Fulton Beach Road Living Shoreline

20-030-000-B737

Final Report
February 2022

Prepared By:

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The Grant Connection
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361-463-1428

A REPORT FUNDED BY A TEXAS COASTAL MANAGEMENT PROGRAM GRANT APPROVED BY THE TEXAS LAND COMMISSIONER PURSUANT TO NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION AWARD No. NA19NOS4190106.

Project Background

Funding for this project was used for permitting and preliminary design, the first of the three-phase Fulton Beach Road Living Shoreline Project. Subsequent phases are final design and construction. The project goal is two-fold: provide long-term protection and restoration of the shoreline using living shoreline treatments to control erosion and enhance habitat, and protect adjacent public and private infrastructure.

Seventy acres of waterfront property at risk of erosion along the project site have a cumulative value of more than $14 million. Additionally, this roadway is critical to the local communities as an evacuation route, which could be undermined or damaged if the erosion in this area is not controlled. Protecting habitat for commercially and recreationally valuable spaces will support the coastal community and recreational industries, and thereby sustain economic diversity along the coast.

Cumulative shoreline erosion caused by wave energy and erosion from boat traffic, storms, and predominant wind direction has depleted much of Aransas Bay's in-shore marsh along Fulton Beach Road, which is largely unprotected. When the shoreline is overtopped during storm events, the roadway floods. Large storm events create scarps (very steep banks). In the past, so much of the shoreline eroded that the road and utilities had to be moved further inward. There have been 6 major storm events in the last 24 years to hit this area. In 1980, the road was completely washed out. Post-Harvey inspections showed increased scarping along the shoreline, threatening to undermine the roadway. Simply performing roadway repairs will not alleviate the risk to the road.

The living shoreline treatments, living breakwaters and vegetated shoreline, are constructed habitat that will improve water quality and provide shelter, habitat, and food for marine life and a wide variety of fish and coastal bird species. The breakwaters will help dissipate wave energy, creating a more calm area along the shoreline, and help reduce or prevent shoreline erosion.

Task 1 Summary: Data Collection & Permitting

The Aransas County Board of Commissioners selected Mott MacDonald Engineering for engineering support services to provide preliminary engineering, and to amend the existing United States Army Corp of Engineers (USACE) permit for this project. The contract for the firm was finalized on May 26, 2020.

Engineering analysis in support of the preliminary and final design included engineering data collection: topographic and bathymetric surveys; and geotechnical data; development of specifications for marsh plantings and reef construction, preliminary design, and permitting.

Mott MacDonald analyzed winds, tides, and waves at the project site; developed a numerical modeling grid, and identified potential alternatives for stabilization along the project site.

A Seagrass Survey was performed by Naismith Marine Services, June 26, through July 13, 2020.

After collecting all the necessary data, Mott MacDonald reviewed with the County potential alternatives for stabilization along the project site. Upon agreeing on the best alternative Mott MacDonald finalized and submitted the permit application to the USACE in December 2020.

The permit amendment was approved by the USACE and submitted to the GLO in January 2022.

Task 2 Summary: Project Monitoring and Reporting

The Aransas County Board of Commissioners selected The Grant Connection to provide grant management services for the project, including data collection and reporting, submitting reimbursement invoices, status reports, and project amendments; monitoring compliance with project objectives and program regulations; preparing closeout documents; and other reporting required by the GLO.

Aransas County

Fulton Beach Road Living Shoreline Project

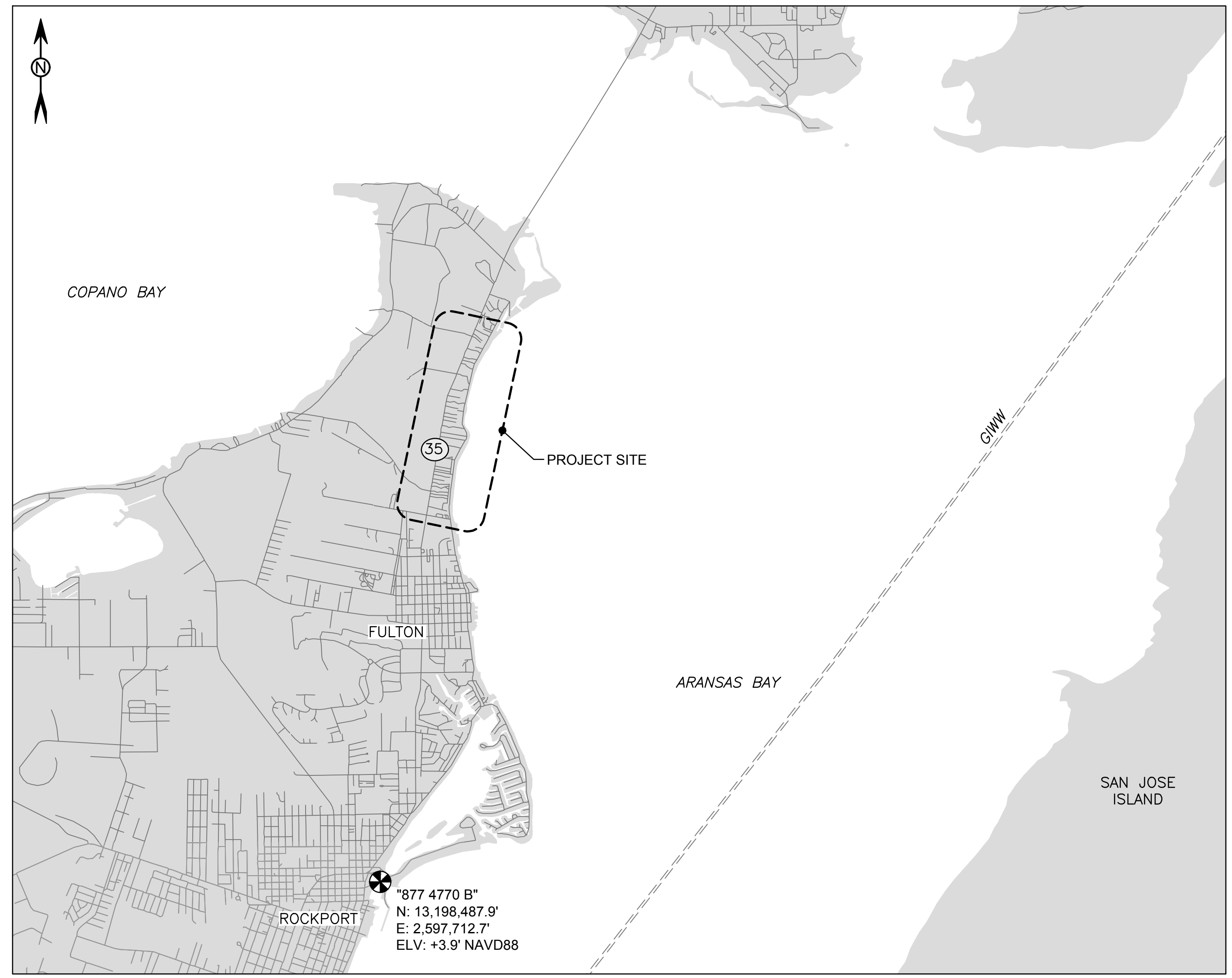
CMP Cycle 24

Design specifications and drawings (30%)

ARANSAS COUNTY

NORTH FULTON BEACH ROAD
SHORELINE PROTECTION EXTENSION

VICINITY MAP
(NOT TO SCALE)



LOCATION MAP

0 4,000 8,000
SCALE IN FEET

DRAWING INDEX

30% SUBMITTAL

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Client
ARANSAS COUNTY
2840 TX-35 BUS
ROCKPORT, TEXAS 73832

Rev	Date	Drawn	Description	Ch'k'd	App'd
	12/8/20	SDK	30% SUBMITTAL		

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LUIS M. MARISTANY SANTAMARIA
TEXAS LIC. 128048

Project Number	B/O	Total
507102160	1	5

Designed	KW	Eng check	
Drawn	SDK	Coordination	
Dwg check	LM	Approved	LM
Scale at ANSI D	Status	Rev	Security
Drawing Number			

Title
ARANSAS COUNTY
NORTH FULTON BEACH ROAD
SHORELINE PROTECTION EXTENSION

COVER SHEET

GENERAL NOTES

A1 AERIAL PHOTOGRAPH FROM TNRIS DATED DECEMBER 2, 2018. THE IMAGE IS ONLY REPRESENTATIVE OF THE CONDITIONS AT THE TIME THE AERIAL PHOTOGRAPH WAS TAKEN.

A2 SURVEY
1. HORIZONTAL DATUM OF ALL COORDINATES REFERENCED TO NAD 83 TEXAS STATE PLANE SOUTH CENTRAL ZONE FT UNLESS NOTED OTHERWISE.
2. ALL ELEVATIONS ARE REFERENCED TO NAVD88.
3. REFERENCE HORIZONTAL AND VERTICAL CONTROL "877 4770 B" (SEE SHEET 1)
   N: 13,198,487.9'
   E: 2,597,712.7'
   ELV: +3.9' NAVD88
4. ALL NEARSHORE SURVEYS WERE REFERENCED TO CONTROL POINT "877 4770 B". SEE BENCHMARK CONTROL POINT TABLE.
5. NEARSHORE SURVEY DATA COLLECTED BY NAISMITH MARINE SERVICES, DATED JULY 13, 2020. SURVEY DATA CAN ONLY BE CONSIDERED REPRESENTATIVE OF THE CONDITIONS AT THE TIME OF THE SURVEY.
6. UTILITY LOCATIONS ARE NOT SHOWN. THE CONTRACTOR IS RESPONSIBLE FOR LOCATING, IDENTIFYING, AND PROTECTING/RELOCATING EXISTING UTILITIES AS NECESSARY TO CONDUCT THE WORK.

A3 DIMENSIONS
THE CONTRACTOR SHALL VERIFY ALL DIMENSIONS AND ELEVATIONS SHOWN ON THE PLANS BY FIELD MEASUREMENT AND SHALL NOTIFY THE ENGINEER OF ANY AND ALL DISCREPANCIES PRIOR TO THE COMMENCEMENT OF WORK.

A4 CONSTRUCTION SCOPE
1. REMOVAL OF RELIC CONCRETE AND DEBRIS ALONG SHORELINE
2. FILL AND REGRADE SHORELINE AS NEEDED
3. CONSTRUCTION OF REVETMENT
4. ROADWAY IMPROVEMENTS
5. SITE RESTORATION

A5 EARTHWORK
1. THE CONTRACTOR SHALL LOCATE, IDENTIFY, AND PROTECT EXISTING UTILITIES AND PIPELINES FROM DAMAGE DURING CONSTRUCTION ACTIVITIES. THE CONTRACTOR SHALL PREMARK ALL AREAS WHERE EXCAVATION AND GRADING OPERATIONS ARE TO OCCUR AND SHALL CONTACT TEXAS811 (811), THE LONE STAR NOTIFICATION COMPANY (800-669-8344) AND THE OWNER/ENGINEER 48 HOURS PRIOR TO THE START OF ONSITE CONSTRUCTION ACTIVITIES.
2. THE CONTRACTOR IS RESPONSIBLE FOR FAMILIARIZING THEMSELVES WITH THE PROJECT SITE CONDITIONS TO DETERMINE HOW THEY WILL ACCESS AND PERFORM THE WORK.
3. THE CONTRACTOR IS RESPONSIBLE FOR FAMILIARIZING THEMSELVES WITH THE SOIL CONDITIONS PRESENT AT THE PROJECT SITE PRIOR TO BIDDING. IT IS THE CONTRACTOR'S RESPONSIBILITY TO DETERMINE AND CONDUCT AT THEIR EXPENSE ANY GEOTECHNICAL TESTING THEY BELIEVE IS NEEDED TO BID OR PERFORM THE WORK.
4. EXCAVATION, GRADING AND CONSTRUCTION ACCESS SHALL ONLY OCCUR WITHIN THE BOUNDARIES SHOWN ON THE DRAWINGS, OR WITH PRIOR WRITTEN APPROVAL BY THE ENGINEER OR OWNER.

A6 PROJECT SITE CONDITIONS
1. THE CONTRACTOR IS RESPONSIBLE FOR FAMILIARIZING THEMSELVES WITH THE SITE ACCESS, BATHYMETRIC, AND HYDRODYNAMIC CONDITIONS PRESENT AT THE PROJECT SITE PRIOR TO BIDDING. WATER LEVELS MAY VARY DUE TO SEASONAL AND/OR DAY TO DAY VARIATIONS. THE PROJECT SITE CAN FLOOD, POND, AND/OR BECOME INUNDATED BY RUNOFF, WIND, STORM TIDES AND WEATHER EVENTS.
2. FLUCTUATIONS IN WATER LEVEL AND WAVES AT THE PROJECT SITE OCCUR ON A DAILY BASIS. THE CONTRACTOR IS RESPONSIBLE FOR UTILIZING EQUIPMENT AND METHODS APPROPRIATE FOR THE CONDITIONS AT THE TIME OF CONSTRUCTION

A7 SITE ACCESS
1. CONTRACTOR MAY USE CONSTRUCTION MATS, OR SIMILAR, WITHIN THE CONTRACTOR ACCESS AREAS. CONSTRUCTION MATS, OR SIMILAR, MUST BE REMOVED IN THEIR ENTIRETY AT THE CONCLUSION OF THE PROJECT. EXISTING IMPROVEMENTS SHALL BE PROTECTED FROM CONSTRUCTION ACTIVITIES BY USE OF CONSTRUCTION MATS AND TEMPORARY SAFETY FENCING, OR SIMILAR. COST TO REPAIR DAMAGE TO BE THE RESPONSIBILITY OF THE CONTRACTOR, NO SEPARATE PAYMENT WILL BE MADE.
2. CONTRACTOR SHALL BE RESPONSIBLE FOR THE REPAIR AND/OR BACKFILL OF ANY RUTTING IN THE CONTRACTOR ACCESS AREAS THAT MAY RESULT FROM THE CONTRACTOR'S ACTIVITIES INCLUDING THE USE OF CONSTRUCTION MATS, OR SIMILAR.
3. THE SITE MUST BE ACCESSED VIA LAND ONLY. SIMILARLY, CONSTRUCTION ACTIVITIES MUST BE LAND BASED. THERE SHALL BE NO ACCESS OR CONSTRUCTION ACTIVITIES FROM THE WATER SIDE.
4. THE CONTRACTOR SHALL NOT ACCESS OR PLACE PERSONNEL, EQUIPMENT, FILL, RIPRAP, STAKES, FENCING, SIGNAGE, OR ANY OTHER MATERIALS REQUIRED FOR CONSTRUCTION OUTSIDE THE LIMITS OF CONSTRUCTION.

A8 ENVIRONMENTAL PROTECTION
1. CONTRACTOR SHALL REFER TO THE PERMIT DOCUMENTS IN THE BID DOCUMENTS AND ABIDE BY ALL SPECIFIED REQUIREMENTS.
2. WETLANDS AND SEAGRASS EXTENTS SHOWN IN THESE PLANS ARE ONLY REPRESENTATIVE OF THE CONDITIONS AT THE TIME THEY WERE SURVEYED AND ARE SUBJECT TO CHANGE. THE CONTRACTOR'S PRE-CONSTRUCTION SURVEY SHALL DELINEATE THE CURRENT EXTENTS OF ALL WETLANDS AND SEAGRASS AND SHALL STAKE THEIR BOUNDARIES IN THE FIELD.
3. SHOULD THE CONTRACTOR OBSERVE ANY SEAGRASS, WETLANDS, OR OYSTERS WITHIN THE PROPOSED WORK AREA LIMITS DURING THE PRE-CONSTRUCTION SURVEY OR AT TIME OF CONSTRUCTION, THE CONTRACTOR SHALL NOTIFY THE ENGINEER IMMEDIATELY FOR MODIFICATION TO THE WORK AREA LIMITS AND/OR BREAKWATER ALIGNMENTS. THE CONTRACTOR IS RESPONSIBLE FOR PROTECTION OF SEAGRASS, WETLANDS, AND OYSTER AT ALL TIMES DURING WORK ACTIVITIES.
4. THE CONTRACTOR SHALL INSTALL AND MAINTAIN ALL NECESSARY BMP'S TO MAINTAIN WATER QUALITY PER TCEQ GUIDELINES AND REGULATIONS AND PER THE PERMIT.

