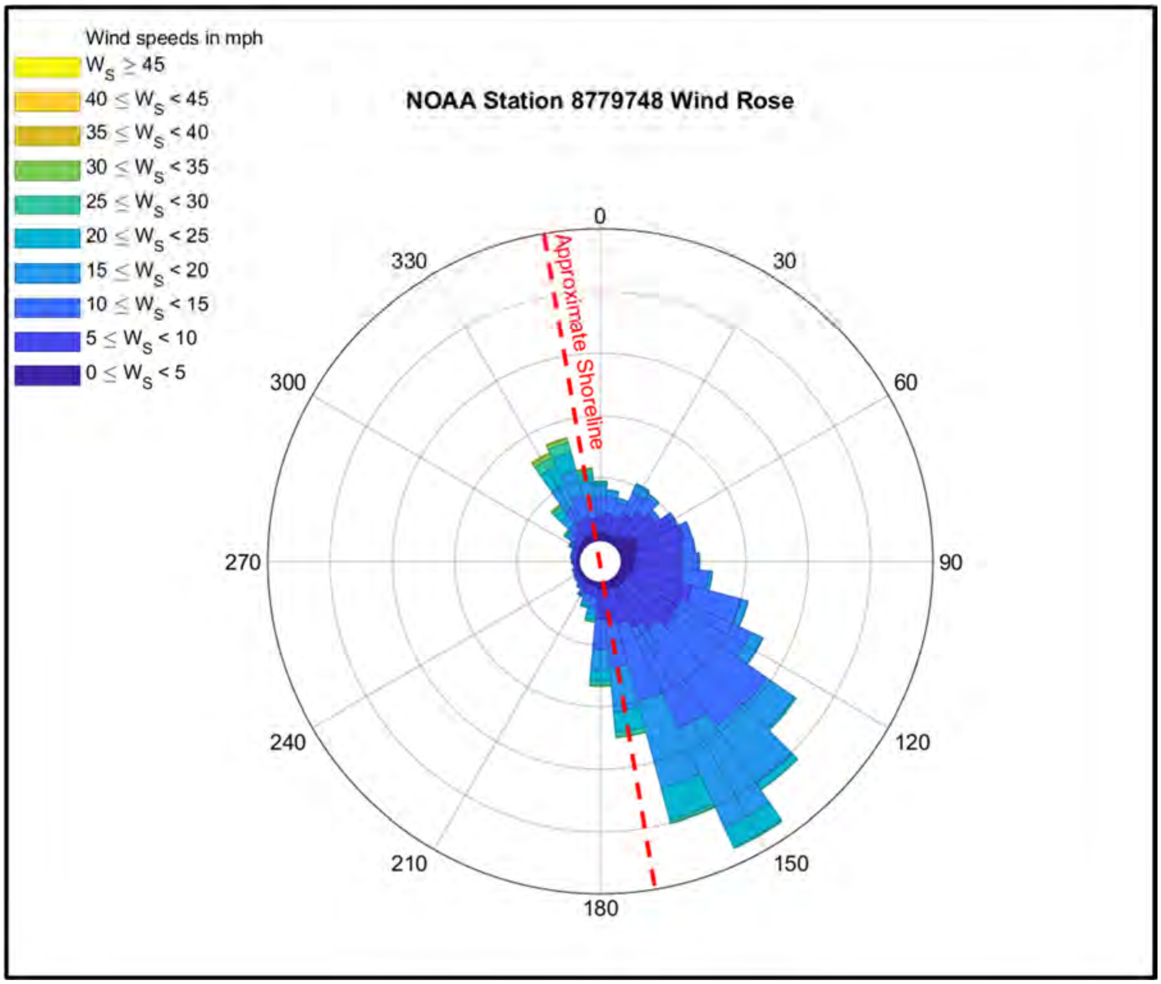

Figure 9. NOAA Station 8779748 wind rose

2.5 Water Level Data

Information on historical water levels, tidal datums, storm surge, and relative sea level rise was gathered using the "NOAA Tides and Current" website (NOAA N. O., 2022). Figure 8 shows the location of NOAA tide stations in the vicinity of the SPI project site. The South Padre Island US Coast Guard Station (No. 8779748) was selected due to its proximity to project site.

2.5.1 Tidal Datums

Tidal datums relative to NAVD for station 8779748 are provide in Table 1 below. These values represent the average high and low tides throughout the year and show a mean tidal range of 1.17 ft.

Table 1. South Padre Island CG Station 8779748 Tidal Datums	
Datum	**Elevation (ft, NAVD)**
MHHW	0.44 ft
MHW	0.38 ft
MSL	-0.12 ft
MLW	-0.79 ft
MLLW	-0.93 ft

2.5.2 Seasonal Water Levels

Historical water level data from NOAA station 8778748 ranging from January 2016 to August 2022 is presented in Figure 10. Of important note is that the average water level elevation will vary throughout the year due to seasonal shifts and oscillations in the Gulf of Mexico. As a result, the average water level will be higher in the spring and fall seasons, with lower average water level in the winter and summer. Water levels are also locally influenced by winter storms and extreme events such as Hurricanes. A zoomed-in view of the water level time series during 2020 is provided in Figure 11 to illustrate seasonal variations and storm surge events caused by recent hurricanes.

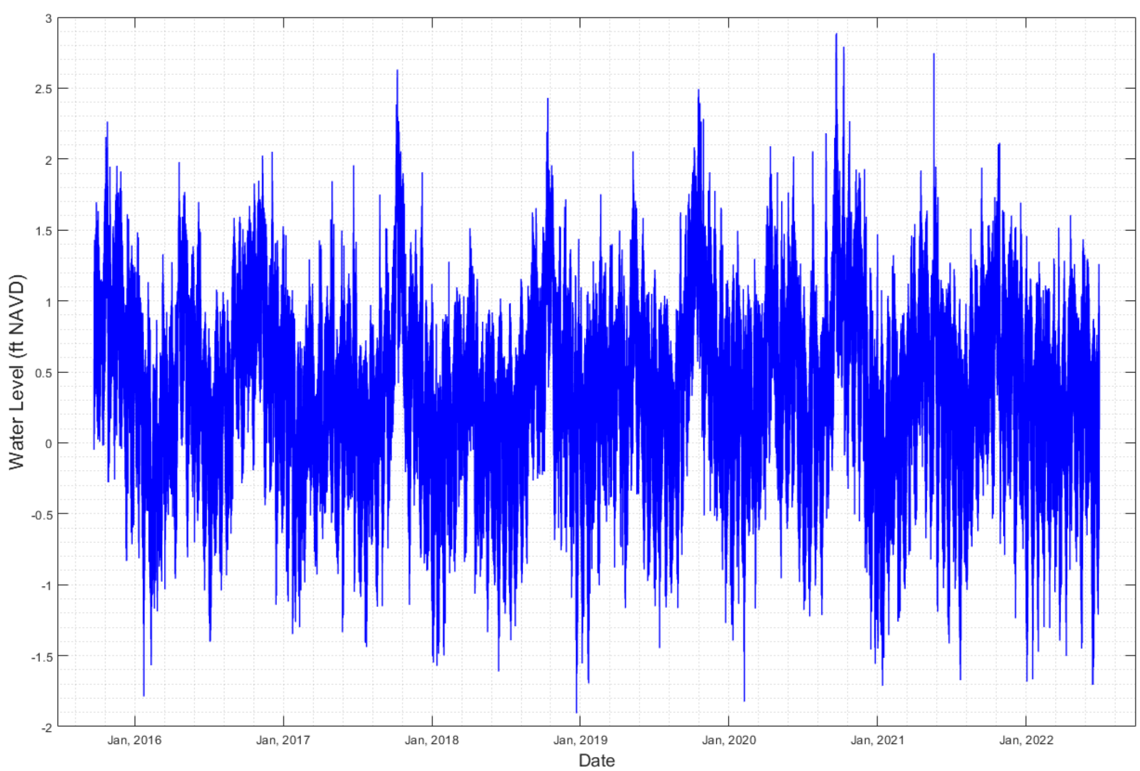

Figure 10. NOAA Station water level time series 2016 – 2022

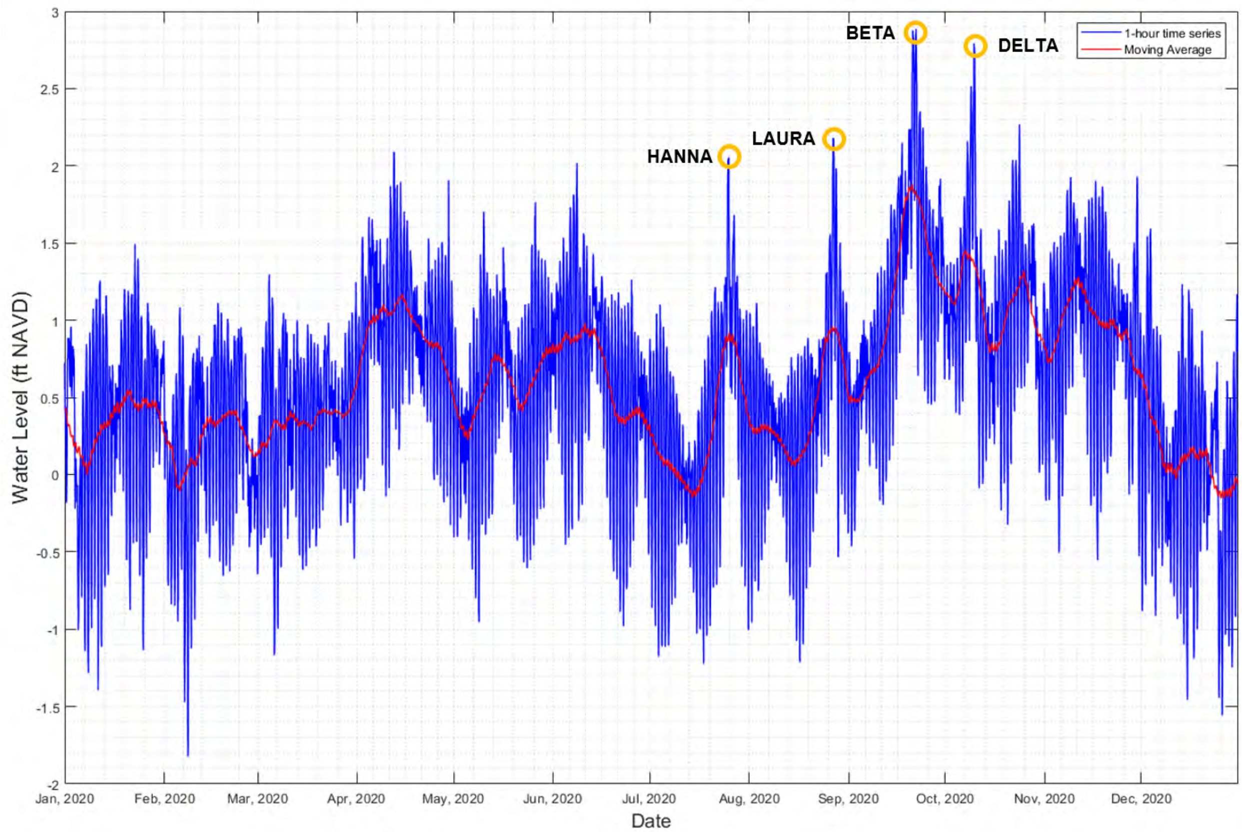

Figure 11. NOAA Station water level time series for 2020

An additional assessment was performed to review water level elevations in combination with wind direction from a passing cold front. The project site is located towards the southeastern end of the Laguna Madre, and as a result, when strong winds associated with winter cold fronts blow across the bay, the water will tend to "stack" up along the shoreline of South Padre Island. Figure 12 shows the predicted and observed water levels during the passage of a cold front in January 2022 (indicated by boxed area on figure). Notice the verified water level (green line) exceeds predictions (blue line) and returns to more normal levels after passage of the front.