A9 SITE PROTECTION
THE CONTRACTOR IS RESPONSIBLE FOR THE INSTALLATION OF TEMPORARY SAFETY FENCING TO ESTABLISH LIMITS OF CONSTRUCTION, AVOIDANCE AREAS, AND TO PROTECT THE GENERAL ENVIRONMENT. LOCATION OF THE INSTALLED FENCING MUST BE APPROVED BY THE OWNER/ENGINEER PRIOR TO ANY EQUIPMENT ACCESS, EXCAVATION, OR CONSTRUCTION BY THE CONTRACTOR. CONTRACTOR IS RESPONSIBLE FOR REINSTALLATION, REPAIR, AND MAINTENANCE OF FENCING AT ALL TIMES.

A10 SAFETY
FOLLOW PROCEDURES AND GUIDELINES CONSISTENT WITH OSHA REGULATIONS.

A11 EXISTING STRUCTURES
1. ALL EXISTING PERMANENT STRUCTURES SUCH AS BULKHEADS, PIERS, AND DOCKS SHALL NOT BE DISTURBED. THE CONTRACTOR IS RESPONSIBLE FOR PROTECTING THESE STRUCTURES AND ENSURING THEY REMAIN STABLE THROUGHOUT CONSTRUCTION.
2. THE CONTRACTOR IS RESPONSIBLE FOR ANY DAMAGE CAUSED TO PRIVATE PROPERTY. IF DAMAGES OCCUR, THE CONTRACTOR SHALL MAKE ALL NECESSARY REPAIRS AND/OR REPLACEMENTS AT NO ADDITIONAL COST TO THE OWNER.

ABBREVIATIONS:

ACM	ASBESTOS CONTAINING MATERIAL
ALUM	ALUMINUM
AW	ANCHOR WALL WORKING POINT
BM	BENCHMARK
B.O.	BOTTOM OF
B.W.	BOTH WAYS
BW	BULKHEAD WALL WORKING POINT
℄	CENTERLINE
CCA	CHROMIUM COPPER ARSENATE
CIP	CAST-IN-PLACE
CLR	CLEAR
CONC	CONCRETE
CJ	CONSTRUCTION JOINT
Ø	DIAMETER
EA	EACH
EHS	ENVIRONMENTAL HEALTH AND SAFETY
E.S	EACH SIDE
E.W.	EACH WAY
EOP	EDGE OF PAVEMENT
EL	ELEVATION
FT	FEET
GALV	GALVANIZED
HDPE	HIGH DENSITY POLYETHYLENE
MLW	MEAN LOW WATER
MIN	MINIMUM
MAX	MAXIMUM
O.C.	ON CENTER
O&M	OPERATIONS AND MAINTENANCE
PMCS	PROJECT MANAGEMENT AND CONSTRUCTION SERVICES
PSP	PROFESSIONAL SERVICE PROVIDERS
RW	REVETMENT WORKING POINT
SIM	SIMILAR
SS	STAINLESS STEEL
STD	STANDARD (WALL)
STA	STATION
TCEQ	TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
T.O.	TOP OF
T.O.C.	TOP OF CAP
T.O.S.	TOP OF STEEL
TYP	TYPICAL
UGC	UNIFORM GENERAL CONDITIONS
UHMW	ULTRA HIGH MOLECULAR WEIGHT POLYETHYLENE
UT	THE UNIVERSITY OF TEXAS
WP	WORKING POINT
W/	WITH
XS	EXTRA STRONG (WALL)
@	AT
'	MINUTES OR FEET
"	SECONDS OR INCHES

SURVEY CONTROL POINTS

POINT ID	NORTHING	EASTING	ELEVATION (NAVD88)
877 4770 B	13,198,487.9	2,597,712.7	+3.9'

TIDAL ELEVATIONS (NAVD88)*

MEAN HIGHER HIGH WATER (MHHW)	+1.30'
MEAN SEA LEVEL (MSL)	+1.12'
MEAN LOWER LOW WATER (MLLW)	+0.93'

** TIDAL ELEVATIONS WERE DETERMINED AT ROCKPORT, TX NOAA TIDE STATION ID 8774770*

CALL BEFORE YOU DIG!

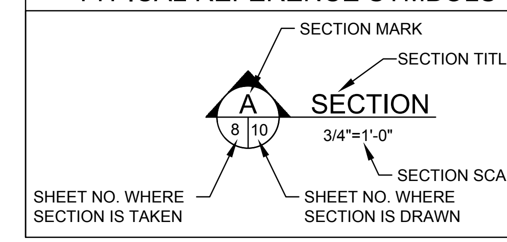
MOST AGENCIES REQURE AT LEAST 48 HOURS NOTICE BEFORE YOU DIG, DRILL, OR BLAST - STOP CALL

DIG TESS
AT 1-800-344-8377

Texas One Call System
AT 1-800-245-4545

THE LONE STAR NOTIFICATION COMPANY
AT 1-800-669-8344

TYPICAL REFERENCE SYMBOLS



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507102160	2	5

Designed	KW	Eng check	
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Dwg check	LM	Approved	LM
Scale at ANSI D	Status	Rev	Security

Drawing Number

Title

ARANSAS COUNTY
NORTH FULTON BEACH ROAD
SHORELINE PROTECTION EXTENSION

GENERAL NOTES

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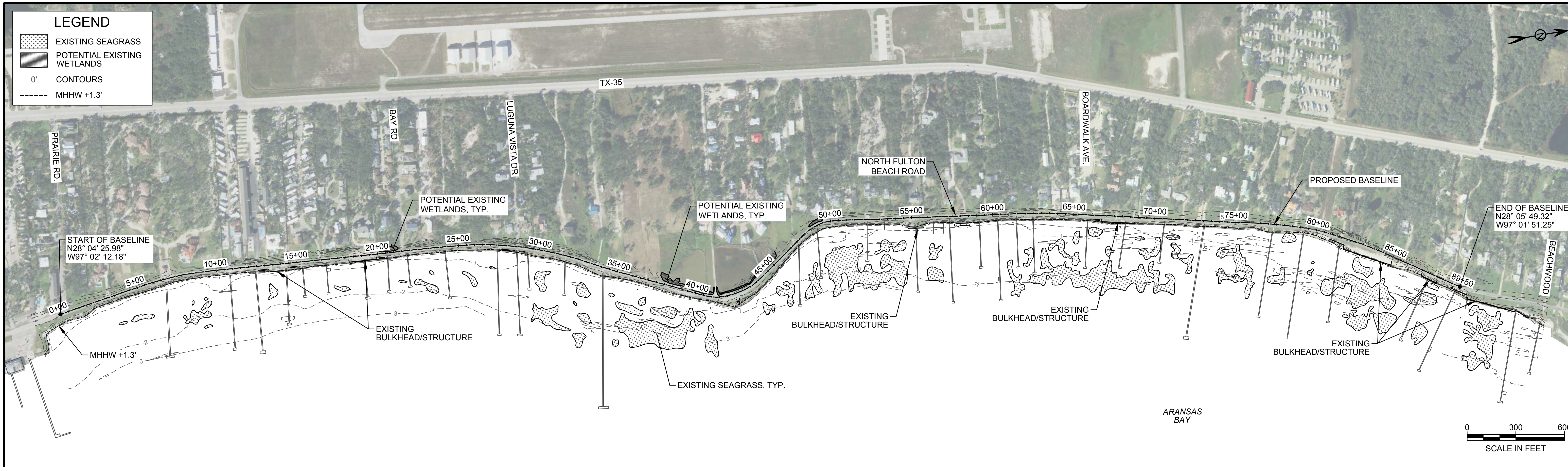

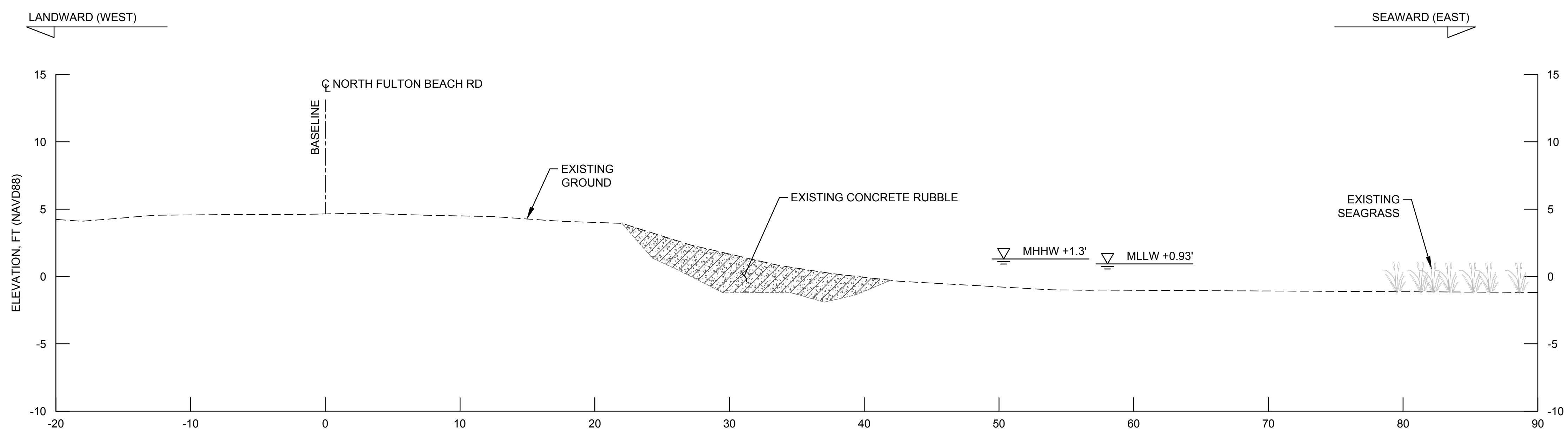

TYPICAL SECTION

EXISTING

HORIZ. 0 5 10

VERT. 0 5 10

SCALE IN FEET

NOTES:

1. AERIAL PHOTOGRAPH DATED 12/2/2018 FROM TNRIS AND IS ONLY REPRESENTATIVE OF THE CONDITIONS AT THE TIME TAKEN.
2. VEGETATION, BATHYMETRIC, AND TOPOGRAPHIC SURVEY WAS CONDUCTED BY NAISMITH MARINE SERVICES IN JUNE-JULY 2020.
3. BASELINE LOCATION AND COORDINATES SHOWN ARE APPROXIMATE AND MUST BE VERIFIED. BASELINE SHOULD FOLLOW THE CENTERLINE OF THE EXISTING ROADWAY.

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507102160	3	5

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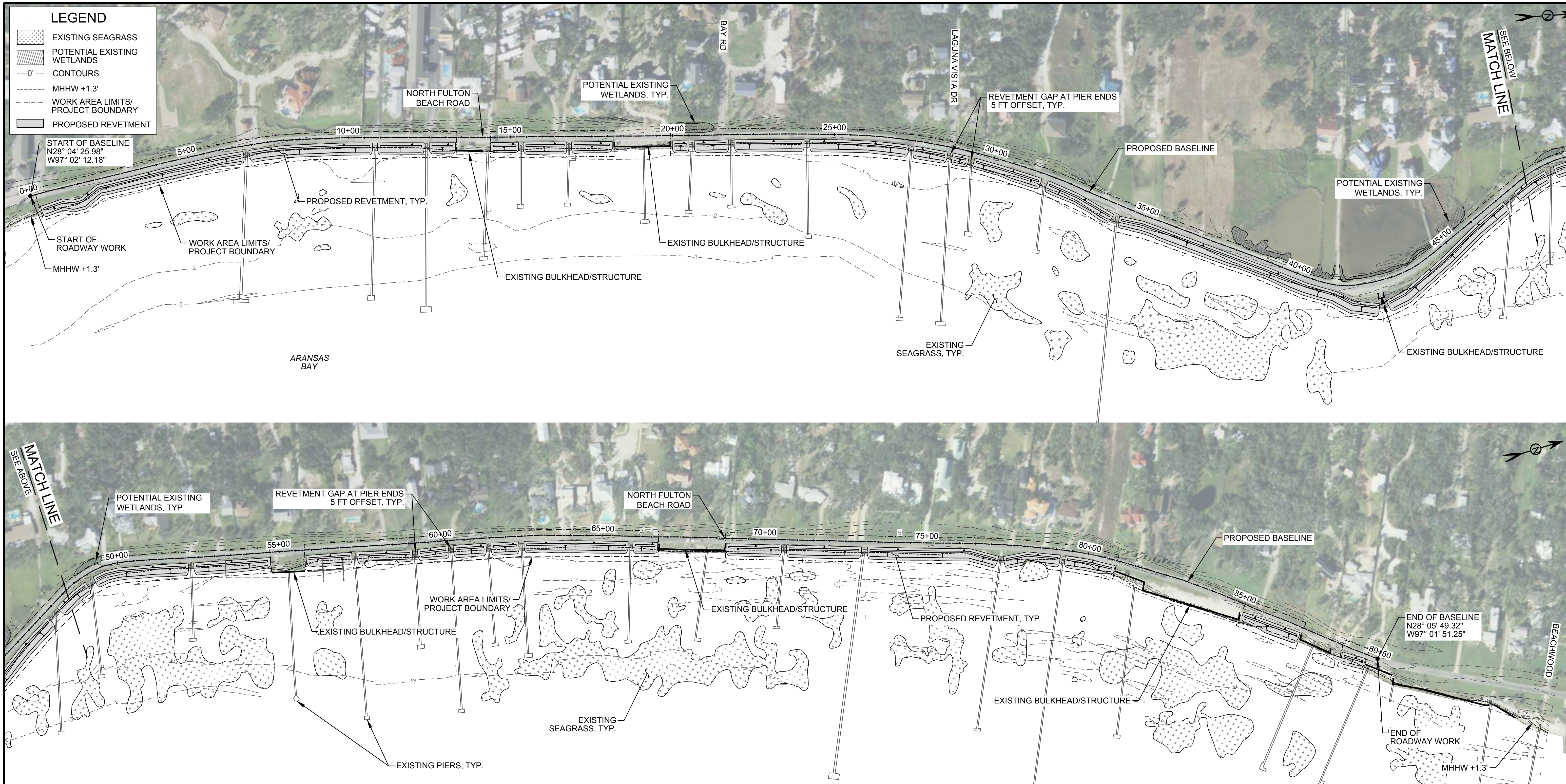
Drawing Number			

Title

ARANSAS COUNTY
NORTH FULTON BEACH ROAD
SHORELINE PROTECTION EXTENSION

EXISTING SITE PLAN



NOTES:

1. AERIAL PHOTOGRAPH DATED 12/2/2018 FROM TNRIS AND IS ONLY REPRESENTATIVE OF THE CONDITIONS AT THE TIME TAKEN.
2. REVETMENT SECTIONS SHALL TERMINATE 5 FT FROM ALL EXISTING PIERS AND PEIR LEASED AREAS.
3. THE CONTRACTOR SHALL ACCESS THE SITE VIA NORTH FULTON BEACH ROAD, AND THE REVETMENT SHALL BE CONSTRUCTED UTILIZING LAND-BASED EQUIPMENT ONLY.
4. ROADWAY WORK EXTENTS SHOWN INCLUDE ROADWAY AND DRAINAGE IMPROVEMENTS.
5. BASELINE LOCATION AND COORDINATES SHOWN ARE APPROXIMATE AND MUST BE VERIFIED. BASELINE SHOULD FOLLOW THE CENTERLINE OF THE EXISTING ROADWAY.

0 150 300
SCALE IN FEET

30% SUBMITTAL

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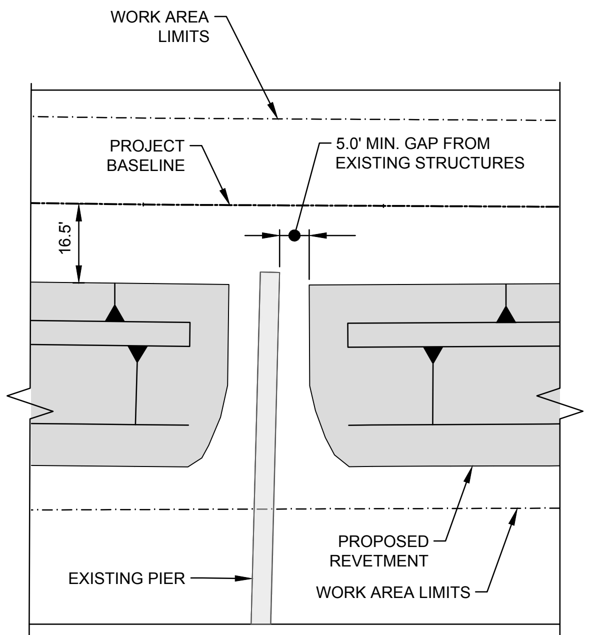
ARANSAS COUNTY
NORTH FULTON BEACH ROAD
SHORELINE PROTECTION EXTENSION

PROPOSED SITE PLAN



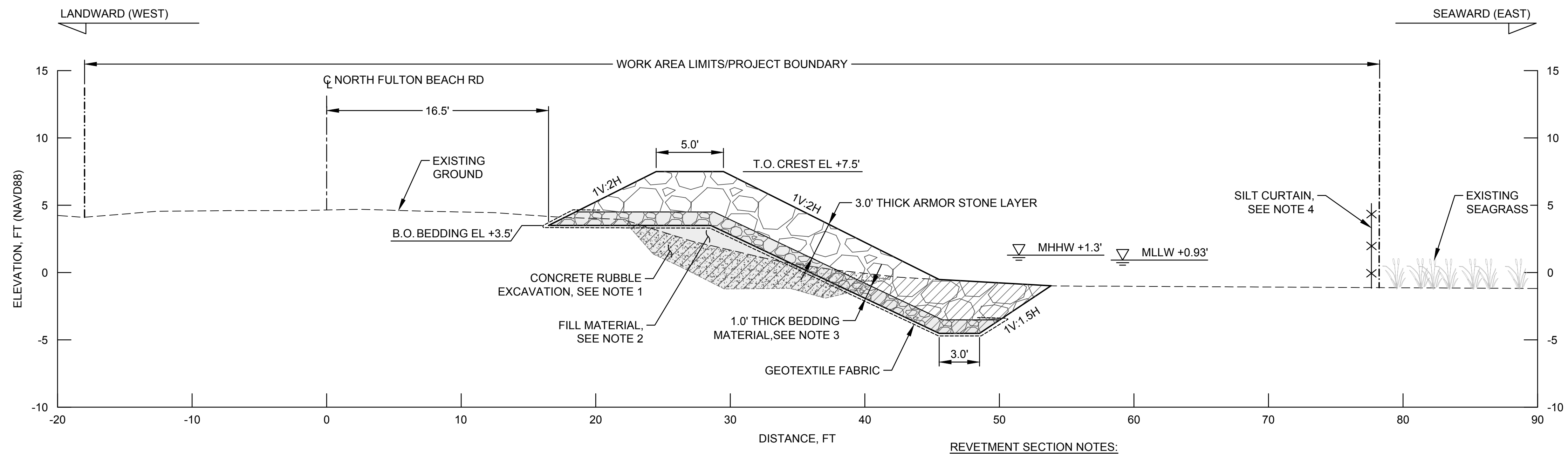
SITE PLAN

REVETMENT END

HORIZ. 0 20 40
SCALE IN FEET

REVETMENT SITE PLAN NOTES:

1. REVETMENT SECTIONS SHALL TERMINATE A MINIMUM OF 5 FT OFFSET FROM ALL EXISTING PIERS AND PIER LEASES
2. ALL EXISTING PRIVATE STRUCTURES SHALL BE PROTECTED DURING CONSTRUCTION.



TYPICAL SECTION

REVETMENT

HORIZ. 0 5 10
VERT. 0 5 10
SCALE IN FEET

REVETMENT SECTION NOTES:

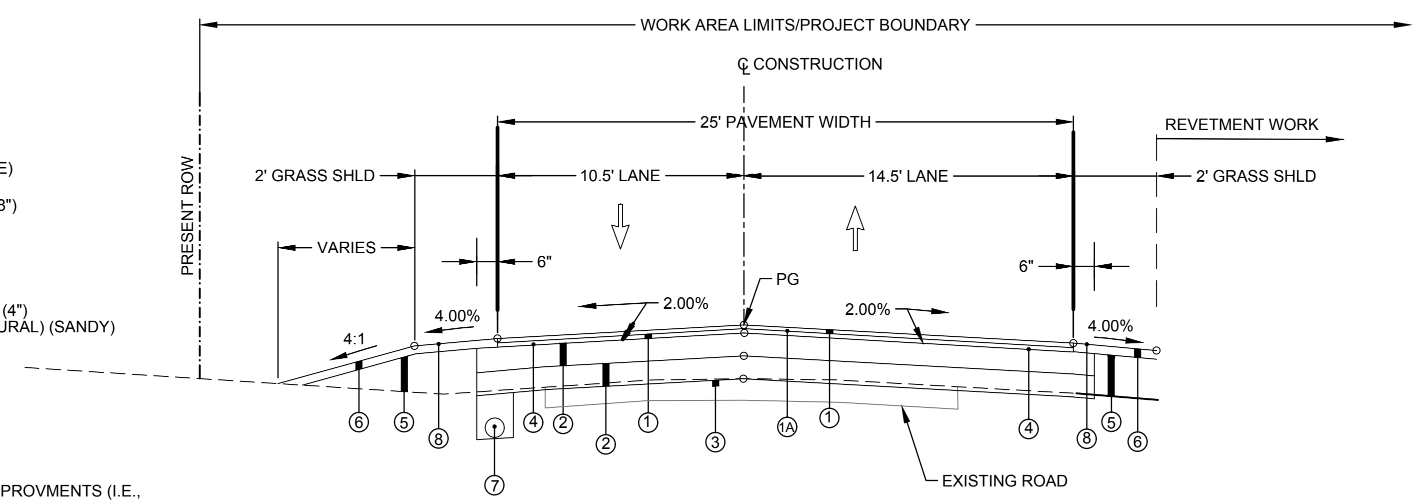
1. EXISTING CONCRETE RUBBLE AND OTHER DEBRIS ALONG SHORELINE MUST BE EXCAVATED WHERE PRESENT.
2. CLEAN FILL EXCAVATED FROM REVETMENT TOE AREA MAY BE USED AS FILL MATERIAL TO BACK FILL VOIDS LEFT FROM CONCRETE RUBBLE EXCAVATION AND TO CREATE STABLE SLOPE FOR CONSTRUCTION OF THE REVETMENT.
3. BEDDING MATERIAL MAY CONSIST OF NEW STONE AND/OR REUSED CONCRETE EXCAVATED FROM THE SHORELINE AND REGRADED PER THE CONTRACT SPECIFICATIONS.
4. CONTRACTOR SHALL INSTALL TURBIDITY CURTAINS AND/OR APPROVED EQUAL BMPS TO MINIMIZE TURBIDITY DUE TO CONSTRUCTION ALONG THE SHORELINE.

REQUIRED MATERIAL LEGEND

LEGEND NO.	DESCRIPTION
1	DENSE-GRADED HOT-MIX ASPHALT (SMALL QUANTITY) TYPE D
1A	TACK COAT
2	FLEXIBLE BASE (COMPLETE IN PLACE) (TYPE A, GRADE 1-2) (6")
3	REWORK BASE MATERIAL (TYPE C) (8") (DENSITY CONTROL)
4	PRIME COAT
5	BACKFILL TYPE A
6	FURNISHING AND PLACING TOPSOIL (4") BROADCAST SEED (PERMANENT) (RURAL) (SANDY)
7	PIPE UNDERDRAIN TYPE 6, 6"
8	BLOCK SODDING

ROADWAY SECTION NOTES

1. ROADWAY WORK ALSO INCLUDES DRAINAGE IMPROVMENTS (I.E., CULVERTS, ETC.) NOT SHOWN.



TYPICAL SECTION

ROADWAY WORK
N.T.S.

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ARANSAS COUNTY
NORTH FULTON BEACH ROAD
SHORELINE PROTECTION EXTENSION

TYPICAL DETAILS & SECTIONS

Aransas County

HMP - North Fulton Beach Rd

30% Design Estimate of Probable Construction Cost

1.0 Revetment Work from Praire Rd to 1581 N Fulton Beach Rd (STATION 0+00 - 55+50)

Item No.	Item Description	Quantity	Unit	Unit Cost	Total Cost
1.01	Mobilization and Demobilization	1	LS	$ 150,000.00	$ 150,000.00
1.02	Construction Surveying	1	LS	$ 48,900.00	$ 48,900.00
1.03	Environmental Protection (BMP)	1	LS	$ 35,200.00	$ 35,200.00
1.04	Earthwork (including concrete and shoreline excavation, demolition of concrete rubble, native backfilling and grading)	1	LS	$ 336,900.00	$ 336,900.00
1.05	Bedding Material (assuming concrete reuse with new stone as needed)	6,260	CY	$ 55.00	$ 344,300.00
1.06	Armor Stone	26,160	TON	$ 165.00	$ 4,316,400.00
1.07	Geotextile Fabric	23,620	SY	$ 9.00	$ 212,580.00
1.08	New Shoreline Fill	4,770	LF	$ 22.00	$ 104,940.00
				Total Revetment Cost	$ 5,549,220.00

2.0 Roadway Work from Praire Rd to 1581 N Fulton Beach Rd (STATION 0+00 - 55+50)

Item No.	Item Description	Quantity	Unit	Unit Cost	Total Cost
2.01	Roadway Work	5,550	LF	$ 367.00	$ 2,036,850.00
				Total Roadway Cost	$ 2,036,850.00
				SUM	$ 7,586,070.00
				Contingency (30%)	$ 2,275,821.00
				TOTAL REVETMENT AND ROADWAY WORK COST	**$ 9,861,891.00**

3.0 Revetment Work from 1581 N Fulton Beach Rd to 1929 N Fulton Beach Rd (STATION 55+50 - 89+50)

Item No.	Item Description	Quantity	Unit	Unit Cost	Total Cost
3.01	Mobilization and Demobilization	1	LS	$ 100,000.00	$ 100,000.00
3.02	Construction Surveying	1	LS	$ 23,200.00	$ 23,200.00
3.03	Environmental Protection (BMP)	1	LS	$ 16,700.00	$ 16,700.00
3.04	Earthwork (including concrete and shoreline excavation, demolition of concrete rubble, native backfilling and grading)	1	LS	$ 176,200.00	$ 176,200.00
3.05	Bedding Material (assuming concrete reuse with new stone as needed)	2,970	CY	$ 55.00	$ 163,350.00
3.06	Armor Stone	12,420	TON	$ 165.00	$ 2,049,300.00
3.07	Geotextile Fabric	11,210	SY	$ 9.00	$ 100,890.00
3.08	New Shoreline Fill	2,270	LF	$ 22.00	$ 49,940.00
				Total Revetment Cost	$ 2,679,580.00

4.0 Roadway Work from 1581 N Fulton Beach Rd to 1929 N Fulton Beach Rd (STATION 55+50 - 89+50)

Item No.	Item Description	Quantity	Unit	Unit Cost	Total Cost
4.01	Roadway Work	3,400	LF	$ 367.00	$ 1,247,800.00
				Total Roadway Cost	$ 1,247,800.00
				SUM	$ 3,927,380.00
				Contingency (30%)	$ 1,178,214.00
				TOTAL REVETMENT AND ROADWAY WORK COST	**$ 5,105,594.00**

TOTAL PROJECT REVETMENT AND ROADWAY WORK COST $ 14,967,485.00

Notes:

1. All costs are in 2020 dollars
2. Costs do not include final engineering, bidding phase support, construction oversight, or construction administration
3. Mobilization & Demobilization costs assume local contractor
4. Actual quantities at time of construction may vary due to change in site conditions
5. Unit costs depend on material availability and fluctuate over time
6. Roadway costs include separate equipment mob. & demob., demolition of the existing roadway, and installation of new roadway and drainage improvements
7. Roadway costs are preliminary and were estimated using the Aransas County HMP Fulton Beach Road project design
8. Earthwork includes the cost for concrete rubble excavation, excavation for the revetment toe, fill labor for native material, and shoreline grading

December 8, 2020

Aransas County

Fulton Beach Road Living Shoreline Project

CMP Cycle 24

Coastal Engineering Analysis

Mott MacDonald
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Coastal Engineering Analysis

North Fulton Beach Road Shoreline

December 7, 2020

Aransas County

Issue and revision record

Revision	Date	Originator	Checker	Approver	Description
A	12/07/2020	DS	LM	AH	For Review

Document reference: 507102160 | 01 | A

Information class: Standard

Contents

1 Introduction

This report summarizes the results of work conducted by Mott MacDonald (MM) under Task 2 of the Scope of Work at the request of Aransas County, Texas (County) for the Aransas County North Fulton Beach Road Shoreline Restoration Extension Project. The work involves an extension of roadway elevation, drainage improvements, and shoreline protection along the portion of North Fulton Beach Road, north of the previous shoreline protection design developed by Mott MacDonald for the Aransas County Hazard Mitigation Project (HMP) (Mott MacDonald, 2019), referred to as the South Fulton project henceforth.

1.1 Design Approach

The goal of the extended design is to stabilize the shoreline in order to protect the adjacent roadway from erosive waves along the remainder of North Fulton Beach Road from Prairie Road north towards the Kontiki Beach Resort. The original design approach for the shoreline component was anticipated to be a continuation of the final shoreline protection design developed for the USACE authorized HMP South Fulton project, which included concrete debris removal and construction of a living shoreline consisting of beach fill, vegetation planting, and offshore detached breakwaters. However, based on public comments, it is understood that this protection scheme may not be preferred by the public for the remainder of North Fulton Beach Road. Furthermore, the recent habitat survey performed for this project showed a widespread coverage of existing seagrass within the project site and close to the shoreline. The presence of seagrass poses additional challenges, since the shoreline protection scheme must not impact existing seagrass, otherwise mitigation efforts would be required. Therefore, Mott MacDonald reinvestigated a number of potential alternatives and evaluated their ability to meet the project goals of the North Fulton Beach Road project. The alternatives assessed included the following:

- Bulkhead
- Articulated concrete block mat (ACBM) revetment
- Riprap revetment
- Offshore reef units
- Breakwaters & vegetation planting (Living Shoreline)
- Rock revetment with jointed vegetation planting
- Rock revetment with toe vegetation planting
- Revetment with offshore reef units

Due to the presence of seagrass, any offshore structural alternatives, such as the reef units and breakwaters would likely need to be installed seaward of the seagrass extent. Placing the structures this far offshore would require a significant amount of materials in order to achieve the desired level of wave attenuation, which would result in high project costs. The bulkhead and revetment alternatives mitigate impacts to the seagrass, but also have considerable pros and cons: bulkheads are effective at stabilizing the shoreline, but are also associated with high costs and limit access to the water; revetments typically require a high crest elevation in order to provide the desired level of protection from overtopping, but require no to low-maintenance; ACBM revetments are less durable than riprap; the addition of vegetation plantings would help provide habitat, but the survivability is expected to be low as they will be exposed to direct wave impact, etc. The assessment of these alternatives is further detailed in the Memorandum of

Project Understanding, dated August 5, 2020 (Mott MacDonald, 2020), submitted to Aransas County; a copy of this document is provided in Appendix A. Following review of these alternatives, the County identified the preferred alternative to be a riprap revetment along the shoreline. A revetment will provide a cost-effective measure to shoreline stabilization, will mitigate impacts to seagrass, and using riprap will ensure its durability over the intended 30-yr project life.

The objectives of this report are to briefly review the existing and new data collected, summarize the coastal engineering analysis developed to reflect conditions at the project site, and establish design parameters for the riprap revetment. The revetment will be designed to provide shoreline stabilization and protection during daily and storm conditions up to the 100-yr event.

1.2 Project Site Description

The project site is located along the northern portion North Fulton Beach Road in the City of Fulton, within Aransas County, Texas. The project location and extents can be seen in Figure 1 and Figure 2.

Figure 1. Project location map.

Figure 2. Project site map. Note that the proposed shoreline protection may not extend along the full length of the project site.

The roadway within the project site area is currently exposed to high tide events and is frequently flooded during storm events due to the small vertical relief between the seaward edge of the road and the water line. The shoreline is currently lined in most areas with non-engineered concrete rubble that has been placed over time to help stabilize the shoreline but is not sufficient for coastal projection. This is evident in Figure 3 and Figure 4, which show shoreline damage and vulnerability to North Fulton Beach Road due to Hurricane Hanna in July 2020, and Tropical Storm Beta in September 2020, respectively.

Figure 3. Damage at North Fulton Beach Road from Hurricane Hanna in July 2020 (Rockport Pilot, 2020).

Figure 4. Flooding along North Fulton Beach Road due to Tropical Storm Beta in September 2020.