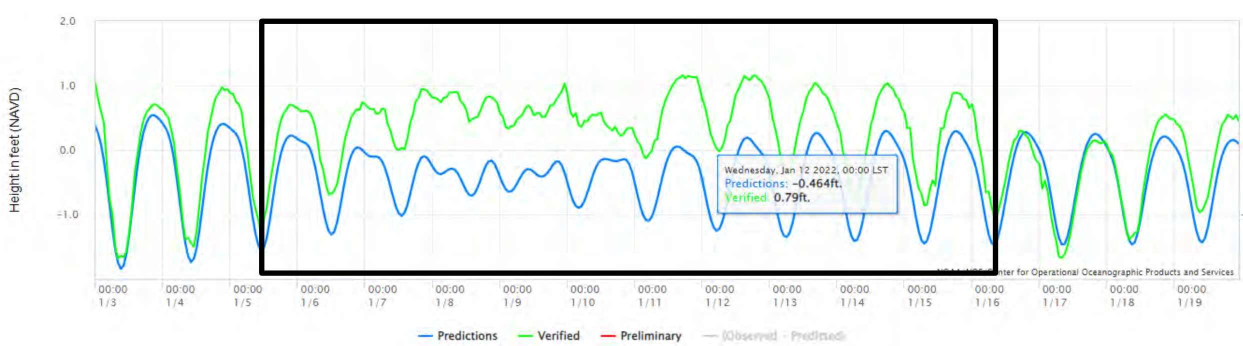

Figure 12. NOAA water levels at SPI CG Station gage during cold front passage

2.5.3 USGS Water Level Data

The USGS installed a gaging station (USGS Station 260552097100701) at the shoreline of the LLM near Corral Street to collect water level data near the project area (Ockerman, D., 2022). The published data was collected at 15-minute intervals and spans from August 18, 2021 to April 27, 2022. The USGS water level data is consistent with the measurements taken at the NOAA Station No. 8779748 (see Figure 10). Comparing both data sets, a slightly smaller intertidal range is observed in the USGS data as shown in Figure 13; the red solid line represents the USGS data whereas the blue dashed line corresponds to the NOAA data. This can be attributed to the project area being located further into the bay, away from the Brazos Santiago Pass inlet.

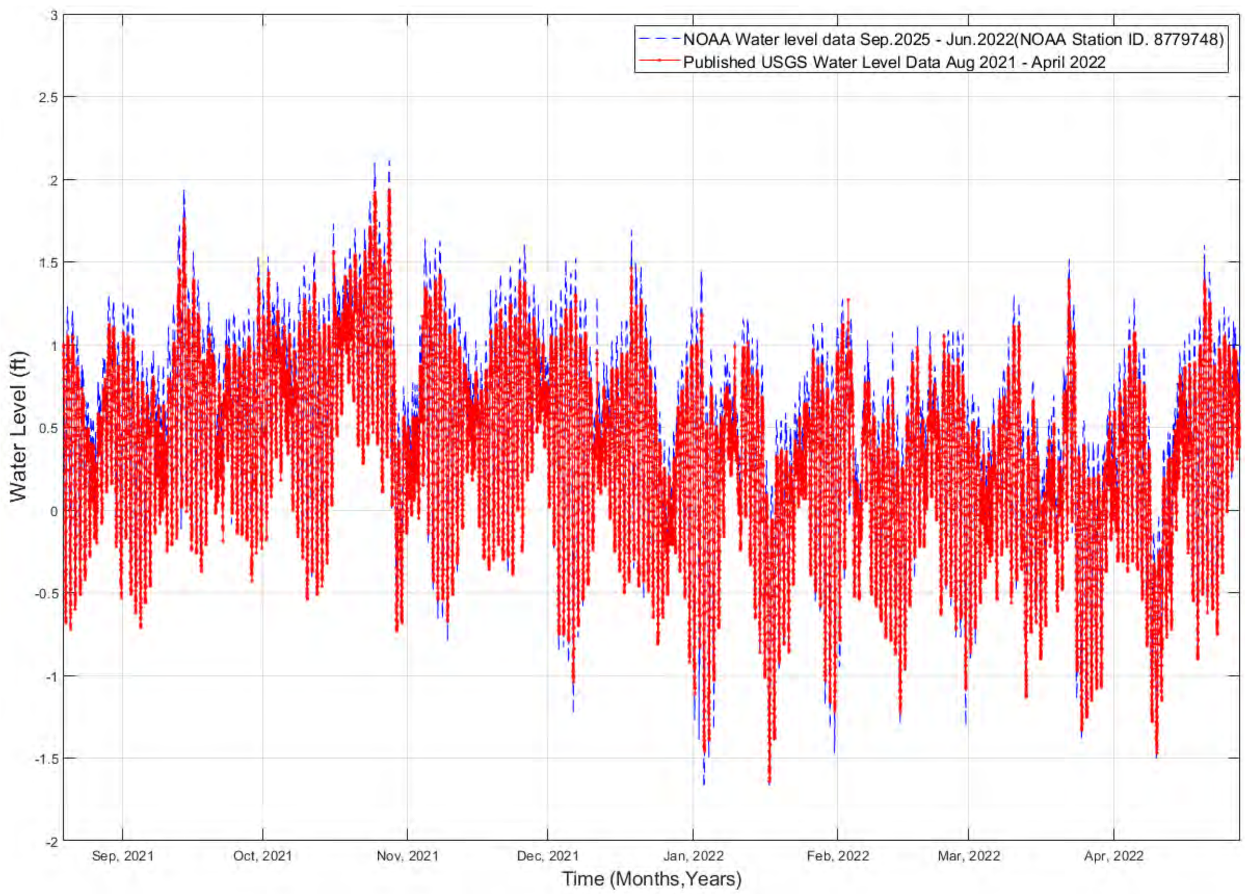

Figure 13. Comparison of USGS and NOAA water level data

2.6 Storm Surge Data

Storm surge is caused by extreme events such as hurricanes, as a result of their more severe meteorological characteristics (i.e., atmospheric pressure and wind speed). These two factors raise water levels and push larger volumes of water onshore, resulting in significantly higher water levels along the coastline. Figure 11 shows the water level spikes caused by Hurricane Hanna Laura, Beta, and Delta during 2020. Note that while Hurricane Hanna made landfall closest to the project site (north of Mansfield Pass), the other storms passed close enough to South Padre Island to affect coastal water levels. FEMA and the NOAA have both conducted their own combination of numerical modeling, historical water level data evaluation, and statistical analysis to estimate the extreme water levels during these severe events., these water levels are shown below in Table 2. The FEMA values were obtained from the 2018 Cameron County FIS report (FEMA, 2018) along transect 28 on the bay side whose location is shown in Figure 14. The NOAA data was provided by the NOAA Tides and Currents site for the Brazos Santiago Pass station 8779750 (NOAA N. O., 2022). The NOAA values are based upon measured events and can be lower than the model results provided by FEMA analyses.

Table 2. FEMA and NOAA extreme water level analysis

Return Period	FEMA Water Level (ft NAVD)	NOAA Water Level (ft NAVD)
10-year	+4.1	+3.3
50-year	+7.4	+4.5
100-year	+9.2	+6.9

Figure 14. FEMA transect location

2.6.1 Hurricane Tracks

Hurricane and tropical storm track data for storms from 2000 to 2020 within a 60 nautical mile radius were gathered using the NOAA Hurricane Tracker website (NOAA, 2022) . Information from the website is provide in Table 3 and Figure 15. Storms of interest, which are storms that were located close to the project site and had an impact on the site, are boldened to further refine the set of information to be analyzed and used for later phases.

Table 3. Hurricane track information

Name	Start Date	End Date	Category	Windspeed	Landfall Category	Landfall Windspeed
Hanna	**7/23/2020**	**7/26/2020**	**H1**	**92 mph**	**H1**	**92 mph**
Don	7/27/2011	7/30/2011	TS	52 mph	TS	40 mph
Hermine	9/4/2010	9/10/2010	TS	69 mph	TS	69 mph
TD 2	7/7/2010	7/10/2010	TD	35 mph	TD	35 mph
Dolly	**7/20/2008**	**7/27/2008**	**H2**	**98 mph**	**H2**	**86 mph**
Erika	**8/14/2003**	**8/17/2003**	**H1**	**75 mph**	**H1**	**75 mph**

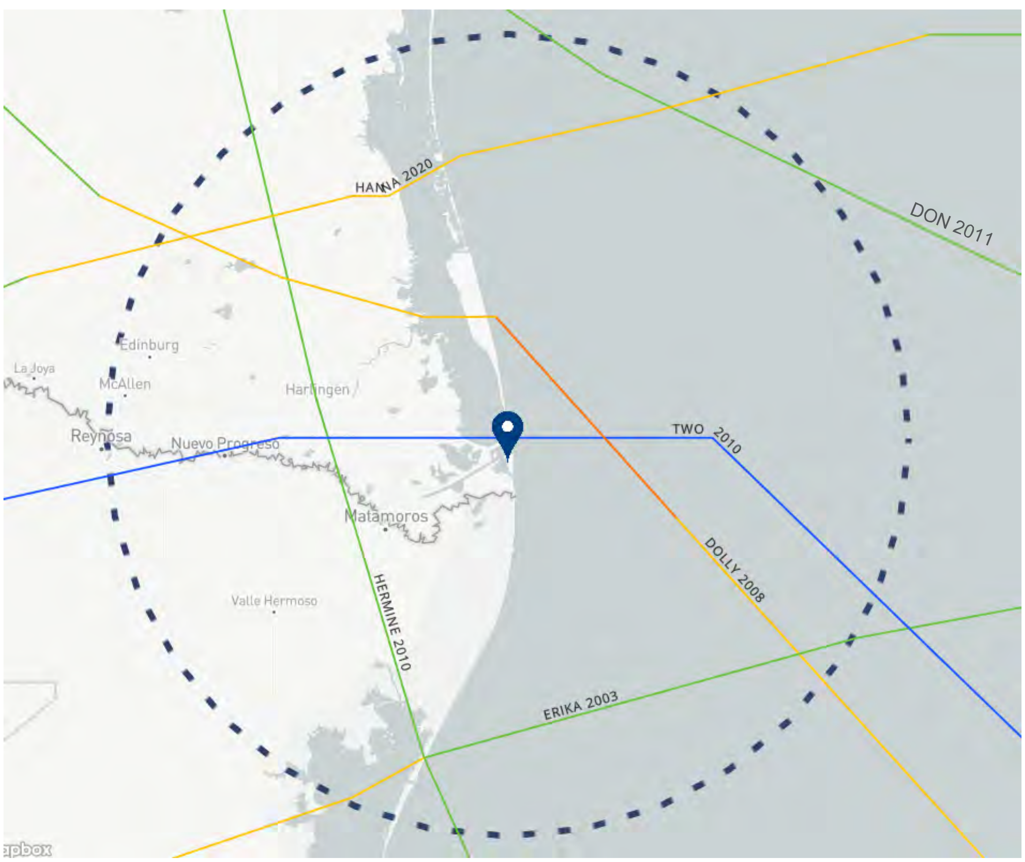

Figure 15. Hurricane track map 2000-2020

2.6.2 Relative Sea Level Rise Projections

Relative sea level rise (RSLR) considers sea level rise and local settlement or other geological changes to determine an increase in water levels unique a region. The RSLR data shown in Figure 16 was generated using the United State Army Corp of Engineer's (USACE) Sea Level Change Curve Calculator (USACE, 2022). The RSLR information will be used to inform design alternatives.

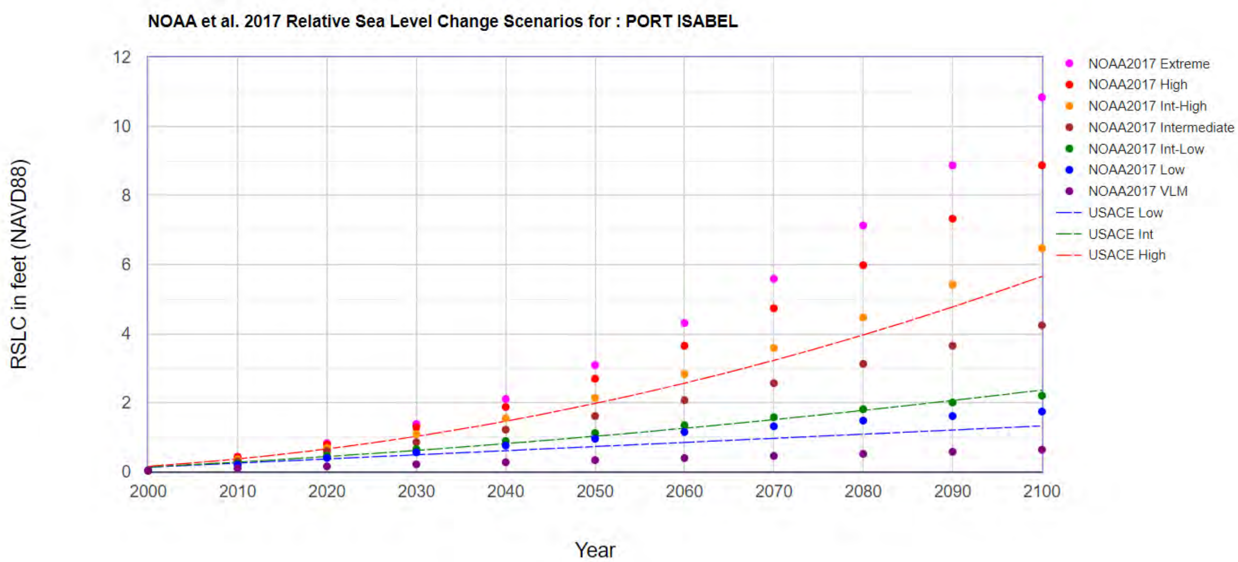

Figure 16. USACE RSLR Chart

2.7 Wave Analysis

Waves are a primary driving force behind morphological change along coastlines. It is, important to have a proper understanding of wave climates in an area before design can occur. Using the gathered wind data, a preliminary wave analysis was conducted using the Automatic Coastal Engineering System (ACES). This program computes wave heights and periods in terms of windspeed, wind duration, fetch length, and water depths. A 28-mph sustained windspeed was used to represent the expected windspeed during northern cold fronts. The longest fetch lengths were measured in ArcMAP and are shown in Figure 17. The results of the preliminary wave analysis are shown in Table 4. It is important to note that there are several factors including fetch length, duration, and water level, that dictate how a wave climate develops. Due to this, it is common practice to run a more robust numerical model to acquire a more accurate prediction of the wave climate.

Figure 17. SPI Pilot Project Fetch Lengths

Table 4. Estimated wave heights and periods		
Fetch Length	**Significant Wave Heights (Hmo)**	**Peak Periods (Tp)**
13 miles	1.70 ft	3.03 s
8 miles	1.51 ft	2.68 s

2.8 Current

The USGS collected current velocity data near the project area from August 18, 2021 to April 27, 2022, at the same time as the water level data collection (Section 2.5.3). Current velocities were measured hourly with an acoustic doppler current profiler (ADCP) which was installed on the seabed approximately 300 ft from the shoreline. The distance between the ADCP instrumentation and the USGS tidal water level station was roughly 1,100 ft (Ockerman, D. 2022). The locations were both data sets were collected are shown in Figure 18.

Figure 18. Locations of USGS hydrodynamic Instrumentation

Using the same MATLAB script used to process wind data in Section 2.4, a rose graph of current velocity data was generated showing direction, magnitude, and occurrence of current velocity data, see Figure 19. Reviewing the processed data, current velocities in the project area appear to be predominately influenced by local tides. Measurements above 0.25 ft/s are aligned with incoming and outgoing tides (around 330° to 350° on outgoing tides and approximately between 140° to 160° on incoming tides). Average velocities are between 0.25 ft/s to 0.5 ft/s with extreme values remaining below 2.0 ft/s.

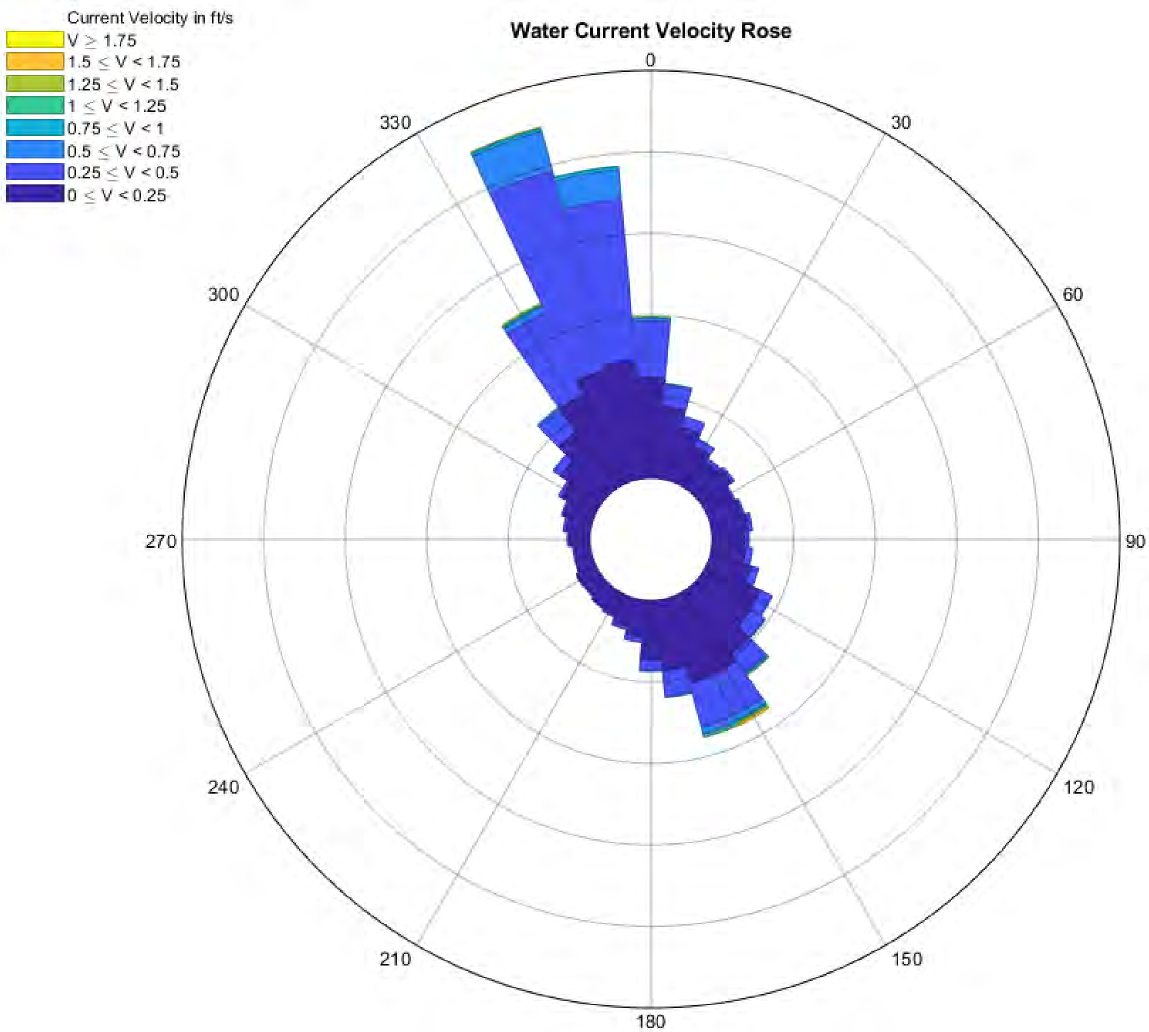

Figure 19. Rose of USGS current velocity data

3 Conceptual Alternatives

A stakeholder meeting attended by the City, HDR, and USGS was held on February the 22nd of 2022 to review data of the project area and brainstorm ideas for living shoreline design. Reducing seagrass impacts, protecting failing bulkheads, private property owner by-in, and project scope and feasibility were among the main topics discussed. Three principal objectives for the pilot project were identified as 1) reducing wave impacts on bay shoreline, 2) develop wetlands/intertidal marsh, and 3) decrease flooding by storm surge.

Regarding project design, it was determined that a living shoreline between the Tompkins Channel and the bay shoreline would not be feasible due to limited space, existing infrastructure such as docks, and conflicts with property owners. Relocating the Tompkins Channel further into the bay to create marsh habitat or space for a living shoreline inside of the channel was also considered. However, the magnitude of this endeavor and the impacts to seagrass that would be incurred were deemed too high for the current scope of the project. Alternatively, a living shoreline located to the west of Tompkins Channel was determined to be the preferred approach. Intertidal berms with marsh planting and artificial islands were among some of conceptual ideas that were generated. Based on these discussions, HDR prepared several preliminary living shoreline alternatives to be presented them to the City in a subsequent meeting for further feedback.

While preparing design alternatives, HDR referenced a variety of literature on living shorelines in the Gulf coast. Two of the principal sources were a *Guide to Living Shorelines in Texas* manual created by NOAA and the Texas General Land Office, and the *Living Shoreline Site Suitability Model* produced by the Harte Research Institute at Texas A&M. The manual highlighted different types of living shorelines that have been used in the Gulf of Mexico, the benefits each offered, and in what conditions each strategy was suitable. The latter mapped the entire Texas coast and provided a recommended type of shoreline protection based on local conditions. The management strategy that is recommended from these two sources based on the project area corresponds with a hybrid stabilization, “a living shorelines [that] incorporates hard features with natural elements to provide additional erosion protection” (GLO, 2020). An example of a hybrid living shoreline project with a breakwater (hard feature) and marsh fill and planting (natural elements) inside of the breakwater is shown in Figure 20.