2 Data Utilized in Design

Existing data was compiled to assist in the coastal engineering analysis and the design of the preferred alternative. This existing data was collected from the South Fulton Project, which included rectified aerial images, wind, tide, and geotechnical boring data. New data was collected at the project site, which included site photos, topographic, bathymetric, and habitat surveys. This section describes the existing and new data collected and processed to assist in the coastal engineering analysis and design of the riprap revetment.

2.1 Design Standards and Guidelines

The following design standards and guidelines were identified for this analysis:

- US Army Corps of Engineers (USACE)
- Coastal Engineering Manual (CEM)

2.2 Datums

Based on its proximity to the project site, the tidal datum for the project site was acquired from the National Oceanic and Atmospheric Administration (NOAA) Station No. 8774770 at Rockport, TX, shown in Figure 5. Tidal datums for the tidal epoch of 1983-2001, relative to North American Vertical Datum (NAVD88) GEOID12B, were collected via the NOAA Tides and Currents website and are presented in Table 1.

Figure 5: Aerial showing location of the NOAA Station 8774770 at Rockport.

Table 1. Tidal Datums at the NOAA Rockport Station referenced to NAVD88

Datum	Elevation [ft NAVD88]
Mean Higher High Water (MHHW)	1.30
Mean High Water (MHW)	1.29
Mean Sea Level (MSL)	1.12
Mean Low Water (MLW)	0.94
Mean Lower-Low Water (MLLW)	0.93
North American Vertical Datum of 1988 (NAVD88)	0.00

2.3 Geotechnical Data

A geotechnical investigation was previously conducted for the South Fulton project by Rock Engineering & Testing Laboratory (RETL), which was executed in 2019. Locations of the core samples are shown in Figure 6. No new geotechnical data was collected for the North Fulton Beach Road project site at this time; thus, the information provided in these existing borings will be utilized to inform the preliminary design. The geotechnical investigation report from the South Fulton project is provided in Appendix B. However, new geotechnical data will need to be collected within the North Fulton Beach project site prior to development of the final design (to be conducted under a future phase).

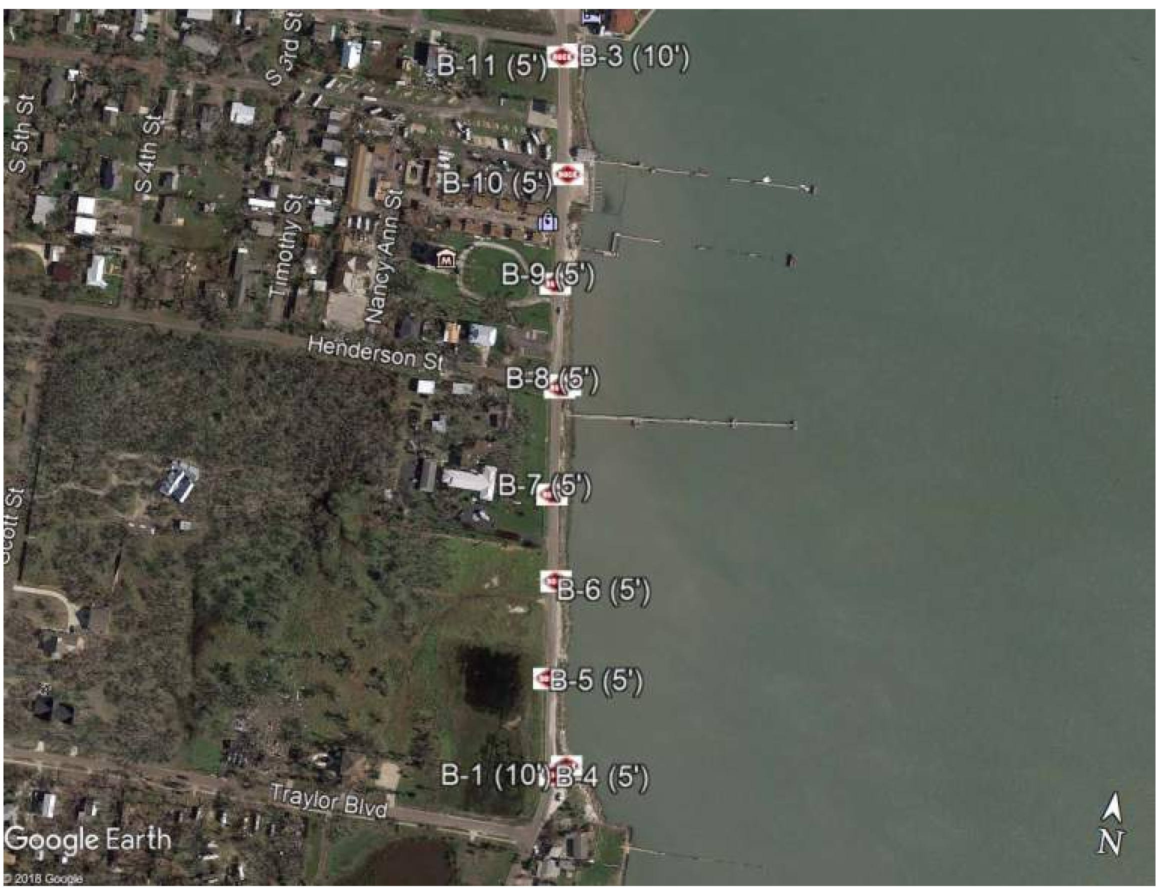


Figure 6: Boring sample locations along Fulton Beach Road (from the South Fulton project).

2.4 Bathymetric and Topographic Data

New topographic and bathymetric surveys were conducted within the project site by T. Baker Smith in July 2020. Topographic survey transects extended approximately 100 ft landward of the shoreline and bathymetric survey transects extended approximately 350-400 ft seaward of the shoreline. A copy of the survey report is provided in Appendix C. A surface was created from the survey transects and will be used for the development of the design drawings.

2.5 Environmental Data

Environmental data pertinent to this scope includes the presence of seagrass and or oyster beds in the vicinity of the project. Identifying and mapping the spatial extents of any seagrass and oyster beds within the site is required in order to avoid impacts to these habitats. Seagrass and oyster bed surveys were conducted at the project site by T. Baker Smith in July 2020. The survey shows that no oyster beds currently exist within the project site. The survey also shows that there is a large presence of seagrass within the nearshore area; however, it is located far enough seaward of the shoreline where it is not expected to be impacted by the installation of a revetment along the shoreline. Figure 7 provides an aerial showing the extents of the seagrass presence within the surveyed area. The presence of seagrass will require the use of environmental best management practices such as silt curtains or turbidity fences during construction of the revetment, to mitigate any temporary impacts to the adjacent seagrasses. A report of the full survey results is provided in Appendix C.

Figure 7. Areas of seagrass designated by the yellow polygons within the project site, based on the survey performed by T. Baker Smith during July 2020.

2.6 Historical Wind and Water Level Data

Historical wind and water level data was collected from the Rockport (Station 8774770) and the Port Aransas (PTAT2) NOAA National Data Buoy Center (NDBC) buoy (NOAA, 2019). Although there are other wind and water level gauges in the area, each available source for historical data was assessed for dataset length, duration, completeness, and location during previous work performed by Mott MacDonald for the Aransas County Hazard Mitigation Projects (Mott MacDonald, 2019). Data was collected in order to determine the predominant and extremal wind and tidal conditions at the site to be used for the development of the shoreline protection design that has been identified by the County as the preferred alternative along the shoreline of North

Fulton Beach Road. The approximate locations of these gauges are shown in Figure 8. The period of record for each gauge and interval at which data was recorded is shown in Table 2.

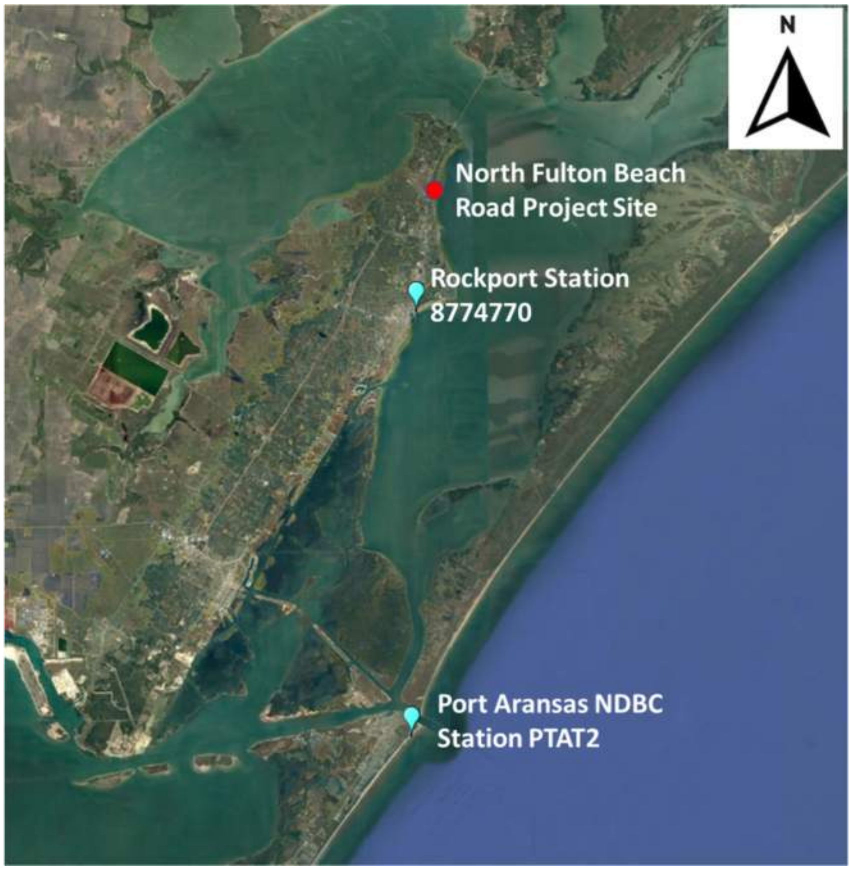


Figure 8. NOAA stations where wind and water level data were collected.

Table 2. Summary of historical wind and water level data collected.

Location	Data Type	Date Range
Port Aransas	wind, hourly	3/9/84 to 12/31/19
Rockport	water level, 6 min	1/1/1996 to 6/1/2020

2.6.1 Water Level Data

Since the NOAA Rockport Station provides the longest and most complete historical dataset of water levels near the project site, this station's dataset was used in the extremal analysis, which is reported in Section 3.1.

In addition, relative sea level rise (RSLR) data and predictions were reviewed for this project. RSLR reflects changes in the local sea level over time and is a combination of eustatic sea level rise and local land subsidence. An analysis of RSLR was conducted by NOAA National Ocean Service (NOAA, 2019) for the NOAA Rockport tide station. This station documents a historical sea level rise trend of 5.77 mm/year, as shown in Figure 9. The NOAA Rockport station also provides projection estimates for low, intermediate, and high sea level rise magnitudes (among others) for future years, up to the year 2100; these projections are shown in Figure 10. The black line on Figure 10 represents the measured sea level rise for this station, which is currently in line with the current projections. The design sea level rise increment for this project based on the 30-year projection at the NOAA Intermediate growth rate is 1.3 feet. This sea level rise value will be taken into consideration for design the structure crest elevations in order to ensure the longevity of the design over the life of the project.

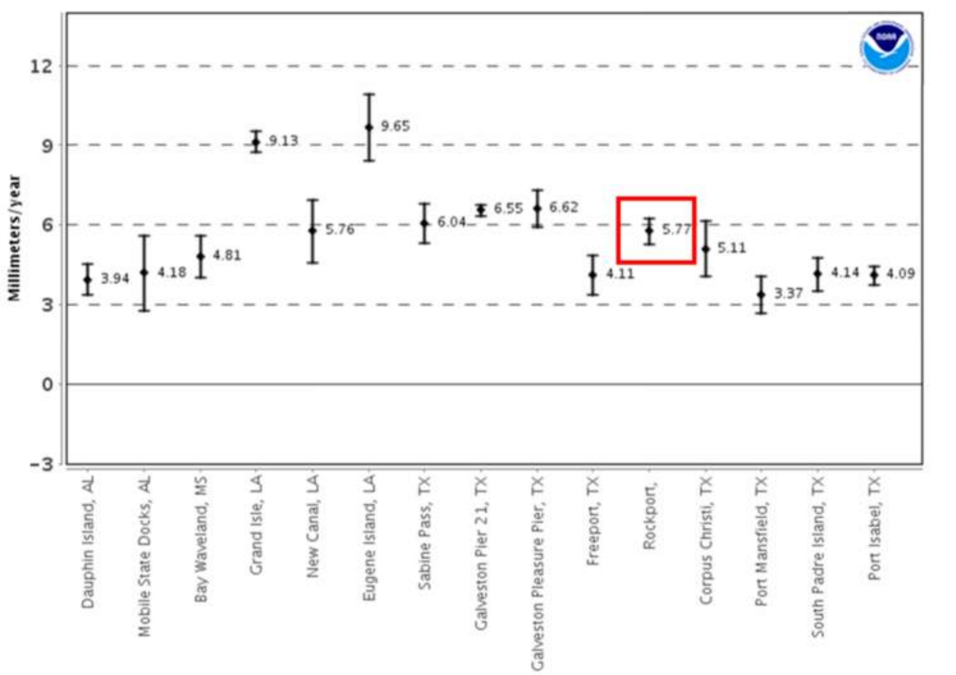


Figure 9. NOAA RSLR Trends for the Gulf of Mexico (NOAA, 2019); Rockport data identified by the red rectangle.

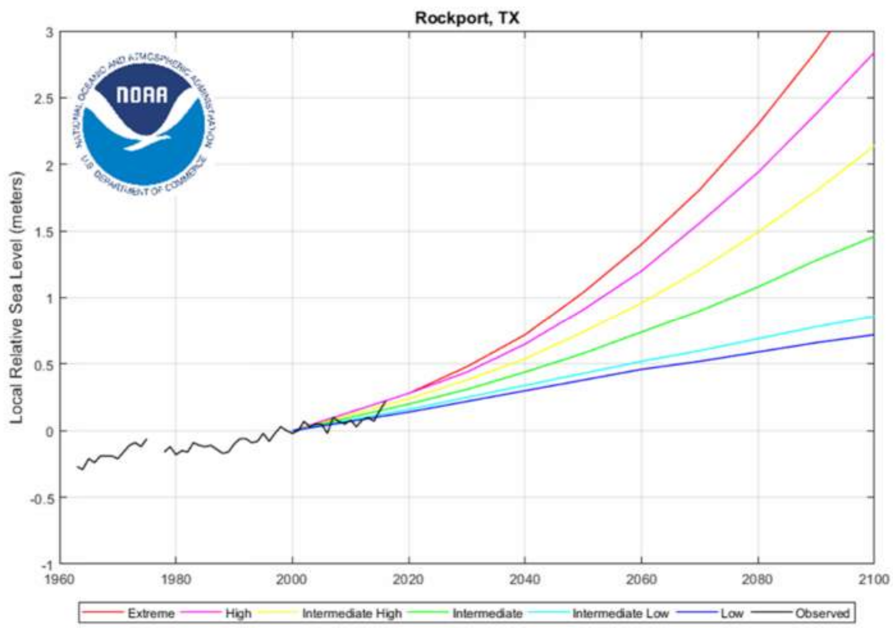


Figure 10. NOAA RSLR Projections for Rockport, TX (NOAA, 2019).

2.6.2 Wind Data

Wind data was collected from the NOAA National Data Buoy Center (NDBC) and Tides & Currents for Port Aransas. After evaluating the completeness, accuracy and duration of available historical wind datasets from the Hazard Mitigation Projects (Mott MacDonald, 2019), the Port Aransas station dataset was selected for the extreme wind analysis, which is documented in Section 3.1 of this report.

Periods of record for this station is specified in Table 2. Wind roses, shown in Figure 11, were developed for the dataset. These plots illustrate the frequency of occurrence of events for 16 directional bins for various wind magnitudes and for the higher speed winds (> 30 mph) to understand the directional distribution of stronger winds which would be representative of design conditions at the site. According to this station's dataset, the highest winds typically come from north-northwest to north-northeast directions at this site, while the predominate winds are from the southeast direction.