Figure 20. Marsh Restoration at Powderhorn Lake, TX

Based on the collected data from USGS and HDR, discussions with the City and the literature review mentioned above, four initial living shoreline concepts were created. Due to the presence of seagrass in the project area (Section 2.2.1), conceptual design started with living shoreline concepts that would have the smallest impact and then gradually increased their footprint and scale. These initial concepts are presented in the following sections.

3.1 Artificial Reef

A stand-alone, artificial reef array was considered as an alternative with the smallest environmental impact. Designed and installed correctly, artificial reefs provide wave attenuation and create plant and animal habitat. Another benefit with artificial reefs is the increased flexibility in how individual units can be configured. There are a variety of artificial reef products available. The reef ball product is perhaps one of the more commercially recognizable artificial reef shapes and comes in several different dimensions based on the design intent. For the conceptual level design an "Ultra ball", approximately 5 ft in diameter and 4 ft tall, was assumed (see Figure 21). An example layout of a system of 100 ft-long reef ball arrays is shown in Figure 22. To provide sufficient wave attenuation, artificial reef arrays can consist of multiple rows of reef balls. Gaps in between reefs would allow increased water flow, boating access, and minimize overall footprint.

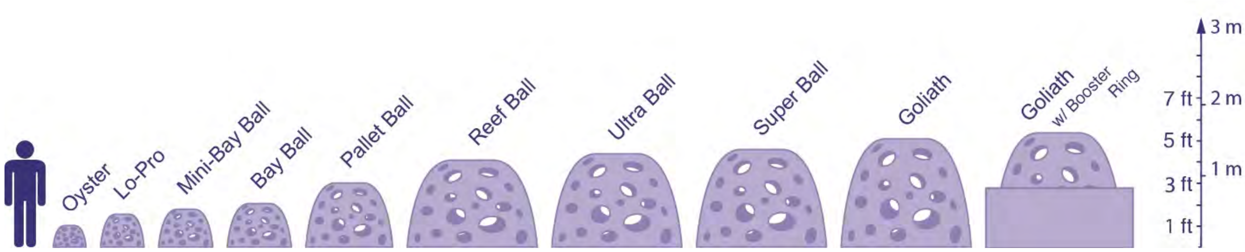

Figure 21. Spectrum of reef ball sizes, photo taken curtesy of Reefball.org

Figure 22. Conceptual layout of artificial reef array

Additional considerations for an artificial reef living shoreline were identified as the following.

1.) Compared to a breakwater or berm, more wave and storm surge energy could be transmitted through artificial reefs. Additionally, there is less information regarding how to quantify wave transmission through artificial reefs.
2.) Individual units within a reef ball array could be moved during an extreme event such as a hurricane. This could incur additional impacts to seagrass and alter the efficiency of the overall structure to reduce wave and storm surge energy.
3.) Other artificial reef products could be used to reduce footprint and/or change amount of wave attenuation. Atlantic Reefmaker ® is a 1 ft diameter vertical post that supports disks placed at the intertidal range to breakup wave energy and provide substrate for marine species (Figure 23). Other artificial reef products such as oyster castles and WADs ® could be considered as well.

Figure 23. Reefmaker artifical reef constructed at, photo taken curtesy of Atlantic Reefmaker

3.2 Intertidal Berm

A system of intertidal berms was the next concept for a living shoreline that was evaluated. Intertidal berms could provide marsh habitat on the channel side of the berm. The amount of the marsh habitat would depend on the crest height of the berm, the side slope of the berms, and the elevation range at which local marsh species grow. Marsh planting on the intertidal berms could help increase wave attenuation. However, the marsh planting (30 ft – 50 ft wide depending on berm geometry) will not reduce as much wave or storm surge energy as would a wide patch of fully established marsh (over 100 ft).

An intertidal berm would knock down more wave energy compared to an artificial reef given the width and composition of the structure. The amount of wave attenuation and the effectiveness of protecting against storm surge would depend on the crest height, length, and width of the berms. For the berms to remain in the intertidal range, the maximum elevation would be around the MHHW datum of approximately +0.5 ft NAVD. Adding an additional 0.5 ft of crest height to account for SLR would improve the efficiency over the project life but would also increase seagrass impacts due to the wider footprint. As shown in Section 2.5.2, water levels in the project area are observed to exceed the MHHW datums. By maintaining the berms in the intertidal range, another option to improve wave attenuation would be to increase berm width or create two rows of berms with a determined amount overlap. Both options would entail more impacts to seagrass. A conceptual level configuration of overlapping intertidal berms is shown in Figure 24. If the bayside of the berm was to be armored with riprap or other hard substrate, a steeper side slope could be constructed, thus reducing the overall footprint of each individual berm. This is shown with a dotted line drawn on the bayside of each berm.

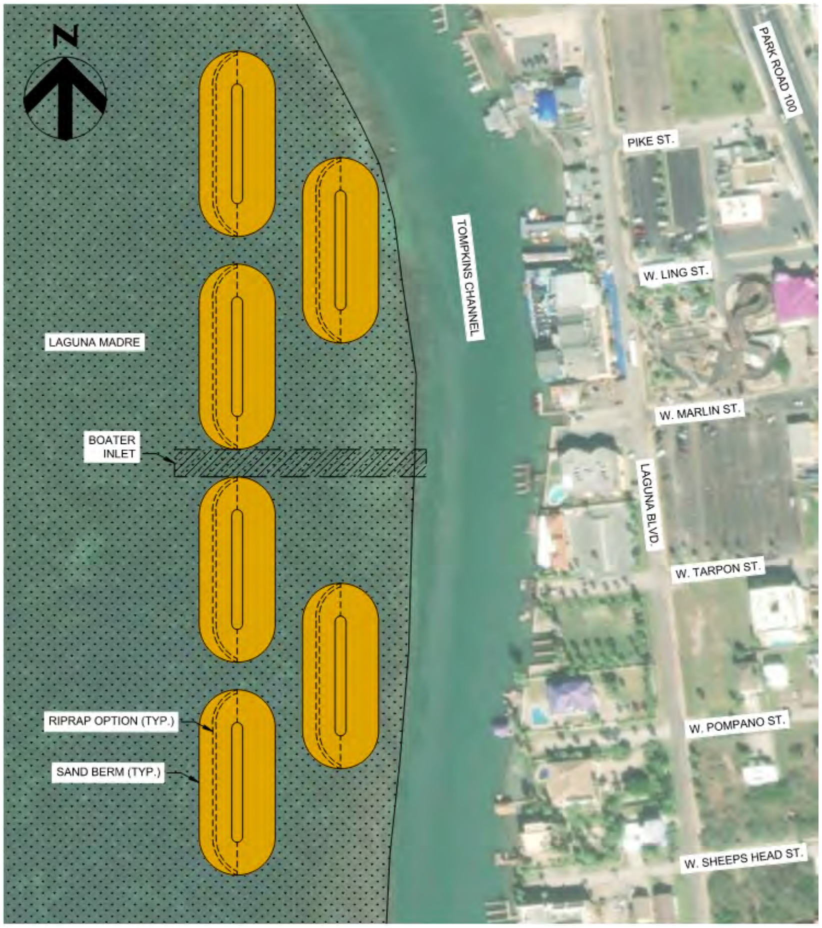

Figure 24. Conceptual layout of overlapping intertidal berms

In addition to seagrass impacts, the success of the marsh planting, and the amount of wave attenuation desired, the following would also need to be considered.

1.) The type of material used to construct the berms would affect the design and the project cost. Borrow source availability may dictate which material is used. Clean sand could be imported from a borrow area at a higher unit cost than locally sourced material. Alternatively, stiff clays could be used to construct berms at a steeper slope than sand but require more work to shape the material. A photo of a marsh restoration project in Dollar Bay were in situ stiff clays were used to construct marsh terraces is shown in Figure 25. Oyster shells are another material that has been used to construct submerged breakwaters and armor side slopes in projects on the Texas coast but is not commercially sold (GLO, 2020).

2.) Erosion and reshaping of the berms can also occur. If berms are reshaped over time by natural processes and result in having a wider footprint, seagrass impacts and permitting issues can arise. Erosion would also affect the how much the berms continue to reduce wave and storm surge energy. Armoring on the bay side of the berm could also assist in reducing erosion and possible reshaping but would incur more project costs.

Figure 25. Marsh Terraces constructed from in situ clays in Dollar Bay, TX

3.3 Living Breakwater

A living breakwater was proposed as the third alternative for a living shoreline. This concept consists of fill material placed on the inside of a breakwater. Marsh planting could be performed in the fill material similar to the intertidal berms. Fill material could be sourced locally from channel dredging projects to reduce project costs. While the breakwater is considered a hard feature, the rock acts as substrate for marine species. This option would provide more protection from wave energy given the harder features, elevated crest height, and wider footprint. The width of the fill material area behind the breakwater would depend on balancing seagrass impacts with creating marsh habitat. A planting shelf directly behind the breakwater could provide habitat for high marsh and slope down to low marsh elevations then the natural bay bottom creating habitat for intertidal marsh grasses. The conceptual level layout is provided in Figure 26. While not a living breakwater project, an example of where marsh fill and planting has been performed behind a breakwater is shown in Figure 27, located in Dickinson Bayou, Texas.

Figure 26. Conceptual level layout of a living breakwaters

Figure 27. Example of living breakwater, Dickson Bayou, Tx.

3.4 Containment Cell

Expounding upon the living breakwater concept, the containment cell would surround the fill material entirely with hard features. On the bayside of the containment cell, a breakwater similar to the previous alternative would be used. On the channel side, facing the bay shoreline, a smaller sill would be placed to contain fill material within the structure. Fill material consisting of clays, silts, or organics would benefit from having this containment feature. Just as with the living breakwater, the amount of area inside of the breakwater and sill could be reduced or increased depending on which takes priority, seagrass impacts or marsh habitat creation. A conceptual level layout of a containment cell in the project area is provided in Figure 28.

Figure 28. Conceptual level layout of containment cells

Additional considerations for both the living breakwater and containment cell concepts are listed below.

1. Cost savings to the City could be generated in future dredging projects by using living breakwaters or containment cells as placement areas for dredged material; less distance traveled to dump dredged material in ODMDSs or upland placement areas. An example of a containment cell style breakwater recently constructed in Corpus Christi, Texas is shown in Figure 29. This breakwater was constructed around an existing dredge spoil island and designed to allow future fill placement to expand the island and marsh area.
2. These two concepts have bigger footprints than an artificial reef array or intertidal berm. Additionally, these living shorelines would cost more to construct. However, they offer more protection from waves and storm surge and create more marsh habitat as well as rock substrate.
3. These features would change the view of the LLM from the bay shoreline. Property owner by-in may generate conflicts.
4. Water depths in and around the project area are shallow. Contractors would most likely need to use light-loaded barges to access the project area to be able to construct the breakwater features. Light-loading operations increase project costs as the contractor is required to handle the construction materials more thus increasing time and labor.

5. Soil grab samples from an ongoing dredging project for Tompkins Channel have revealed that nearby channel material contains sands with silts and clays mixed in. This material could be used for fill but would require containment to prevent material from settling outside of the berm footprint or eroding.

Figure 29. Containment Cell for future fill material in Corpus Christi, Tx

3.5 Evaluation of Conceptual Alternatives

The four conceptual living shoreline alternatives described above would create habitat, but of varying types and areas. While the artificial reef would not create marsh habitat, it would act as substrate for shellfish and plants and provide shelter for fish. Breakwater and riprap stabilization components would also provide this same habitat. However, seagrass impacts will not be able to be mitigated by these forms of created habitat and depending on the scale of the impacts could require a separate mitigation project; this is further discussed in Section 4.4.

All living shoreline alternatives would also reduce wave energy. The amount of wave attenuation would depend on the alternative and the final design dimensions. Given the size of this pilot project, these living shoreline concepts would not prevent flooding but could reduce wave induced water setup along the western shoreline of the City. A living shoreline network that spanned the entire length of the bay shoreline would offer greater protection against flooding caused by wave setup. However, reduction in flooding from storm surge by tropical storm systems passing or directly impacting the project site may be minimal. Further assessment during detailed design would be required to assess flood reduction from project alternatives.

4 Design Alternatives

The four conceptual living shoreline alternatives were presented to the City on the 10th of March 2022. After reviewing the preliminary living shoreline alternatives presented in Section 3, the City indicated interest in advancing the design of the intertidal berms and the living breakwater alternatives. HDR proceeded to develop the design and prepare estimates of the extents of environmental impact, material quantities, and probable construction costs associated with these two alternatives. This information for both alternatives is presented in the following sections.

4.1 Intertidal Berm

Three configurations of how an intertidal berm living shoreline could be constructed were developed. The level of protection, amount of seagrass impacts, and project cost vary from one configuration to another. The dimensions and orientation of the intertidal berms were determined based on the available data discussed in Section 2, input from the City, and typical design assumptions of construction material properties.

4.1.1 Description and Function

The crest height was placed at +0.5 ft NAVD for all three configurations. This was based on placing the berm height on the middle to high end of the intertidal range in the project area. As discussed in Section 2.5.1, the project area appears to have a slightly smaller intertidal range. By opting for a crest height above the middle of the intertidal range, a greater allowance for SLR would be factored into the design as well as increased wave protection on the front end of the project's life.

The crest width was set at 20 ft wide. Side slopes were assumed to be constructed at 10H:1V, representative of using clean sand for berm construction. The type of material used will influence at what side slope the berm can be constructed at. While a steeper side slope could be achieved by using more cohesive material, cleaner sands would not require containment.

A riprap revetment was included on the bayside of the berm to provide erosion protection from waves on the LLM. The riprap would extend from the toe of the berm and key to the top of the crest. Preliminary dimensions of the revetment toe, thickness and crest tie-in were assumed based on the wave climate discussed in Section 2.7 to calculate quantity estimates.

The location and orientation of the berms were based on the bathymetry collected by USGS. A ridge was observed on the bayside of the channel. The intertidal berms were placed adjacent to this ridge to prevent material that migrated out from the construction footprint from entering the channel. Placing the berms closer to the channel would also offer better accessibility for construction equipment. A rendering of a typical cross-section is shown in Figure 30.

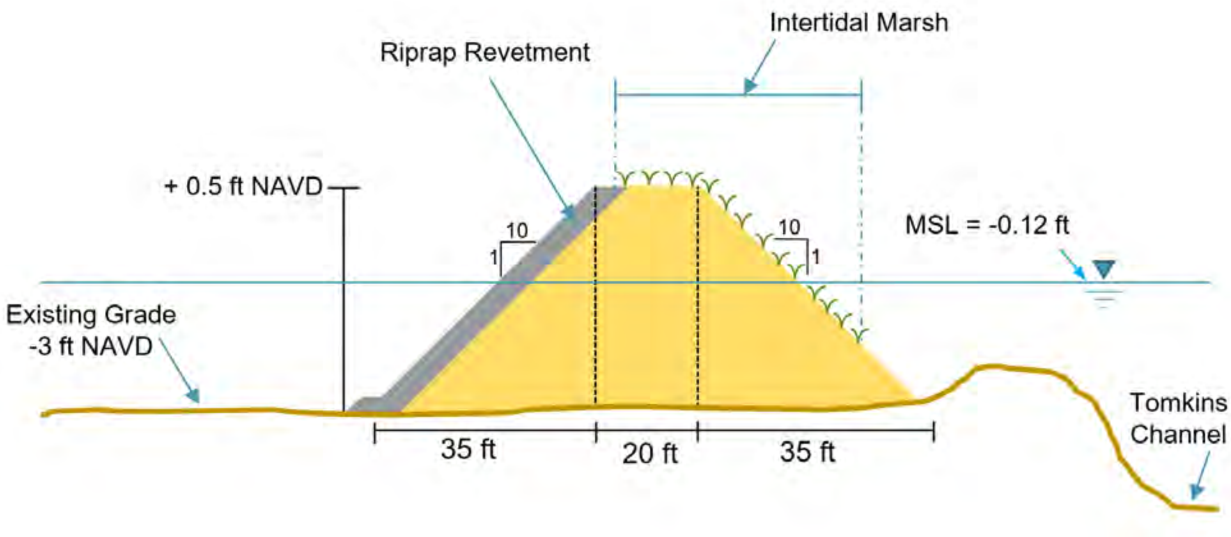

Figure 30. Cross-section of 10H:1V intertidal berm

The first configuration represents two rows of intertidal berms spaced approximately 50 ft to 75 ft apart. The overlap between the rows was conceived to provide more protection from waves proceeding from the predominant wind direction and at the same time optimize the overall project footprint. The proposed plan view for this configuration is shown in Figure 31.

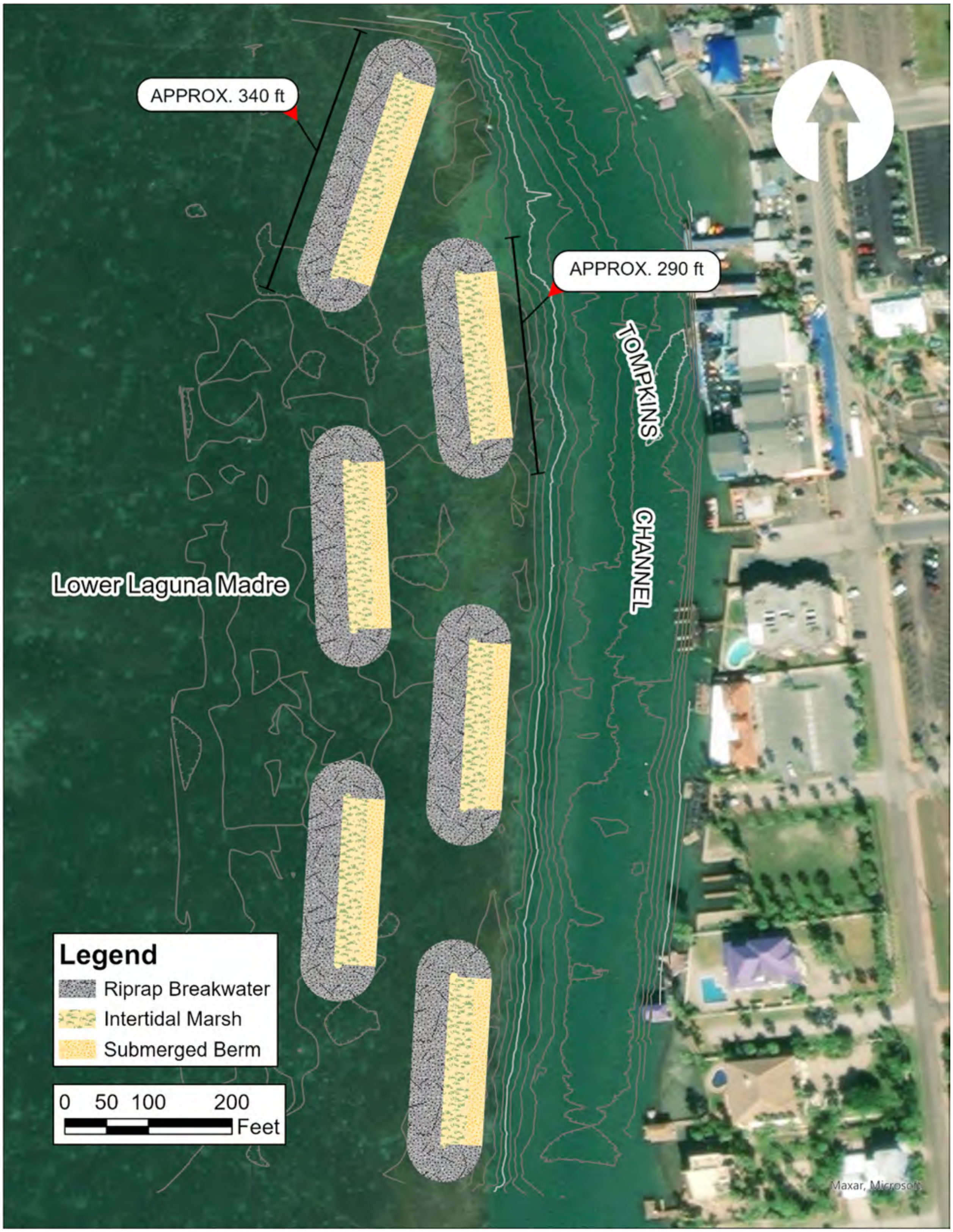

Figure 31. Plan view of 2 rows 10H:1V Intertidal Berms

The next configuration eliminates the second row and places in between each intertidal berm a reef array reduce wave energy passing through the gaps between berms. These gaps could also be left open for recreational boat passage; however, this would allow for some wave energy to propagate through the system of intertidal berms. Similar to what was proposed in Section 3.1, an ultra ball ® was used as a placeholder for the type of artificial reef product used. The cross-section and plan view of this configuration are shown in Figure 32 and Figure 33.