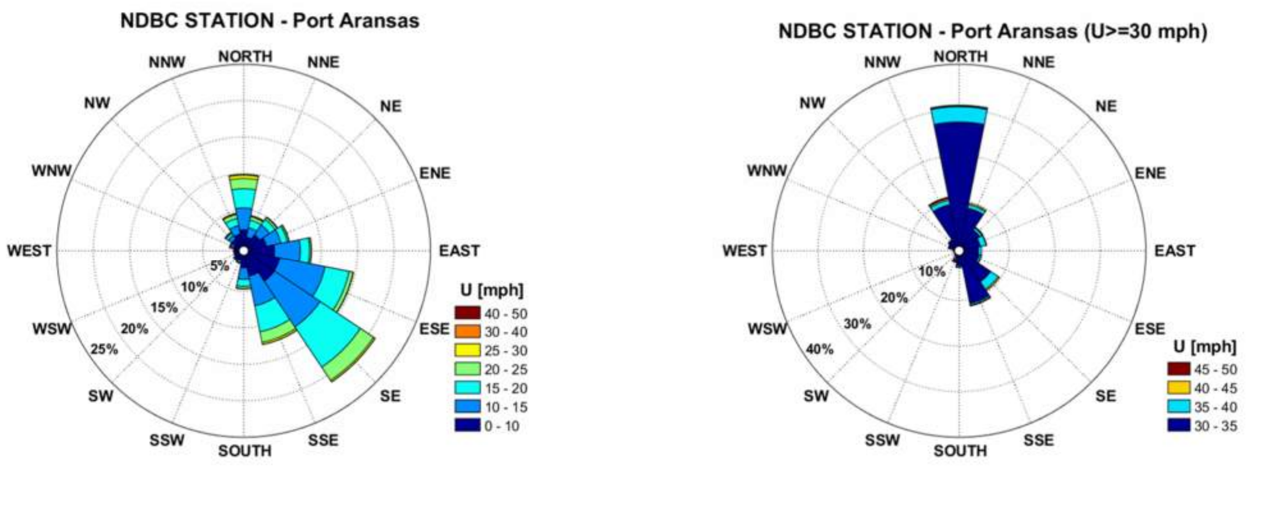


Figure 11. Wind roses for the NDBC Port Aransas station for (left) the full dataset, and (right) windspeeds 30 mph and greater.

3 Coastal Engineering Analysis

The coastal engineering analysis previously developed for the South Fulton project was updated to build upon an existing knowledge base of coastal processes near the project site and reflect the current conditions in the area. This investigation included a statistical analysis of wind and water level data from the sources identified in Section 2. The calculated statistics were used to inform design parameters for the preliminary design of the riprap revetment.

3.1 Extremal Analysis Results

An extremal analysis was conducted for both water level elevations and wind speeds to provide estimates of water levels and wind speeds associated with extreme weather events. As identified in Section 2, wind data from the NOAA Station 8775237 at Port Aransas and water level data from the NOAA Station at Rockport were used for the extremal analyses.

The extremal analysis results for return periods ranging from 1 year to 100 years are shown in Table 3. A return period corresponds to an Annual Exceedance Probability (AEP), or percent likelihood of the event occurring in any given year. The ratio associated with any AEP is one over the return period (i.e. a 1-year return period has a 1/1 ratio or 100% AEP, and a 100-year return period has a 1/100 ratio or 1% AEP). These probabilities and magnitudes will be referenced throughout this document as they represent the design conditions for the coastal protection alternatives developed. Note that the extremal water levels do not include potential storm surges from hurricanes which could result in higher water levels. Also, the probabilities shown are for any given water level or wind speed, not the joint probabilities of any given wind speed and water level event occurring simultaneously.

Table 3. Extreme analysis results for water levels and wind speeds.

Return Period [years]	Water Levels [ft NAVD88]	Wind Speed [mph]
1	2.9	40
2	3.1	40
5	3.4	42
7.5	3.5	44
10	3.6	45
15	3.8	74
20	3.9	87
25	3.9	92
50	4.1	114
75	4.2	129
100	4.3	136

3.2 Waves

Numerical wave modeling was performed for the South Fulton project in order to evaluate wave conditions over a range of storm scenarios along the shoreline. Wave modeling was conducted using the SWAN Cycle III version 41.01 model (Delft, 2014), which is a 2-D spectral (phase-averaged) wave transformation model that can be used to generate wind-driven waves and transform those wave conditions to the nearshore region. The SWAN modeling grid includes most of Aransas, St. Charles, and Mesquite Bays with the purpose of capturing the maximum fetch for wave generation in all directions. An example image of the modeling grid showing bathymetry elevations within the region of the project site is provided in Figure 12. The range of water levels tested include: MSL, MHHW, 100-yr, 10-yr, 5-yr, 2-yr, and 1-yr. The range of wind speeds tested include: 100-yr, 10-yr, 5-yr, 2-yr, and 1-yr. The range of wind directions tested included: southeast (135 degrees TN), the predominant direction, and northeast (66 degrees TN), the longest fetch. Since South Fulton was the focus of the previous modeling effort, the grid is more course and did not include the recent bathymetric survey along North Fulton Beach Road. However, due to the proximity and orientation of the North Fulton Beach Road project site relative to South Fulton, the resulting wave conditions near the northern end of South Fulton are likely applicable to the North Fulton Beach Road shoreline. Thus, the maximum wave height for the 100-yr condition along South Fulton was extracted from the model results. The breaking wave height was then calculated utilizing the updated bathymetric depths along the North Fulton site from the recent survey. The resulting wave and water level data for the design storm conditions are shown in Table 4.

Table 4. 100-yr Design Storm Conditions

Design Condition	Elv. (ft NAVD88)	Wave Height (ft)	Wave Period (s)
Water Level	5.6	-	‘
Wave	-	3.3	4.6

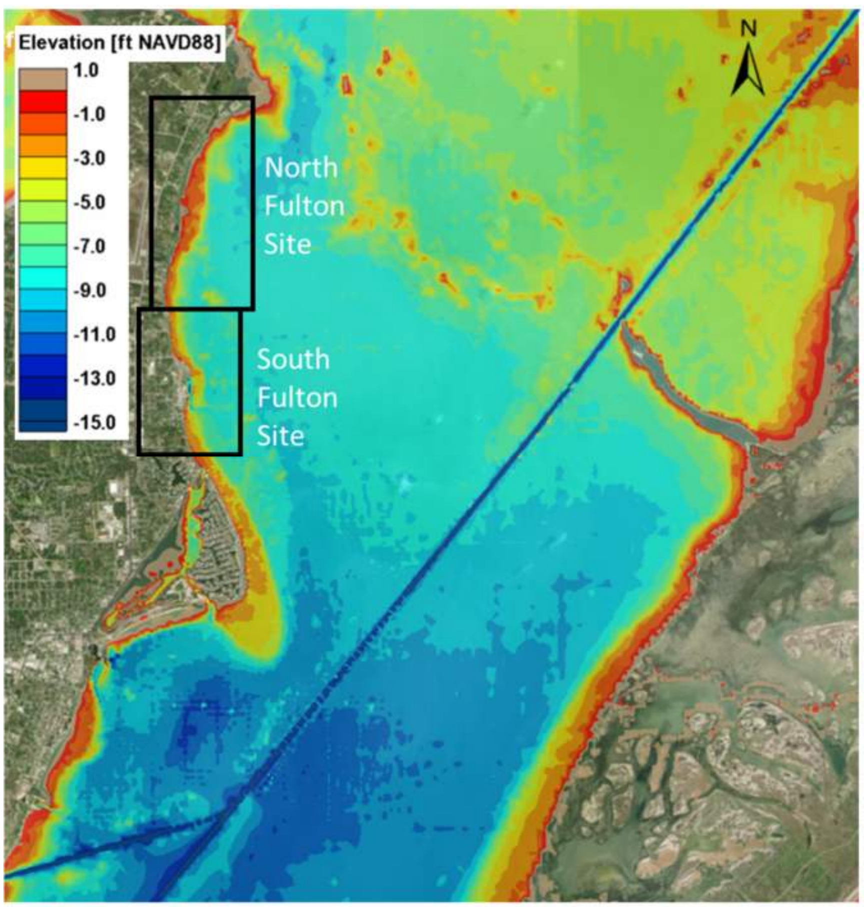


Figure 12. Bathymetric elevations in the numerical modeling grid within the project site region.

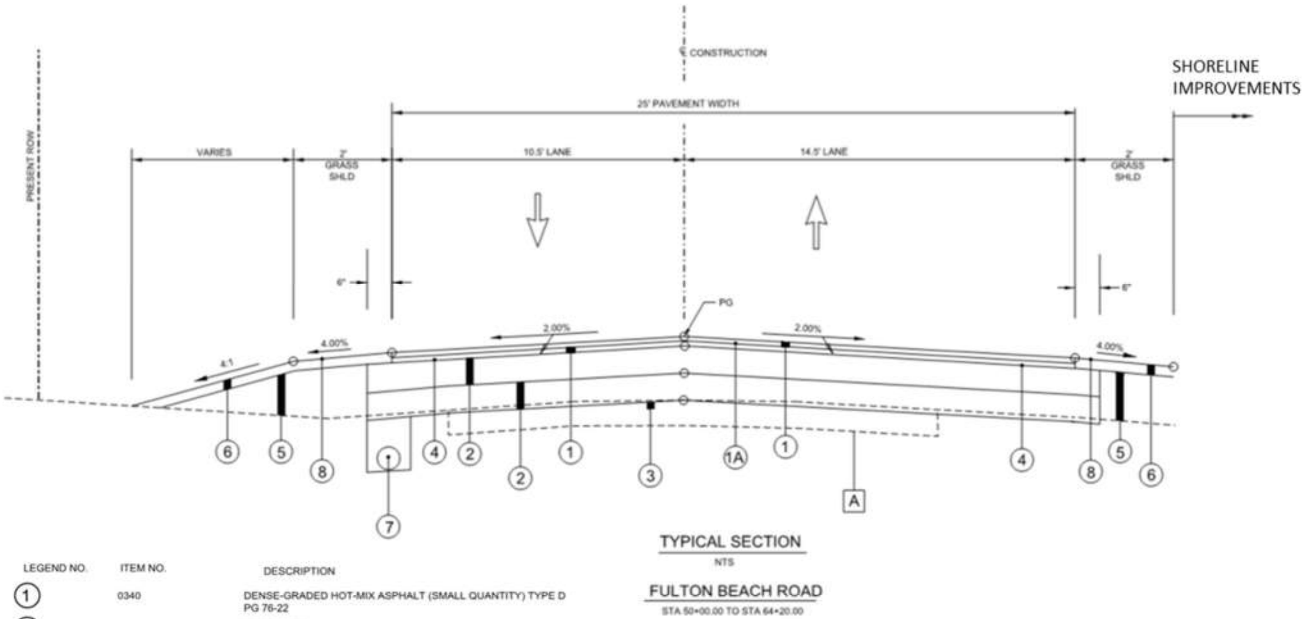
4 Design Parameters

4.1 Roadway

North Fulton Beach Road is a two-lane roadway located along the eastern shoreline of the town of Fulton in Aransas County, Texas. The existing road consists of two 10-foot-wide lanes surfaced with asphalt pavement and is primarily used by local residents. The road is also accessed by intermittent intersections and private residential driveways. The South Fulton project included roadway improvements to the southern section of Fulton Beach Road; these improvements consisted of:

- Scarifying existing pavement;
- Raising the grade of the existing road by approximately one foot;
- The roadway includes 12 inches of crushed limestone base and 3 inches of asphalt pavement;
- Additional drainage structures consisting of a roadway swale and cross drains to allow passage of stormwater from west of the roadway to Aransas Bay.

A cross section of the design for the South Fulton project is provided in Figure 13. It is anticipated that the County will continue with similar improvements along the rest of North Fulton Beach Road under future grant opportunities. It is assumed that these roadway improvements will begin where the South Fulton project roadway improvements terminate (about 320 LF south of the intersection with Primrose Drive), and will extend northward towards Beachwood Road. Thus, this project will include estimated costs for the anticipated roadway improvements for budgeting purposes only. The estimated costs will be developed by using the cost per linear foot that was estimated for the South Fulton project. The cost per linear foot will be applied to the total length of the anticipated remaining roadway improvements along North Fulton Beach Road.



LEGEND NO.	ITEM NO.	DESCRIPTION
1	0340	DENSE-GRADED HOT-MIX ASPHALT (SMALL QUANTITY) TYPE D PG 76-22
1A		TACK COAT
2	0247	FLEXIBLE BASE (COMPLETE IN PLACE)(TYPE A, GRADE 1-2) (6")
3	0251	REWORK BASE MATERIAL (TYPE C) (8") (DENSITY CONTROL)
4	0310	PRIME COAT
5	0134	BACKFILL TYPE A
6	0160 0164	FURNISHING AND PLACING TOPSOIL (4") BROADCAST SEED (PERMANENT) (RURAL) (SANDY)
7	0556	PIPE UNDERDRAIN TYPE 6, 6"
8	0162	BLOCK SODDING

Figure 13. Typical section showing the designed roadway improvement for South Fulton.

4.2 Revetment Basis of Design

The proposed shoreline stabilization solution for the project site is a riprap revetment. The riprap revetment was identified as the preferred protection scheme for the project site by the County after review of potential alternatives discussed in Appendix A, and consideration of the widespread presence of seagrass. The revetment will help stabilize the shoreline by securing the underlying sediments and protecting the upper shoreline slope and roadway edge from wave-induced erosion during storm conditions. The riprap revetment will absorb wave energy upon direct impact; thus, it must be designed to withstand the 100-yr design storm conditions over the full course of the 30-yr project life.

Due to the frequent presence of concrete riprap and other debris along the shoreline, this existing material will need to be first excavated from the shoreline. Fill material (in-situ sediment and/or new fill) will need to be placed following the concrete debris excavation in order to create a stable slope for the construction of the revetment.

The revetment design parameters were developed utilizing the coastal conditions previously reviewed for the site. The design parameters were calculated using methodologies in the USACE (2002) and EurOtop (2018) manuals for the 100-yr storm with 30-yr RSLR condition (water level and wave conditions). The resulting design parameters for the riprap revetment are summarized below. A preliminary cross section of the revetment design is shown in the Figure 14. The proposed extents of the revetment are shown in Figure 15.

- Revetment layers:
  - Armor stone outer layer: minimum of 2-stone thickness
  - Bedding material layer: minimum of 1 ft thickness
    - Bedding material layer may consist of new stone or reused concrete excavated from the shoreline and crushed and sized to the appropriate gradation
  - Geotextile underlayer
- Revetment crest elevation: +7.5 ft NAVD88
  - Designed to limit overtopping below 0.344 $ft^3/s/ft$ (0.032 $m^3/s/m$), which is the threshold for damage to revetments per guidance in USACE (2002)
  - For coastal protection structures that abut against land, such as revetments, seawalls, and bulkheads, the crest elevation is extremely critical for the performance of the structure, and often must be higher than offshore structures, such as breakwaters in order to provide a similar level of protection. As waves break at the revetment, the wave run-up propagates upward along the sloped surface. Depending on the water level, wave conditions, and the crest elevation, the run-up may overtop the structure and propagate down the landward side. Once the revetment is overtopped, the adjacent land and roadway becomes exposed to scour, flooding, and high velocity flow damage. Whereas, for breakwaters, overtopping can occur without directly impacting the shoreline (design dependent).
- Side slopes: 1V:2H
  - Minimizes the revetment footprint (and therefore, material quantities) while providing a stable slope
- Crest width: 5 ft
  - Designed to help minimize overtopping landward of the revetment in storm conditions
- Armor stone size, D50: 1.5 ft
  - Stable armor stone size for the design storm conditions
- Revetment extents: The revetment will be designed to cover all areas of the project shoreline where there are no existing bulkhead structures, piers, or sandy beach. A minimum of 5 ft offsets from all piers will be incorporated to accommodate maintenance or repairs of private pier structures.