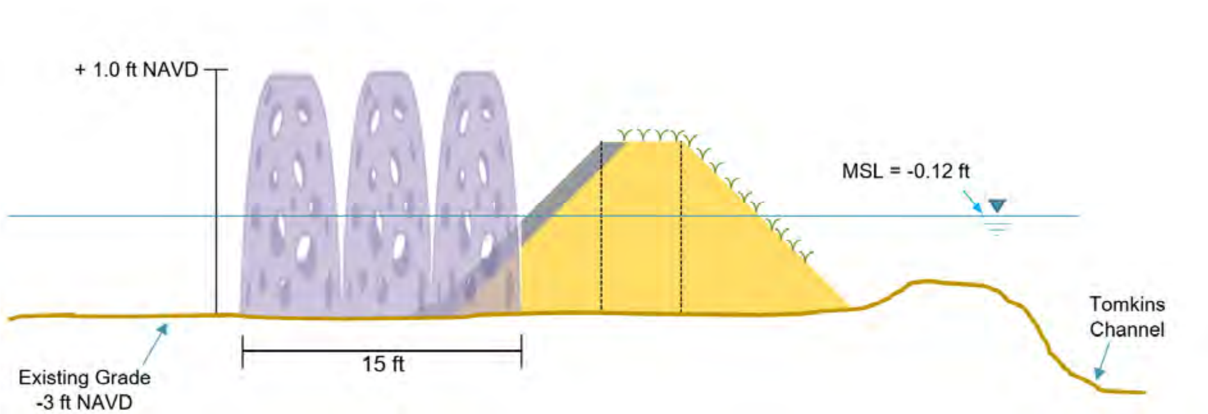

Figure 32. Cross-section of 10H:1V intertidal berm with reef array

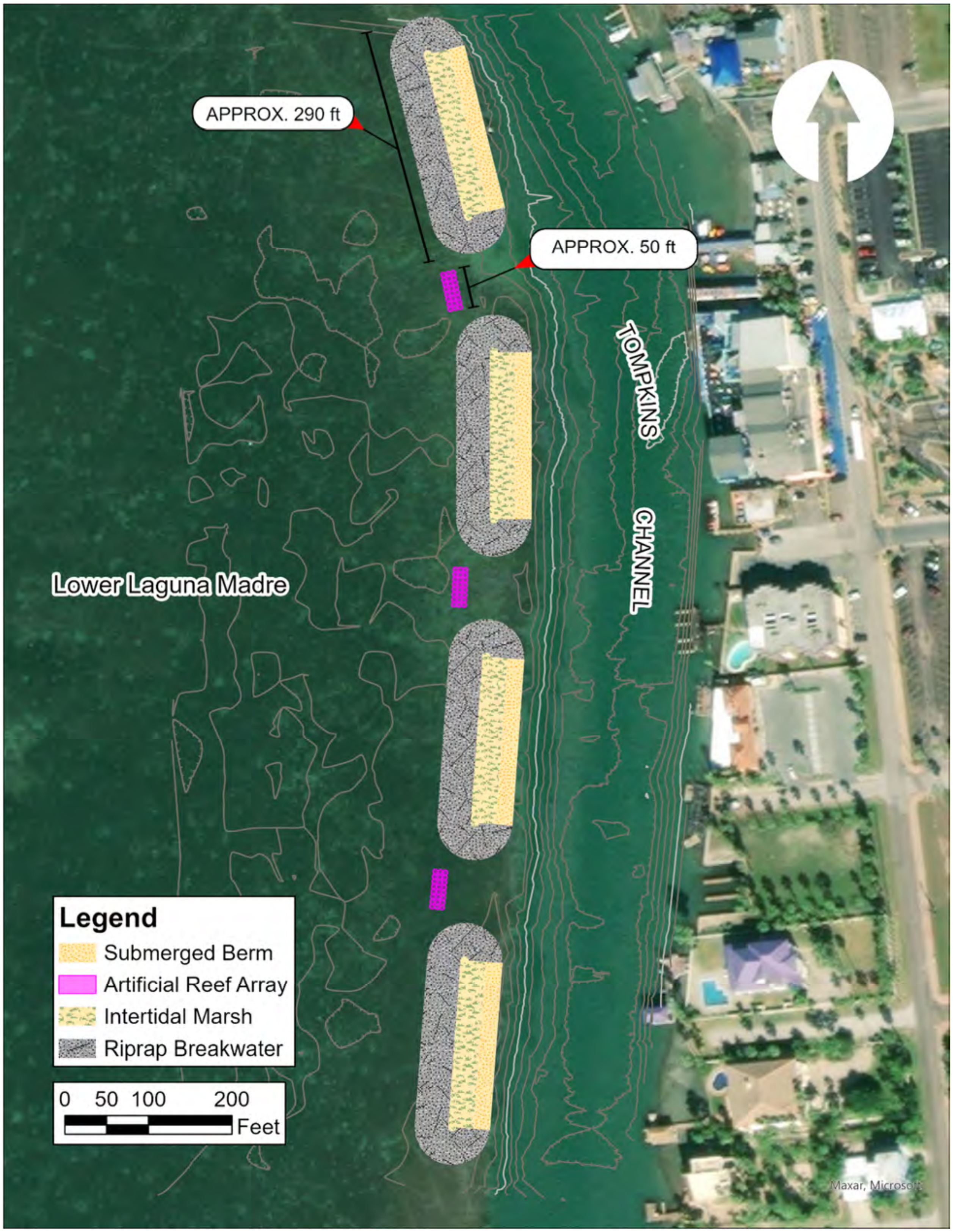

Figure 33. Plan view of 10H:1V intertidal berm with reef array

The last configuration reduced the footprint of the berm by proposing a steeper side slope for the part of the intertidal berms facing the LLM. Sand is still considered to be the material used to construct the berms. A 3H:1V side slope could be constructed by excavating the bay side of the berms after placement and consolidation of the material have been completed. Excavated sand would be placed on the channel side of the berm and riprap would be used to stabilize the steeper slope. This would result in a reduction in the quantity of sand and riprap needed for construction and a smaller permanent seagrass impact. A cross-section and plan view of this configuration are shown in Figure 34 and Figure 35 respectively. Two rows of berms with the reduced footprint are shown in the plan view example. Combining the single row concept shown in the second configuration with a reduced footprint berm could be constructed instead to further reduce impacts to seagrass and project costs.

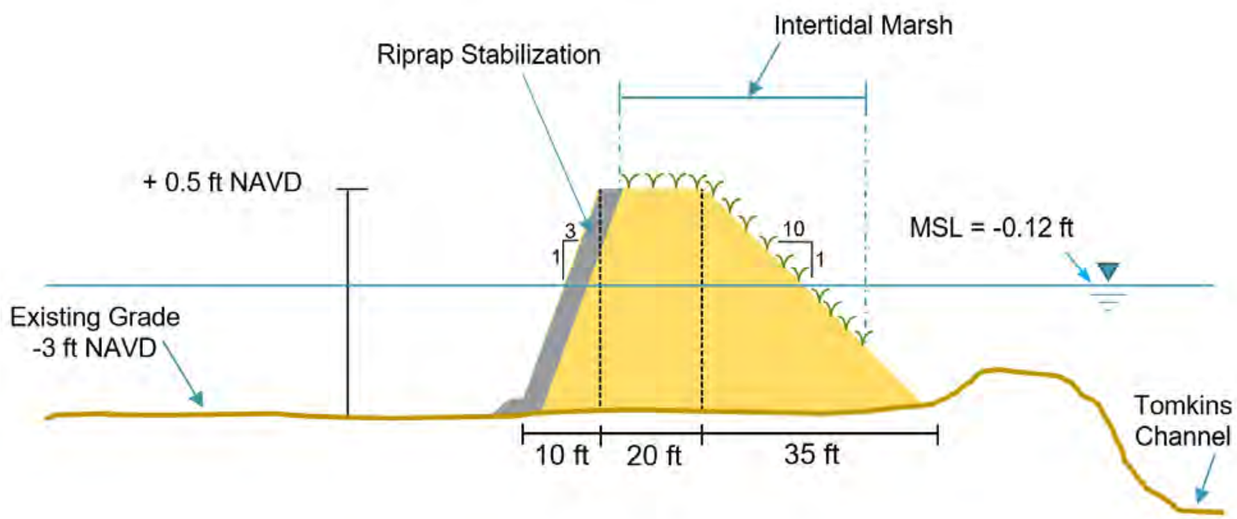

Figure 34. Cross-section of 10H:1V intertidal berm with reduced footprint

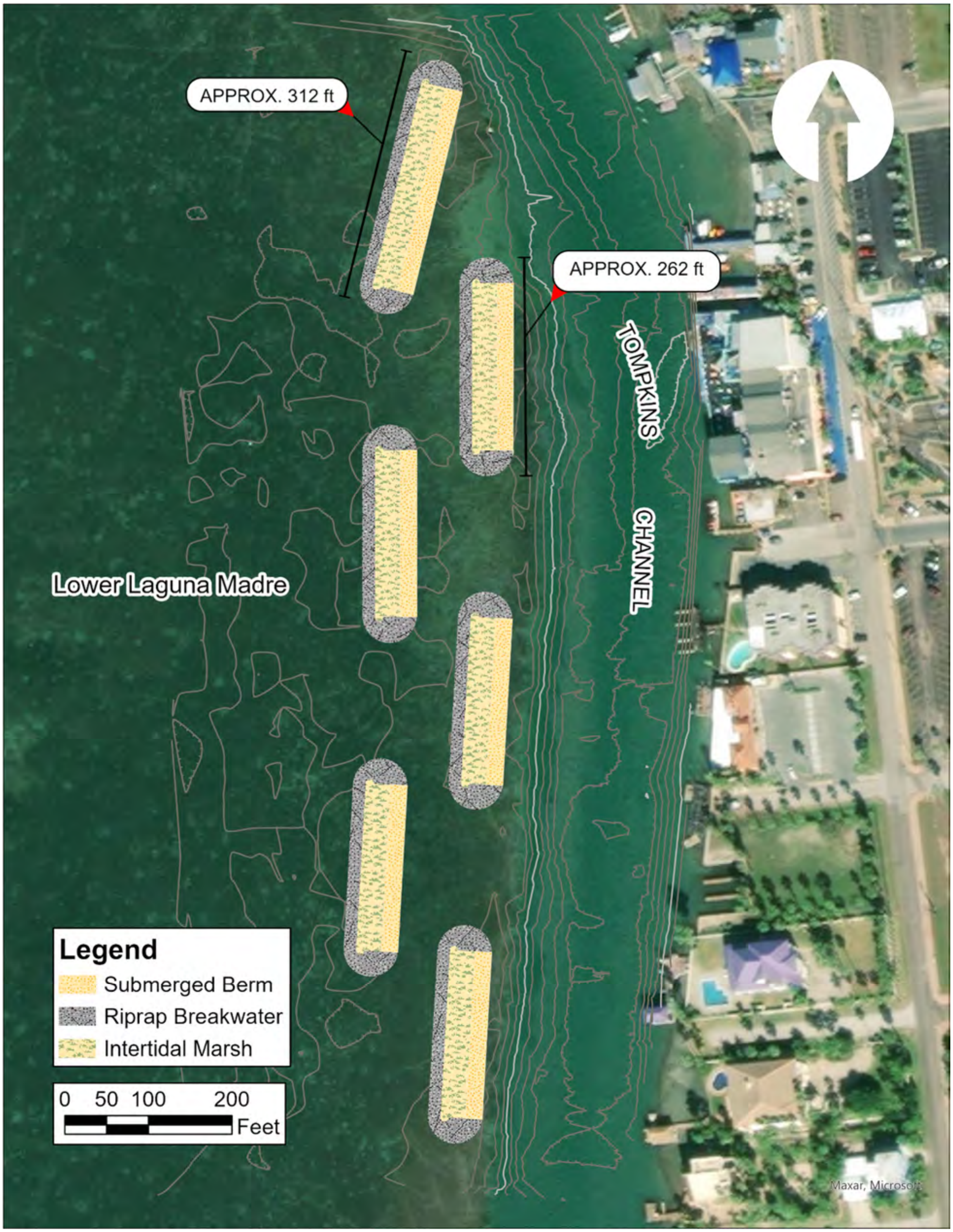

Figure 35. Plan view of Intertidal berm with reduced footprint

4.2 Living Breakwater

The living breakwater concept originally shown in Section 3 consisted of a riprap breakwater with fill material placed behind it and marsh grass planted on top of the fill. As previously mentioned, the material in the Tompkins Channel contains sand as well as silts, clays and/or possibly organic material. This material is suitable to be used as fill but would require some form of containment. A riprap sill set at the intertidal range was included on the backside of the living breakwater to provide containment in the case beneficial use material is used as fill.

4.2.1 Description and Function

The breakwater crest height was set at + 3.0 ft NAVD to match what was observed to be the 5-year storm water elevation. A side slope of 2H:1V and crest width of 5 ft were used to minimize the breakwater's footprint. The sill on the backside of the living breakwater was set at +0.5 ft NAVD. The same side slopes and crest widths were given for the sill. Riprap was assumed to be material used to construct both structures.5

While placement of fill material would likely be performed over time when beneficial use material became available, the living breakwater was designed as it would appear once completely filled. An upland-marsh planting shelf set at +2.0 ft NAVD is shown extending for 20 ft behind the breakwater. This would provide further protection from wave and storm energy when water levels exceed the breakwater. From the planting shelf fill material slopes down at a 20H:1V slope to the bay bottom. Intertidal marsh would be planted on the intertidal portion of this slope. A cross-section and plan view of a living breakwater in the project area are shown in Figure 36 and Figure 37 respectively.

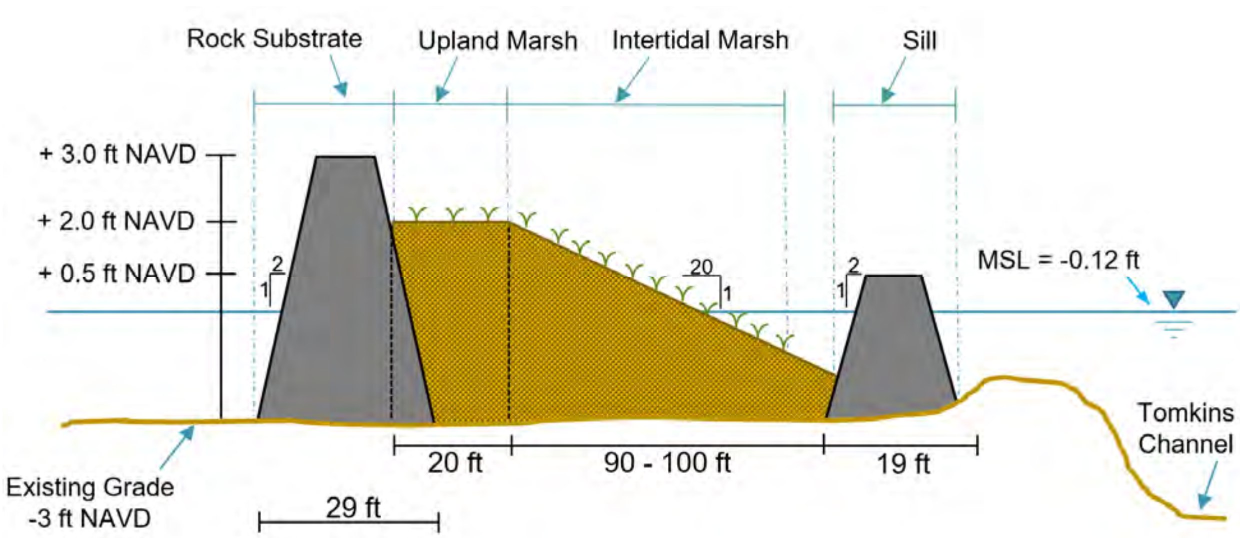

Figure 36. Cross-section of living breakwater with sill

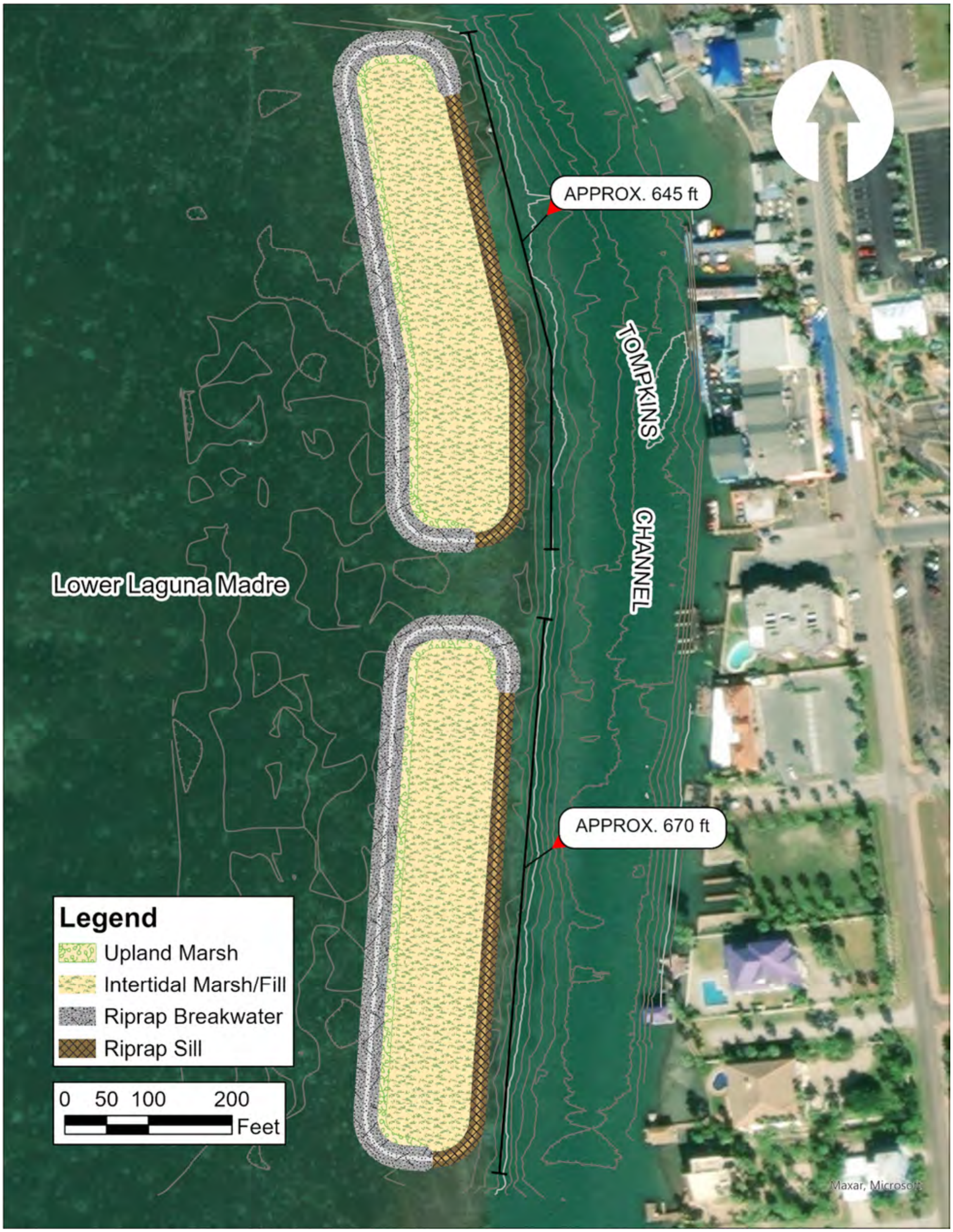

Figure 37. Plan view of living breakwater with sill

4.3 Environmental Impacts and Benefits

The total project footprint and amount of marsh habitat were calculated for both living shoreline alternatives. The project footprint equates to the amount of seagrass that would be permanently impacted. No temporary impacts to seagrass due to construction operations were considered. Estimates reflect the conceptual dimensions assigned to each feature at this level of design. Modifying the conceptual design dimensions could be used to further reduce the total footprint in later project phases. Due to the size and scale of the proposed seagrass impacts, the project budget for design and construction will need to consider the design and implementation of a mitigation project to offset the impacts. Permitting and seagrass mitigation is further discussed in Section 4.4.

4.3.1 Intertidal Berms

For the intertidal berms, the first two proposed configurations show a berm with 10H:1V side slopes on both sides, resulting in a footprint of approximately 0.6 acres for a 200 ft-long berm. By reducing one side to a 3H:1V side slope as shown in the third configuration, the footprint was reduced to around 0.4 acres. The length of the berms also will affect the footprint of individual berms; berm lengths of 200 ft and 250 ft were used at this level of design. Conceptual level estimates of the project footprint and the amount of intertidal marsh created are listed in Table 5 for each configuration.

Table 5. Intertidal berm environmental impact and benefits summary

Intertidal Berm Configuration	Project Footprint (ac)	Marsh Habitat Created (ac)
2 Rows of 10H:1V Intertidal Berms	3.80	0.70
1 Rows of 10H:1V Intertidal Berms	2.50	0.50
2 Rows of Intertidal Berms with Reduced Footprints	2.60	0.70

The project footprint is bigger for each configuration than the marsh habitat created given the area occupied by the riprap revetment/stabilization placed on the bayside of the berms and part of the berm that would always remain submerged. Marsh planting on the channel side of the berms would range from the crest of the berm to the bottom of the intertidal range. The rest of the berm that extends to the bay bottom would not be suitable for marsh growth.

4.3.2 Living Breakwater

The living breakwater design consists of a northern and southern component. These were drawn to follow the alignment of the Tompkins Channel. The length of the total structures was based on covering the majority of the project area. The width of the structures was based in part by the proposed extent of the planting shelf and intertidal marsh area. These dimensions could be altered to reduce the overall footprint at the cost of reducing the amount of marsh habitat created. Estimates of the footprint and acreage of marsh habitat created for the living shoreline alternative are shown in Table 6. The estimate of created marsh habitat corresponds to the entire fill area, representing a maximum amount of habitat given the conceptual dimensions.

Table 6. Living shoreline with sill environmental impact and benefits summary

Living Breakwater Components	Project Footprint (ac)	Marsh Habitat Created (ac)
Northern Component	2.25	1.00
Southern Component	2.35	1.00
Total	4.60	2.00

4.4 Permitting and Mitigation

The footprint of each living shoreline alternative as listed in the previous section will cause permanent seagrass impacts and the construction of any of the alternatives may result in temporary impacts outside of the footprint. While prolific in the LLM, seagrass is considered essential fish habitat and protected by USACE, TPWD, and NOAA National Marine Fisheries Service (NMFS). Any project with a permanent or temporary impact to jurisdictional waters of the United States requires a Section 10 and/or 404 request for authorization from USACE. During the Section 10/404 review USACE will conduct formal or informal interagency Section 7 consultation with USFWS and NMFS for the impacts to protected species and to essential fish habitat. In order to conduct this consultation an essential fish habitat assessment and/or a biological assessment would be included with the permit application request.