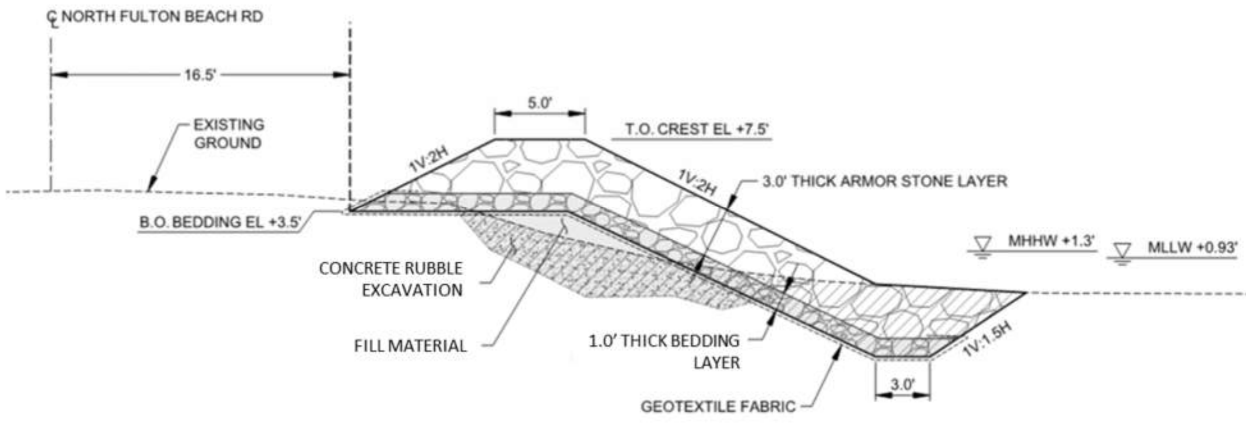


Figure 14. Conceptual cross section of the revetment design.

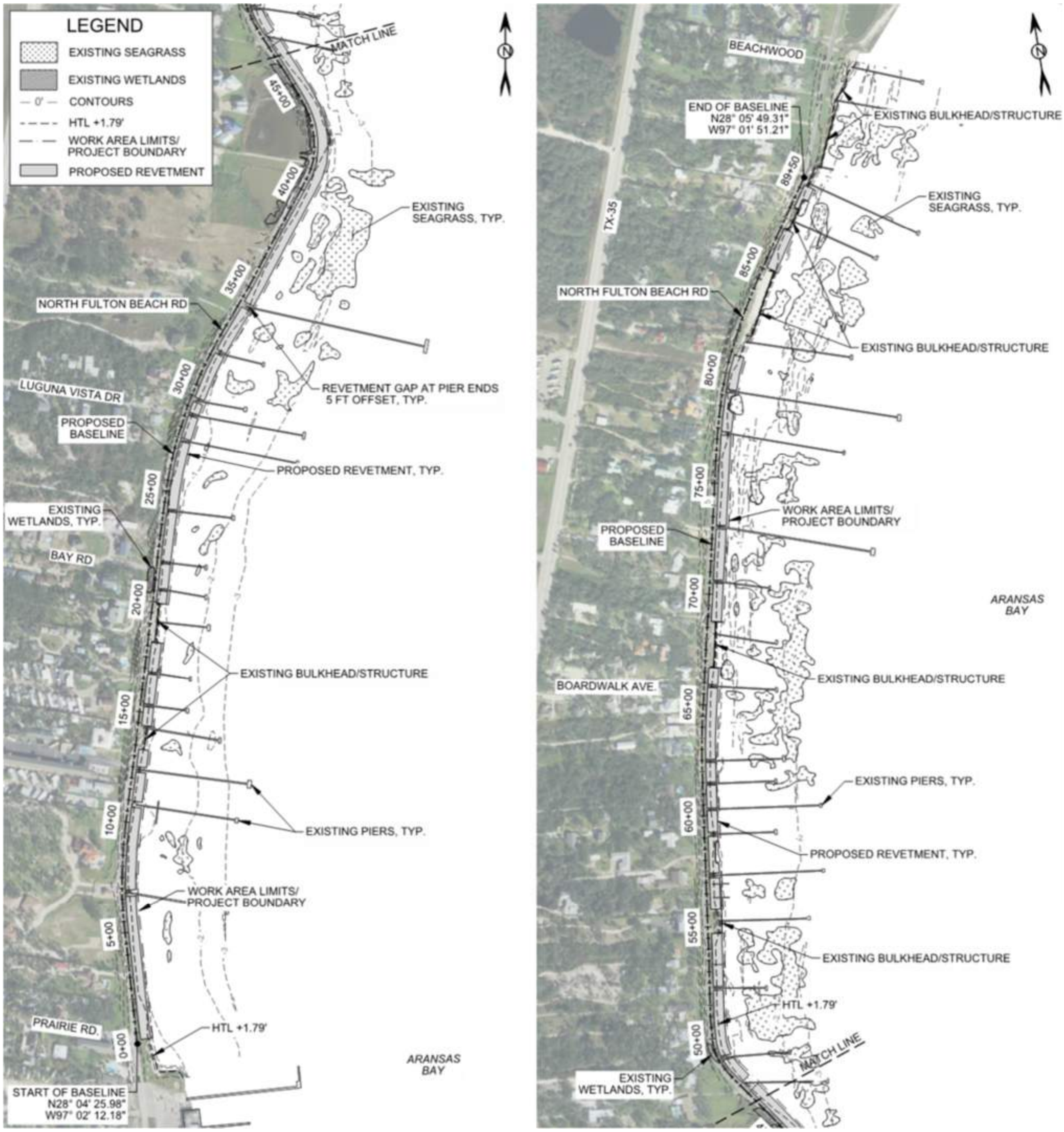


Figure 15. Proposed preliminary extents of the revetment indicated by the solid grey hatch; (left) southern half of project site; (right) northern half of project site.

5 Conclusions

This report summarizes the results of work conducted by Mott MacDonald (MM) under Task 2 of the Scope of Work at the request of Aransas County, Texas (County) for the North Fulton Beach Road shoreline restoration extension project. As part of this task, Mott MacDonald has summarized the results of data collection efforts and existing conditions at the site. Topographic/bathymetric surveys and habitat surveys were performed and summarized. Furthermore, existing coastal conditions at the site including geotechnical data, tides, winds, waves, and sea level rise were analyzed. MM was also able to apply an understanding of the site conditions from previous coastal engineering analysis efforts performed for the South Fulton project.

Potential shoreline protection alternatives were coordinated with the County separately from this technical memo (the alternatives are further discussed in Appendix A). As a result, the County had identified a riprap revetment to be the preferred shoreline protections scheme for the project site. Thus, utilizing findings from the assessment of site conditions, preliminary design parameters were developed for the riprap revetment. The revetment will feature a crest elevation of +7.5 ft NAVD88, crest width of 5 ft, slope of 1V:2H, and armor stone size, D50 of 1.5 ft. These parameters have been developed to ensure the revetment is stable in the 100-yr design storm conditions while limiting overtopping to mitigate structural damage to the revetment itself.

The development of the revetment design will progress through the 30% design phase under this current Contract. Drawings will be developed to the 30% design level and submitted to the County as the final deliverable for this Contract. Refinement for the revetment design will need to occur under future project phases in order to progress the design from 30% level to the 100% level. The future refinement will likely include optimization of the design parameters and development of design details such as the revetment toe, radial ends, gradation specifications, accommodation of outfalls and drainage pipes, etc.

6 References

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Appendix A – Memorandum of Project Understanding

MOTT MACDONALD

Technical Memorandum

Project:	Aransas County – North Fulton Beach Road Shoreline Restoration Extension		
Our reference:	507102160	**Your reference:**	John Strothman
Prepared by:	DS	**Date:**	08/05/2020
Approved by:	LM	**Checked by:**	KW
Subject:	Memorandum of Project Understanding		

Introduction

This memorandum is submitted to Aransas County by Mott MacDonald and marks the completion of Task 1 of the Aransas County North Fulton Beach Road Shoreline Restoration Extension Project. The contract between Mott MacDonald and Aransas County was executed on May 26, 2020, initiating the start of work. This project is intended to be an extension of the work to be completed as part of the Aransas County Hazard Mitigation Project (referred to as the HMP South Fulton project henceforth) along Fulton Beach Road. The purpose of the project to extend the roadway improvements and shoreline protection work to include the remainder of Fulton Beach Rd from Prairie Road, northward to the end (Figure 1). Note that a formal kick-off meeting was not held for this project. This Technical Memorandum summarizes the work conducted to date.

The objectives of this Memorandum of Project Understanding (MOU) include:

- Develop a consensus on project goals and objectives
- Summarize the tasks complete to date and next steps

The Tasks under the Scope of Work for the project site include:

- Task 1 – Project Review and Data Collection
- Task 2 – Coastal Engineering Analysis
- Task 3 – Regulatory Coordination
- Task 4 – Engineering Design Plans, Specifications, and Estimates

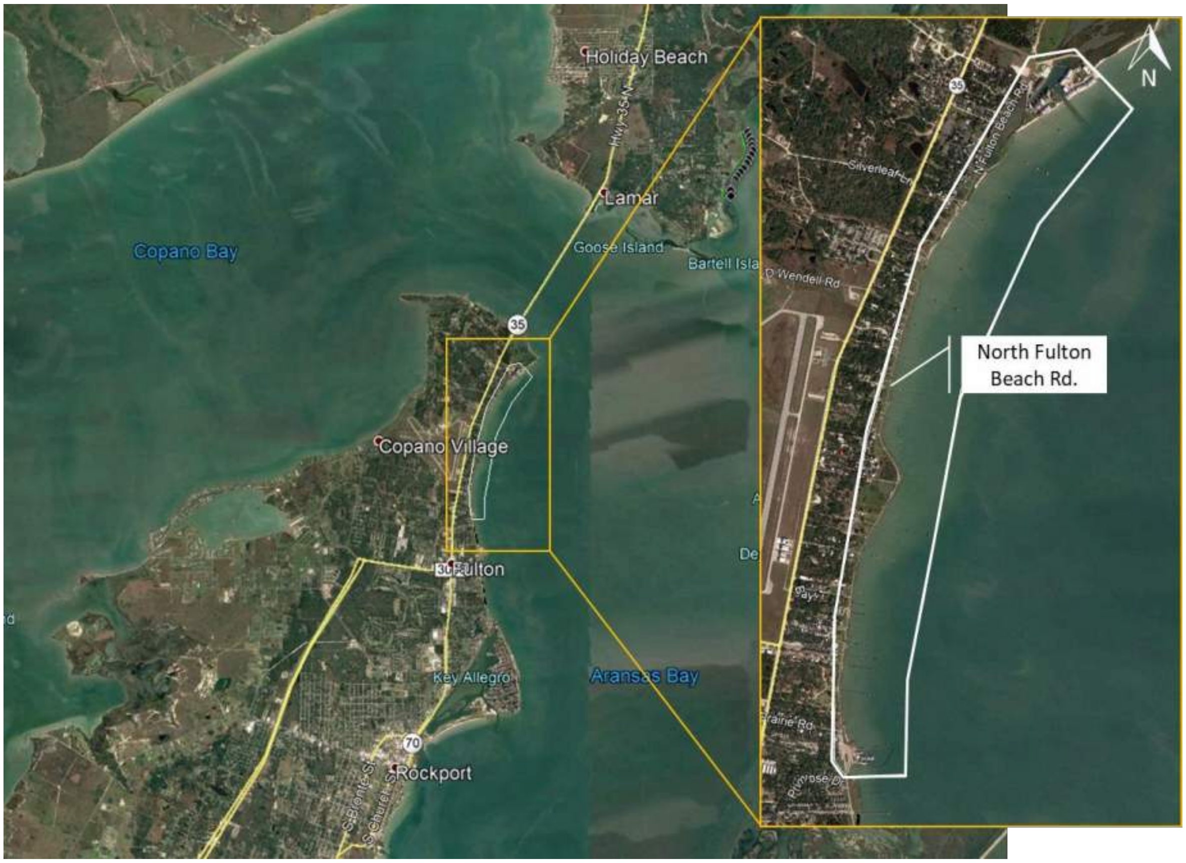


Figure 1. Project location map showing the extents of the North Fulton Beach Road project limits.

Figure 2. Project site map showing the location of the North Fulton Beach Road Shoreline Restoration Extension project extents relative to the previous HMP South Fulton project.

Project Objectives and Goals

The shoreline along North Fulton Beach Road has been vulnerable to damage from flooding and wave impact due to its close proximity to Aransas Bay, low elevation, and lack of continuous engineered shoreline protection. The erosion (especially after Hurricanes Harvey (2017) and Hanna (2020)) has been significant enough to damage the shoreline and undermine the road at several locations making it unsafe for public use. The road also frequently floods, impacting home and business owners. North Fulton Beach Road is an important evacuation route for those living in the area and must be repaired, enhanced, and protected to ensure accessibility during future high surge and rain events. The first phase of this project has been funded through the Coastal Management Plan Grant Cycle 24 and will consist of the following work for the shoreline component of the project:

- Data Collection
- Coastal Engineering Analysis
- Preliminary Engineering Design
- Application and coordination necessary to obtain a USACE Individual Permit

The original design approach for the shoreline component was anticipated to be a continuation of the final shoreline protection design developed for the USACE authorized HMP South Fulton project, which included concrete debris removal and construction of a living shoreline consisting of beach fill, vegetation planting, and offshore detached breakwaters. However, recently (at time of writing), several members of the public have expressed strong discontent towards the selected alternative of the HMP South Fulton project. To accommodate the public's view, Mott MacDonald will reinvestigate a number of potential alternatives and will evaluate their ability to meet the project goals of the North Fulton Beach Rd project. An initial list of potential alternatives is provided in Section 4. It should be noted that a detailed alternatives analysis was performed for the HMP South Fulton project, as is expected with the section of Fulton Beach Road as described herein. Through this analysis, the breakwater and living shoreline alternative was found to be the highest performing and most cost-effective alternative to meet the project goals.

Background

North Fulton Beach Road is a public roadway in the City of Fulton, Texas in Aransas County. This site is currently exposed to high wave energy, and when the shoreline is overtopped during storm events, the flooded roadway is damaged. Several major storms have hit the area in the last 20 years. In August of 2017 Hurricane Harvey passed almost directly over the site and the resulting storm surge and wave action eroded the shoreline. Most recently, Hurricane Hanna made landfall on July 25; resulting in significant water levels and wave heights that eroded the shoreline. This erosion undermined the road and private structures along the shoreline. Washout of the concrete rubble and sediment along the shoreline left areas adjacent to the road vulnerable to wave action, resulting in waves breaking over the road and private structures. This road is a vital evacuation route for residents in the area and simply performing roadway repairs will not mitigate further damage to the shoreline.

In order to address the previous damage and mitigate future coastal storm impacts along North Fulton Beach Road, the road will be raised 1-foot, drainage improvements will be implemented, and some form of shoreline protection will be constructed. A range of potential shoreline protection alternatives will be instigated for their suitability at the project site.

The present project shoreline is composed of a combination of concrete riprap, bulkheads, and sections of sandy beach along several areas. While the concrete riprap mitigates some erosion of the shoreline, it is not sufficient for long term stabilization; nor does it provide adequate protection against wave overtopping. The lack of protection was apparent during Hurricane Hanna, when sections of the roadway became undermined as shown in Figure 3. Other damages along the shoreline, due to the recent hurricane, include significant washout/erosion of sediment, retreat of vegetation line, and the undermining of private structures. A summary of these damages can be found in Appendix A. Approximately 45% of the project shoreline has private leased/permitted areas that contain these structures, as delineated by the red lines, shown in Figure 4. At the time of writing, it is unclear if the shoreline protection design can include areas of private leases/permitted structures, and will need to be discussed with Aransas County and property owners.

Figure 3. Photo taken by Rockport Pilot showing significant road damage from Hurricane Hanna.

Figure 4. Areas along North Fulton Beach Road containing private leased shoreline structures delineated in red.

Project Tasks

Task 1.1 – Project Review and Data Collection

Mott MacDonald has reviewed all available existing relevant data for the project site and collected additional data necessary for the preliminary design of the shoreline protection including:

Topographic and Bathymetric Surveys
Mott MacDonald has collected new topographic and bathymetric surveys of the project site which will also mark locations of existing structures such as piers and bulkheads within the project area as well any drains or other structures along the roadway to be elevated. T. Baker Smith, LLC was contracted to complete the topographic and bathymetric surveys.

Seagrass/Oyster/Marsh Habitat Survey
Mott MacDonald has collected a survey of seagrass, oysters, and marshes with data taken along bathymetric/wading transects to delineate extents of existing sensitive habitats within the project site on July 13, 2020. This data is necessary for preliminary design in order to minimize impacts of the proposed design and identify any mitigation that may be required. T. Baker Smith, LLC was contracted to complete the seagrass/oyster/marsh habitat survey. The extents of the seagrass found during the survey is shown in Figure 5, where the existing seagrass areas are delineated by the green polygons. Numerous areas of seagrass were found to exist within the nearshore zone, between approximately 10 ft and 500 ft offshore. To avoid mitigation, all shoreline protection structures must be constructed outside of the extents of the seagrass.

Figure 5. Areas of seagrass (green polygons) delineated measured during the July 13th survey. Note that seagrass extents shown are limited to the survey boundaries.

Coastal Boundary Survey (currently underway)
Mott MacDonald will collect a survey of the project site in accordance with the Section 33.136, Natural Resources Code, for the purpose of evidencing location of the shoreline in the area depicted in this survey as the shoreline that existed before commencement of erosion response activity.

Deliverables
This Memorandum of Understanding is a deliverable under Task 1. Other deliverables include maps of topographic, bathymetric, and seagrass/oyster/marsh habitat survey data, and a coastal boundary survey plat and report of the project site.

Task 2 – Coastal Engineering Analysis

A Coastal Engineering Analysis including water elevations, winds, wind-generated waves, storm activity, and the resulting tide, wind, and storm impacts previously developed for the HMP South Fulton project will be updated to reflect current conditions at the project site. Mott MacDonald will further evaluate a select number of potential alternatives from the list discussed in Section 4 for the shoreline protection. The final preferred alternative will be identified based on input from Aransas County. The preferred alternative will be developed into conceptual design. Numerical wave modeling will be used to verify that the proposed alternative will meet the goals of the design. Upon completion of this task, the results of this analysis will be summarized in an updated Coastal Engineering Analysis Technical Memorandum which will be submitted to the County.

Task 3– Regulatory Coordination

Mott Macdonald will gather the necessary application documents for seeking a U.S. Army Corps of Engineers (USACE) Individual Permit (IP) under Section 10 and 404 jurisdictions for the construction of shoreline protection along the North Fulton Beach Road shoreline. Permit level design drawings of the preferred alternative layout identified in Task 2 will be developed. Mott MacDonald will coordinate with USACE to expedite publishing of a 30-day Public Notice (PN) for the project following the submission of the permit application. Upon the receipt of comments from the 30-day PN, Mott MacDonald will assist in developing a response to comments and coordinate with USACE to seek issuance of the IP. Preceding the submission of the permit application, Mott MacDonald will attend a Joint Evaluation Meeting (JEM) in Corpus Christi, TX or via Teleconference with USACE and other state and federal resource agencies. Mott MacDonald will organize the meeting, present the engineering analysis performed, and discuss proposed project details, construction methods, and a timeline for construction.

Task 4 – Engineering Design Plans, Specifications, and Estimates

Mott MacDonald will conduct engineering analysis for the proposed shoreline protection components and the preparation of Plans and a Cost Estimate (P&E). Mott MacDonald will prepare 30% design level plans and 30% level cost estimates for the shoreline protection and roadway enhancements proposed and submit them to the County for review.

Project Execution

Design Criteria

National Oceanic and Atmospheric Association (NOAA) and National Data Buoy Center (NDBC) gauge data will be used from Aransas Wildlife Refuge, Rockport, and Port Aransas as well as any other data sources collected for development of the Coastal Engineering Analysis. Design criteria will be based on Coastal Engineering Analysis of water elevations, winds, wind-generated waves, storm activity, and the resulting tide, wind, and storm impacts on the project area.

Initial analysis shows winds and wind-generated waves coming predominantly from the southeast while strong winds and higher wind-generated waves associated with events coming from the north. Based on the analyzed conditions and to be consistent with the HMP South Fulton project, the shoreline projection design is expected to be based on a 100-yr design storm condition.

Description of Site

There are numerous structures including bulkheads, revetments, groins, timber piers and drainage outfalls along the shoreline of North Fulton Road. Piers along North Fulton Beach Rd. are comprised of commercial and residential wood piling structures that extend seaward approximately 150 ft to 820 ft in some areas, shown in Figure 6. Bulkheads along the shoreline are constructed of concrete panels or sheetpile with concrete caps. An example bulkhead can be seen in Figure 7 and Figure 8. Stone rip-rap groins perpendicular to the shoreline that extend seaward approximately 100 ft have been constructed by private property owners along select areas of the shoreline. Concrete panel breakwaters approximately 100 ft seaward and parallel to the shoreline have also been constructed along select areas of the shoreline, shown in Figure 9 and Figure 10.

Figure 6. Google Street View photo from 2018 showing private residential wood piling pier and a section of North Fulton Beach Road lined with relic concrete and other debris.

Figure 7. Google Street View Photo from 2018 showing a private sheetpile bulkhead and concrete cap along North Fulton Beach Road.

Figure 8. Google Street View Photo from 2018 showing a privately leased bulkhead and timber pier along North Fulton Beach Road.

Figure 9. Google Street View Photo from 2018 showing privately leased timber piers and perpendicular groins along North Fulton Beach Road.

Figure 10. Google Street View Photo from 2018 showing privately leased timber piers and an offshore band on concrete rip rap along North Fulton Beach Road.

Schedule

Mott MacDonald developed a schedule detailing the anticipated timelines for completing the tasks described above at the start of this project. The original schedule and projected completion dates are provided below. However, there have been minor delays in the schedule due to: (1) increased scope of work (reinvestigating project alternatives), and (2) increased time associated with stakeholder coordination and public engagement. Due to recent public outcry against the HMP South Fulton Project, additional public coordination and public feedback is recommended prior to submitting the permit application. Additional time may be necessary to execute this additional public coordination, however, Mott MacDonald will aim to follow the original schedule as close as possible.

Schedule:

- Task 1 – Project Review and data Collection
  - 8 weeks from NTP
  - Completed by 7/21/2020
- Task 2 – CEA
  - 4 weeks from Task 1 completion
  - Original completion date 8/20/2020; revised completion date, TBD
- Task 3 – Regulatory Coordination
  - Permit Application: 4 weeks from Task 2 completion
  - Original completion date 9/17/2020; revised completion date, TBD
  - Coordination: 9-12 months from submittal of application (up to ~Summer 2021)
- Task 4 – Plans, Specifications, and Estimates
  - 30% Design: 2 weeks from completion of CEA (Task 2)
  - Original completion date 9/3/2020; revised completion date, TBD

The North Fulton Beach Road project was issued a Notice to Proceed (NTP) on May 26, 2020. At this point Task 1, Project Review and Data Collection, is completed and this MOU marks the end of Task 1. Task 2, Coastal Engineering Analysis, is presently underway.

Communication Procedures

Luis Maristany (MM Project Manager) is to be the main Mott MacDonald Point of Contact (POC) and John Strothman is to be the main County POC. Aaron Horine (MM Project Director) can also be contacted if the main POC is not available. Mott MacDonald will provide weekly updates, monthly reports provided with all invoices, and quarterly reports to the County. Quarterly reports are to be submitted to FEMA by the County. All deliverables will be sent to the County Project Manager and additional distribution will be coordinated with the County as necessary. Jacky Cockerham will be included in all correspondence as requested by the County.

Potential Alternatives

Mott MacDonald has developed an initial list of potential alternatives for the proposed shoreline protection scheme along the North Fulton Beach Road shoreline. These potential alternatives have been identified in order to investigate a large range of possible shoreline protection design approaches. After developing an initial list, they were further investigated to determine their anticipated performance, impacts, suitability for the site, benefits, and their ability to meet the project goals and protect the shoreline and upland infrastructure from further erosion and coastal storm damage. The list of alternatives was also investigated to determine whether they incorporated benefits to the surrounding habitat and environment. Habitat enhancing solutions or projects with features that benefit the environment, such as living shorelines, vegetation planting and artificial reefs, are the preferred options for funding sources such as the Texas GLO, FEMA and RESTORE, and can be built at any point in time (i.e., not limited to following a major storm event). It is important to note that the breakwater and living shoreline design that was developed for the South Fulton Project (as well as for the Shell Ridge Road and Lamar Beach Road projects) met the criteria for this type of funding. However, shoreline stabilization solutions that do not provide environmental benefits will not be qualified for these types of funds. Project alternatives that only have structural components, such as bulkheads, rock revetments, and articulated concrete block mattresses, create hard boundaries along the shoreline that do not improve, and can often be a detriment to, the ecology of a project site. Thus, projects of this kind will likely only be viable for funding sources related to disaster recovery. Because of the current funding climate, it may take a major storm event to cause enough damage at the site in order to secure the necessary funds to implement a project that does not incorporate habitat benefits into the design. However, even public funding sources geared towards disaster recovery prefer more sustainable solutions.

An overview of these potential alternatives with example photos is provided in Appendix A; they are also listed below with summarized descriptions and relevant points provided in the following table. This list of potential alternatives will be discussed with Aransas County, and a select few alternatives will be identified for further analysis in the next phase.

1. Rock Revetment: Layers of geotextile, bedding stone, and armor stone protection constructed along the shoreline slope; intended to stabilize the underlying soil by absorbing wave energy upon direct impact. Revetments are typically embedded into the seabed at the toe of the shoreline; they extend upward along the shoreline slope to the designed crest elevation at the top, followed by and extension landward in order to tie into the existing grade, as shown in Figure A1 of Appendix A.
2. Articulated concrete block mat (ACBM) Revetment: A mattress of individual concrete blocks laced together by internal cabling placed on the shoreline slope to stabilize the underlying soils. A layer of geotextile and/or small bedding stone is often installed underneath the mattress. Similar to rock revetments, ACBM revetments typically are embedded into the seabed at the toe of the shoreline, extend upwards along the shoreline slope to the design crest elevation, and then extend landward to tie into existing grade, as shown in Figure A2 of Appendix A.
3. Bulkhead: Typically made of steel sheetpiles or concrete panels, driven vertically into the soil creating a wall along the shoreline. Bulkheads are typically capped with concrete, and are supported by a series of either tie-backs that extend landward or a buried anchoring system to encapsulate landward soil, as shown in Figure A3 of Appendix A.
4. Offshore Reef Units: Man-made units, designed to promote marine growth and/or improve marine and intertidal habitat, while also providing some level of wave attenuation when arranged into larger reef-like structures consisting of multiple units. Reef units are typically constructed of materials such as concrete, buy may have components of oyster shell, metal, rock, etc. Example artificial reef units are shown in Figure A4 of Appendix A.
5. Breakwaters & Vegetation Planting (Living Shoreline): Offshore segmented emergent stone breakwaters and shoreline planting of native grasses and marsh vegetation. The breakwaters reduce onshore wave energy by absorbing wave impact further offshore, and the vegetation plantings enhance soil stabilization while creating new habitat. The breakwaters can also be designed to create a low-energy environment in the lee of the structures which is beneficial to existing and future growth of seagrass. An example rendering of this design from the HMP South Fulton Project is shown in Figure A5 of Appendix A.
6. Rock Revetment with Joint Vegetation Planting: A combination of live stakes of rootable native plants placed in the voids of a layer of armor stone protection along the shoreline. The revetment component is intended to provide the necessary stabilization to the underlying soil, while the live staves provide some improved vegetation habitat. The vegetation also provides an aesthetic benefit, as it will often grow dense enough to visually hide the rock revetment. However, the revetment does not protect the vegetation from wave impact; thus, the success of the vegetation growth is highly dependent upon the existing wave climate at the site. The revetment component is embedded into the seabed at the toe of the shoreline and extends along the shoreline slope up to the design crest elevation, followed by an extension landward to tie into the existing grade. An example of a joint vegetated rock revetment design is shown in Figure A6 of Appendix A.

7. Rock Revetment with Toe Vegetation Planting: A rock revetment (Alternative 1) constructed along the shoreline slope with the addition of native vegetation planted along the toe of the structure within the intertidal or nearshore zone. The revetment component is constructed and performs similar as described in Alternative 1, while the vegetation planting creates new marsh habitat seaward of the shoreline. Depending on its density, the marsh also offers some protection to the revetment toe from minor scouring. However, similar to Alternative 6, the revetment does not protect the marsh from wave impact, thus, the success of the planted vegetation will be dependent upon the existing wave climate. An example of a rock revetment and vegetated toe design is shown in Figure A7 of Appendix A.
8. Rock/ACBM Revetment & Offshore Reef Units: This alternative is a combination of either Alternative 1 or 2, with Alternative 4. The revetment is constructed as previously described along the shoreline slope and provides stabilization to the underlying soils, while the reef units are placed in the nearshore zone to provide marine habitat benefits with possible wave attenuation during typical, non-storm conditions (dependent upon the designed reef layout). This combination provides an opportunity to introduce habitat benefits, since the revetment offers none on its own. An example of a rock revetment and potential artificial reef units is shown in Figure A8 of Appendix A.

Table 1. Comparison list of initial potential alternatives.

Alternative	Overall Pros	Overall Cons	Habitat Benefits/ Appeal to Funding Sources	Shoreline & Roadway Protection	Resiliency/ Adaptive Management Against RSLR
1. Rock Revetment	• Common approach for shoreline stabilization (typically accepted by public) • No interference of offshore navigation • No impact to adjacent seagrass	• Would likely have to be built at a higher elevation than existing shoreline to prevent overtopping • Natural establishment of vegetation is unlikely • Presents danger to those who wish to climb down to the water • No protection to nearshore seagrass	• None	• Medium performance in daily, non-storm conditions, when water level and waves are below revetment crest. • Low performance in storm conditions, or when water level and waves are at or above revetment crest	• Difficult to increase crest elevation of revetment during future years, would likely have to be deconstructed and replaced at a higher elevation May be possible to increase crest of revetment during future years, but must account for potential increase in footprint during initial design
2. ABCM Revetment	• Common approach for shoreline stabilization (preferred by public along Fulton Beach Rd) • No interference of offshore navigation • No impact to adjacent seagrass	• Would have to be sized to withstand design wave impacts using the 100-year storm conditions. For example, a design wave height of about 3 feet and a slope of approximately 25% would need a thickness of 14 inches or greater. • No room for vegetation growth • Anchoring system would likely be difficult close to the road • Algae growth on the mats is common; creating potentially hazardous or unsafe conditions for the public • Continuous mats make spot repairs difficult • No protection to nearshore seagrass • Failure due to degradation of the internal cabling is common	• None	• Medium performance in daily, non-storm conditions, when water level and waves are below revetment crest. Holes between or within mattress blocks tend to scour out and become undermined. • Low performance in storm conditions, or when water level and waves are at or above revetment crest	• Not feasible to increase crest elevation of revetment during future years, would require deconstruction and replacement at a higher crest elevation
3. Bulkhead	• Common approach for shoreline stabilization (typically accepted by public)	• Cap would have to be built much higher than existing grade to prevent	• None	• High performance in daily, non-storm conditions, when	• Difficult to increase sheetpile and cap elevation, would likely have to be replaced and

	• No interference of offshore navigation	overtopping and scouring behind the wall. • Increased wave reflection causes more turbulent nearshore conditions which degrades seagrass habitat and is likely not preferred for water recreation • Typically leads to negative end effects at adjacent shorelines • Expensive		water level and waves are below the cap elevation • Low performance in storm conditions, or when water level and waves are at or above the cap elevation	redesigned or future cap elevating would need to be accounted for in the original design
4. Offshore Reef Units	• Some level of wave attenuation during daily conditions when designed into larger reef structures with multiple units • Promotion of marine life habitat	• Many units are needed to provide wave attenuation (i.e., often 2 or 3 rows, and sometimes stacked) • Potential for recreation navigation issues • Reef unit placement will be limited to avoid impact to seagrass	• Improved habitat for marine life • Likely appeals to permitting and funding agencies	• Moderate performance in daily, non-storm conditions, when water level and waves are at or below reef unit elevation • Minimal performance in storm conditions, or when water level and waves are above reef unit elevations	• Oyster recruiting units may form into a live reef, where the oyster growth may migrate vertically with RSLR • Reef structures may be widened with additional rows of units, but not feasible to elevate with additional layers
5. Breakwaters & Vegetation Planting	• Breakwater design can often by optimized for cost and protection of shoreline against erosion and wave energy • Promotion of new vegetation growth in areas of historically high erosion • Minimal safety hazard walking to the water if adequate gap lengths were designed • Created low energy environment for seagrass	• Public disagreement at the HMP South Fulton site • Breakwater placement will be limited to avoid impact to seagrass	• Provides optimal conditions for natural wetland growth • Approved design for previous grant funding and permitting projects	• High performance in both daily and storm conditions	• May be possible to increase crest of breakwaters during future years, but must account for potential increase in footprint during initial design • Vegetation can naturally migrate upward with RSLR
6. Rock Revetment & Joint Vegetation Planting	• Pros of Alternative 1 • Promotion of vegetation growth on the structure	• Cons of Alternative 1 • It is likely that wave energy will not dissipate before reaching the structure making the chances of vegetation growth very small	• Potential to meet requirements of grant funding through integrated shoreline plantings	• High performance in daily, non-storm conditions, when water level and waves are below revetment crest • Low performance in storm conditions, or when water level and waves are at or above revetment crest	• May be possible to increase crest of revetment during future years, but must account for potential increase in footprint during initial design

7. Rock Revetment & Toe Vegetation Planting	• Pros of Alternative 1 • Promotion of wetland growth at the toe of the structure	• Cons of Alternative 1 • It is likely that wave energy will not dissipate before reaching the structure making the chances of planted wetland growth very small	• Potential to meet requirements of grant funding due creation of wetlands, intertidal habitat	• High performance in daily, non-storm conditions, when water level and waves are below revetment crest • Low performance in storm conditions, or when water level and waves are at or above revetment crest	• May be possible to increase crest of revetment during future years, but must account for potential increase in footprint during initial design • Wetlands likely cannot migrate upland with RSLR due to present of revetment
8. Rock/ACBM Revetment & Offshore Reef Units	• Pros of Alternative 1/2 • Pros of Alternative 4	• Cons of Alternative 1/2 • Cons of Alternative 4	• Potential to meet grant funding requirements • Improved habitat for marine life	• High performance in daily, non-storm conditions, when water level and waves are below revetment crest • Low performance in storm conditions, or when water level and waves are at or above revetment crest and reef units	• May be possible to enhance structures in future years but would need to be accounted for in the original design May be

Conclusion

This technical memorandum highlights the understanding of the project goals/objectives, provides an initial list of potential alternatives for the proposed shoreline protection scheme along the North Fulton Beach Road shoreline and marks the conclusion of Task 1 of this project. Further discussion with the County on the initial list of alternatives will be necessary. Mott MacDonald will proceed with the Coastal Engineering Analysis in the meantime. Further coordination with the County and public engagement will then be required prior to proceeding with the following tasks, including permitting application development for the preferred alternative, and 30% design level plans and cost estimate. The 30% level cost estimate will account for anticipated roadway enhancements (to be designed in a future phase) by using estimated costs from the HMP South Fulton Project.