The permitting process can vary based on the scope of the project. The ideal route for permitting a project is through procurement of an applicable Nationwide Permit if possible. Nationwide Permits cover types of projects which the agencies have already reviewed and determined that they would not cause a significant impact on natural resources if they can meet a set of national, state, and regional conditions. For projects that cannot meet the conditions of a Nationwide Permit, the alternative is to seek an Individual Permit for the project. An Individual Permit process includes additional efforts such as a 30-day public notice, project specific Section 401 water quality certification, Section 106 review for cultural and historic resources, Section 7 consultation, and mitigation plan approval. Nationwide Permits that require a Pre-construction Notification generally receive authorization from USACE in 6 to 9 months after a complete application is submitted and Individual Permits generally receive authorization from USACE within 12 to 36 months after a complete application is submitted.

Given that seagrass impacts for the conceptual level design alternatives are estimated to range from approximately 2.5 acres to 4.0 acres, this project under any alternative would not be eligible for a Nationwide Permit. An essential fish habitat assessment, biological assessment for federally protected species, mitigation plan, Section 106 cultural and marine archeological review, Section 401 Water Quality certification, and a TXGLO coastal zone consistency determination request would be required. Because there are no mitigation banks in this watershed the project would require permittee responsible mitigation creation. Mitigation amount for seagrass impacts will be determined by USACE using a ratio of impacts to creation or through the USACE Galveston Functional Assessment. A typical ratio is 3:1; mitigate 3 acres of seagrass for every 1 acre of impacted seagrass. NMFS may consider the USACE's mitigation ratio sufficient to satisfy their requirements for impacts to essential fish habitat. However, additional mitigation from NMFS could be requested. This would add onto the USACE mitigation ratio, further increasing the amount of seagrass habitat that would need to be created and protected in perpetuity for mitigation.

As discussed in Section 3.5, self-mitigating living shorelines are not considered feasible for two reasons. Seagrass requires relatively flat and shallow areas to grow. While it is possible that some seagrass beds may populate areas within the submerged portions of the intertidal berms, the side slope of the berms will not be conducive for seagrass growth. Secondly, creating marsh habitat and hard substrate adds ecological value but does not mitigate for seagrass impacts.

Seagrass mitigation will require identification of a separate area from the project where seagrass enhancement and protection is most likely to be successful and in an area that can be legally protected in perpetuity from development or other impacts. Creating seagrass habitat usually consist of altering the existing conditions in areas with non-existent, sparse, or damaged seagrass beds near to existing sea grass beds. Some methods of alteration that have been successful in the LLM are 1) adding clean material to deeper water to bring up elevation in an unvegetated area to a depth conducive to seagrass, 2) constructing structures that shelter grasses from wave energy, or 3) filling in damaged areas such as those where boat propellers have dug trenches in the seabed (commonly referred to as prop scars). Post-construction monitoring for up to 5 years after the mitigation construction is completed to track the effectiveness of the mitigation project and determine if supplementary action is needed such as planting or other adaptive management. Additionally, monitoring of the living shoreline project would be necessary to document impacts to seagrass that may occur after construction (e.g., reshaping of berms after a hurricane) and to document that any temporarily impacted areas return to pre-construction condition.

Identifying suitable areas for seagrass mitigation and estimating associated project costs will need to be performed in later phases of this project.

4.5 Cost Analysis

A conceptual level opinion of probable cost (OPCC) for the three intertidal berm configurations and the living breakwater are provided in Table 7 to Table 10. Costs are broken down into bid items that are believed to be relevant given the proposed design. Unit costs for bid items were based on previous projects' construction costs. A contingency is included to cover uncertainties in pricing related to market conditions and fuel costs at the time of bidding, possible construction change orders, additional handling of fill material to meet specifications, potential issues with protected species, debris issues, etc. Costs shown do not include mitigation for potential impacts to seagrass or other protected habitat.

Table 7. OPCC of 2 Rows of 10H:1V Intertidal Berm Alternative

Bid Item		Quantity	Unit	Unit Price	Extended Price
1	Mobilization / Demobilization	1	LS	$ 300,000	$ 300,000
2	Surveys				
	Construction Surveys	1	LS	$ 75,000	$ 75,000
	Hazard Survey	1	LS	$ 20,000	$ 20,000
3	Aerial Photography	1	LS	$ 10,000	$ 10,000
4	Sand Fill	8,330	CY	$ 50	$ 416,500
5	Marsh Planting	31,800	PLUG/SF	$ 2.5	$ 79,500
6	Riprap Revetment/Stabilization				
	Geotextile Fabric	3,860	SY	$ 6	$ 24,000
	Graded Riprap	6,470	TON	$ 115	$ 745,000
	Silt Curtains	1,820	LF	$ 5	$ 10,000
7	Day Beacons	6	EACH	$ 5,000	$ 30,000
				Contingencies (30%):	$ 513,000
				Total	$ 2,223,000

Notes:
1. Marsh planting of 1 plug/sq.ft. was assumed.
2. Day beacons were assumed to be needed between gaps in the intertidal berms and on either end of the project area.
3. A 15% contingency was also factored into the estimate of graded riprap tonnage to account for construction losses and settlement.
4. Silt curtains were included as a measure to reduce siltation of seagrass areas outside of the project footprint during construction.

Table 8. OPCC of 1 Rows of 10H:1V Intertidal Berm Alternative					
Bid Item		Quantity	Unit	Unit Price	Extended Price
1	Mobilization / Demobilization	1	LS	$ 300,000	$ 300,000
2	Surveys				
	Construction Surveys	1	LS	$ 50,000	$ 50,000
	Hazard Survey	1	LS	$ 20,000	$ 20,000
3	Aerial Photography	1	LS	$ 10,000	$ 10,000
4	Sand Fill	5,360	CY	$ 50	$ 268,000
5	Marsh Planting	20,360	PLUG/SF	$ 2.5	$ 50,900
6	Riprap Revetment/Stabilization				
	Geotextile Fabric	2,310	SY	$ 6	$ 14,000
	Graded Riprap	4,220	TON	$ 115	$ 486,000
	Silt Curtains	1,820	LF	$ 5	$ 6,000
7	Day Beacons	8	EACH	$ 5,000	$ 40,000
8	Artificial Reef	90	EACH	$ 150	$ 13,500
				Contingencies (30%):	$ 378,000
				Total	$ 1,636,400

Notes:
1. Marsh planting of 1 plug/sq.ft. was assumed.
2. The unit cost of reel ball including installation was taken from Guide to Living Shorelines in Texas manual.
3. The cost of construction surveys was reduced to reflect the smaller project scale for this configuration.
4. Day beacons were assumed to be needed on either end of the artificial reef array and on either end of the project area.
5. A 15% contingency was also factored into the estimate of graded riprap tonnage to account for construction losses and settlement.
6. Silt curtains were included as a measure to reduce siltation of seagrass areas outside of the project footprint during construction.

Table 9. OPCC of Intertidal Berm Alternative with Reduced Footprint					
Bid Item		Quantity	Unit	Unit Price	Extended Price
1	Mobilization / Demobilization	1	LS	$ 300,000	$ 300,000
2	Surveys				
	Construction Surveys	1	LS	$ 75,000	$ 75,000
	Hazard Survey	1	LS	$ 20,000	$ 20,000
3	Aerial Photography	1	LS	$ 10,000	$ 10,000
4	Sand Fill	6,970	CY	$ 50	$ 348,500
5	Marsh Planting	31,800	PLUG/SF	$ 2.5	$ 79,500
6	Riprap Revetment/Stabilization				
	Geotextile Fabric	2,260	SY	$ 6	$ 14,000
	Graded Riprap	3,240	TON	$ 115	$ 373,000
	Silt Curtains	1,670	LF	$ 5	$ 9,000
7	Day Beacons	6	EACH	$ 5,000	$ 30,000
				Contingencies (30%):	$ 378,000
Total					$ 1,637,000

Note:
1. Marsh planting of 1 plug/sq.ft. was assumed.
2. Day beacons were assumed to be needed between gaps in the intertidal berms and on either end of the project area.
3. A 15% contingency was also factored into the estimate of graded riprap tonnage to account for construction losses and settlement.
4. Silt curtains were included as a measure to reduce siltation of seagrass areas outside of the project footprint during construction.

Table 10. OPCC of Living Breakwater Alternative					
Bid Item		Quantity	Unit	Unit Price	Extended Price
1	Mobilization / Demobilization	1	LS	$ 400,000	$ 400,000
2	Surveys				
	Construction Surveys	1	LS	$ 100,000	$ 100,000
	Hazard Survey	1	LS	$ 20,000	$ 20,000
3	Aerial Photography	1	LS	$ 10,000	$ 10,000
4	Marsh Planting	86,900	PLUG/SF	$ 2.0	$ 173,800
5	Riprap Breakwater				
	Geotextile Fabric	6,140	SY	$ 6	$ 37,000
	Graded Riprap	9,530	TON	$ 130	$ 1,239,000
	Silt Fences	1,660	LF	$ 5	$ 9,000
6	Riprap Sill				
	Geotextile Fabric	5,260	SY	$ 6	$ 31,560
	Graded Riprap	3,310	TON	$ 115	$ 380,650
	Silt Curtains	1,170	LF	$ 5	$ 5,850
7	Day Beacons	4	EACH	$ 5,000	$ 20,000
				Contingencies (30%):	$ 729,000
Total					$ 3,155,860

Notes:
1. Marsh fill is assumed to be supplied from beneficial use opportunities from local dredging projects.
2. Marsh planting of 1 - 2 plug/sq.ft. was assumed. A cheaper unit price per plug was used given the greater bulk quantity of marsh plugs.
3. The cost of mobilization and construction surveys were increased to reflect the bigger project scale of this alternative.
4. Day beacons were assumed to be needed on both sides of the gap between the northern and southern living breakwater and on either end of the project area.
5. A 15% contingency was also factored into the estimate of graded riprap tonnage to account for construction losses and settlement.
6. Silt curtains were included as a measure to reduce siltation of seagrass areas outside of the project footprint during construction.

5 Joint Evaluation

<Pending JE meeting>

6 Conclusion

The City of South Padre, USGS and HDR collaborated together to create conceptual level design alternatives for a living shoreline pilot project on the bayside of the City. Conceptual design of these living shoreline alternatives was guided by available data gathered by HDR that was relevant to the project area and field data near and within the project area collected by the USGS. Each alternative will attenuate wave energy and create habitat. The magnitude of wave energy attenuation and acreage of created habitat will vary between each alternative. Alternatives may also reduce wave setup to a limited extent but will not prevent against flooding or storm surge altogether. The impacts to seagrass also differ between conceptual design alternatives. Balancing seagrass impacts with the created benefits and project cost will need to be further analyzed to determine the different Cost to Benefit Ratios (CBR) each alternative provides.

The upcoming Joint Evaluation Meeting (JEM) with the USACE will provide further guidance on mitigation ratios for seagrass impacts and the likelihood of the project to obtain construction permits.

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