References

MM. (2020). *Aransas County North Fulton Beach Rd: Scope of Work*. Mott MacDonald.

NOAA. (2020). *National Oceanic and Atmospheric Association: Tides and Currents.* <https://tidesandcurrents.noaa.gov/>

NDBC. (2020). *National Oceanic and Atmospheric Associations: National Data Buoy Center.* <https://www.ndbc.noaa.gov/>

Appendix A

Slides of Post-Hanna site photos and example shoreline protection alternatives

MOTT MACDONALD

Fulton Beach Road Shoreline Restoration Extension - Alternatives

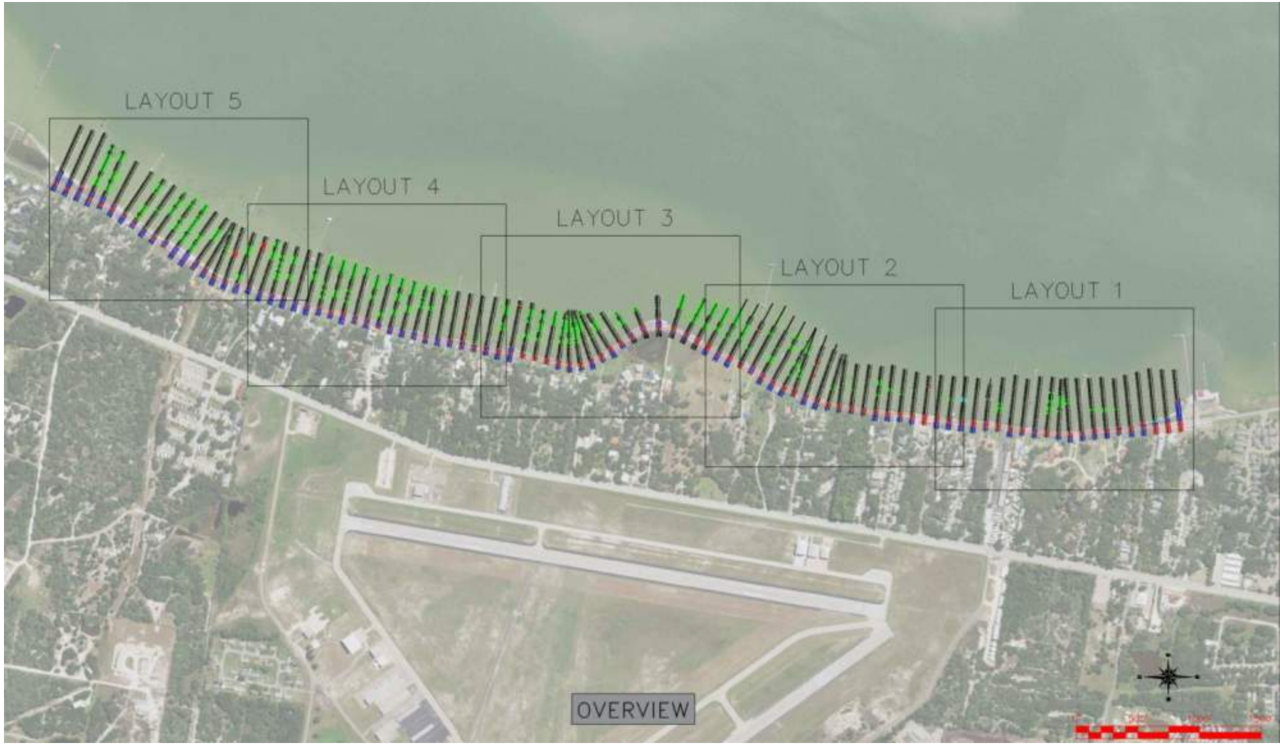
Aransas County

Summary of Constraints

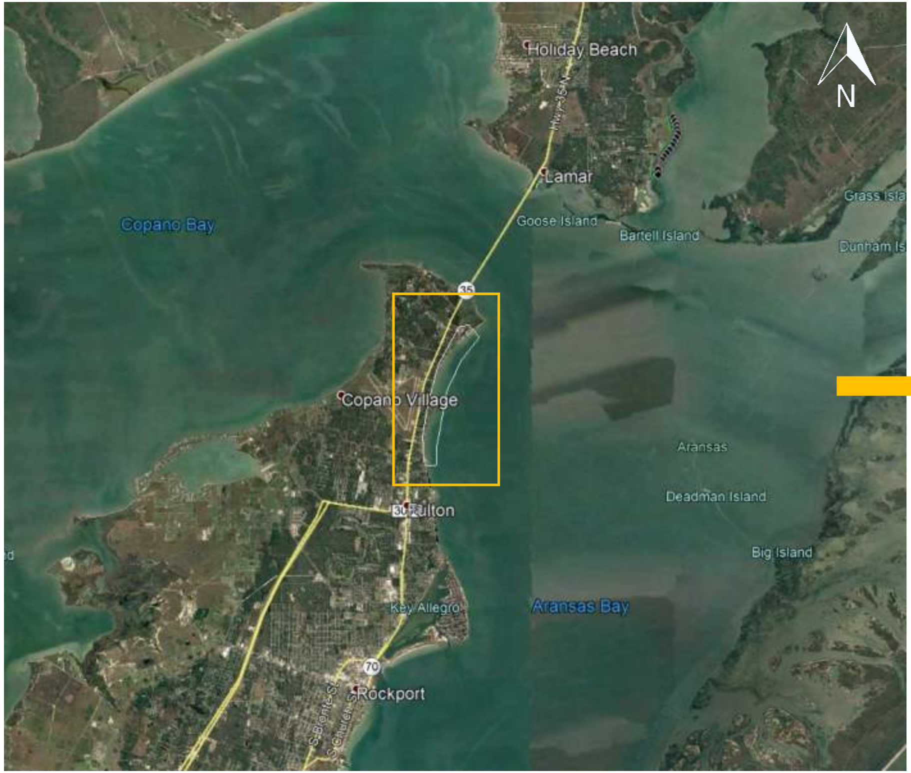
1. Seagrass

2. Grant Application

3. Permitting Consideration



Project Description
Location



Site Conditions
Post Hurricane Hanna

- Misplaced concrete/debris along shoreline
- Significant roadway damage
- Private bulkheads and sidewalks undermined
- Damage to timber pier structures
- Timber debris at the shoreline
- Sediment washout near shoreline
- Shoreline vegetation line pushed landward

Undermined Concrete at N. Fulton Beach Road

- Lack of rubble in this area led to the undermining of this concrete slab of the roadway.
- Direct wave impact and runup scoured and washed out loose sediment.

Significant Scarping along shoreline

- Lack of hard protection led to direct wave impact and sediment erosion, scarping the slope
- Sediment was pushed landward, covering vegetation.

Damage to Roadway

- Wave energy impacting the shoreline washed out sediment and displaced concrete rubble in this area, further exposing the upper roadway to scour impacts.
- This site photo was taken 7/25/2020 by the Rockport Pilot

Significant Scarping along shoreline

- Overtopping of the concrete rubble led to washout of sediment and damage to the vegetation line.

Significant Scarping along shoreline

- Overtopping of the concrete rubble led to washout of sediment and significant scarping along the shoreline.

Damage to Vegetation Line

- Overtopping of the concrete rubble can be seen here, where grass has been pushed down by waves and rubble was found along the roadway.

Significant Scarping along shoreline

- Overtopping of the concrete rubble led to washout of sediment and a erosion to the vegetation line.
- In some areas, this led to the exposure of the roadway to wave action.

Private Bulkhead Damage

- Wave overtopping at this bulkhead led to the failing of the timber cap.

Private Bulkhead Damage

- Wave overtopping at this bulkhead led to the undermining the wall. As the water washed back out to the bay it caused additional souring.

Significant Scarping along shoreline

- Overtopping of the concrete rubble led to washout of sediment and a erosion of the vegetation line.

Site photos taken 7/28/2020

Private Bulkhead Damage

- Corners of bulkheads typically need significant protection as this area becomes a focus point of water rushing around the structure. This bulkhead was overtopped significantly, and sediment was scoured out behind the wall, exposing the tie backs.

Private Bulkhead Damage

- Wave overtopping at this bulkhead led to the undermining the wall, where water washed back out to the bay resulting in significant scouring.

Alternative 1 – Rock Revetment

Pros

- Common approach for shoreline stabilization (typically accepted by public)
- No interference to offshore navigation
- No impact to adjacent seagrass

Cons

- Would likely have to be built at a higher elevation than existing shoreline to prevent overtopping
- Likely to be less room for upland vegetation to grow landward
- Presents danger to those who wish to climb down to the water

Figure A1. Stone Revetment Along Bayshore Drive Rockport, TX

Alternative 2 – ACBM Revetment

Pros

- Common approach for shoreline stabilization (typically accepted by public)
- No interference to offshore navigation
- No impact to adjacent seagrass

Cons

- Would need high crest elevation to prevent overtopping
- Will likely be no room for landward vegetation to grow
- Will present danger to those who wish to climb over to the water side
- Not durable in high energy conditions

Figure A2. ACMB Revetment at La Quinta Terminal Berm

https://acfenvironmental.com/products/erosion-control/hard-armor/articulated-concrete-blocks/

Alternative 3 – Bulkhead

Pros

- Common approach for shoreline stabilization (typically accepted by public)
- No interference to offshore navigation

Cons

- Would have to be built much higher than existing grade to prevent overtopping and the washout of the sediment behind the wall.
- Increased wave reflection causes more turbulent nearshore conditions which degrades seagrass habitat and is likely not preferred for water recreation

Figure A3. Private Sheetpile Bulkhead Along North Fulton Beach Rd. Rockport, TX

Alternative 4 – Offshore Reef Units

Pros

- Positive wave attenuation during daily conditions when designed into a large reef structure (with multiple rows or stacks of units)
- Promotion of marine life in the area

Cons

- May fail to protect the shoreline during storm conditions
- Potential for navigation issues with boaters
- Reef unit placement will be limited to avoid impact to seagrass

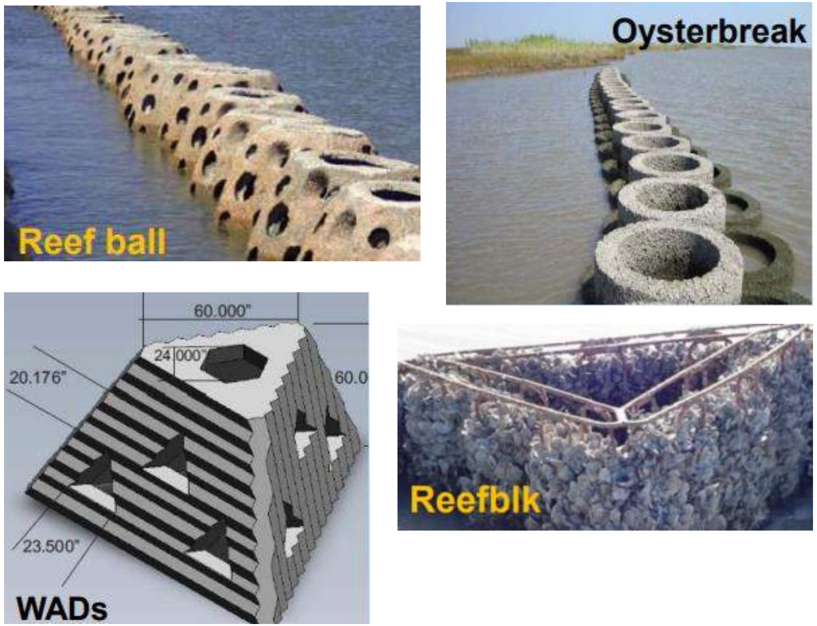


Figure A4. Potential Artificial Reef Units

Alternative 5 – Breakwater & Vegetation Planting

Pros

- Can optimize design for cost and protection to the shoreline from wave energy.
- Approved design for grant funding and permit in previous projects
- Habitat benefits; would allow for natural wetland vegetation growth in the nearshore area.
- Minimal safety hazards walking to the water (assuming adequate gaps were left for the public to walk around the breakwaters or breakwaters were placed far offshore).

Cons

- Public disagreement at the HMP South Fulton site
- Breakwater placement will be limited to avoid impact to seagrass

Figure A5. Rendering of South Fulton Breakwater & Living Shoreline Design

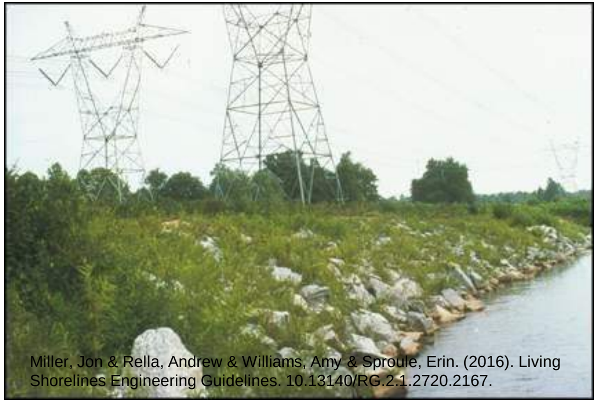
Alternative 6 – Rock Revetment with Joint Vegetation Planting

Pros

- Revetment component is a common approach for shoreline stabilization (typically accepted by public)
- Promotion of vegetation growth on the structure
- No impact to adjacent seagrass

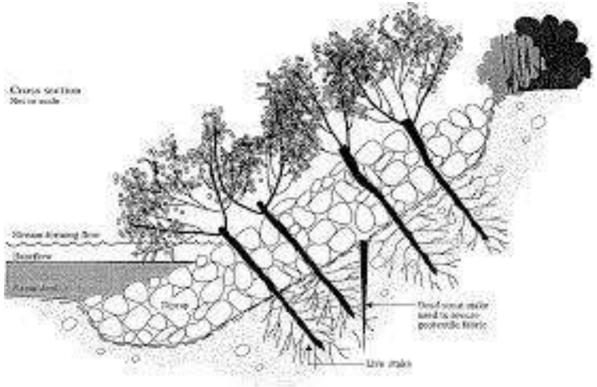
Cons

- Will likely have to be built at a higher elevation than adjacent shoreline to prevent overtopping
- Presents danger to those who wish to climb down to the water
- It is likely that wave energy will not dissipate before reaching the structure making the chances of planted vegetation growth very small



Miller, Jon & Rella, Andrew & Williams, Amy & Sproule, Erin. (2016). Living Shorelines Engineering Guidelines. 10.13140/RG.2.1.2720.2167.

Figure A6. Example Joint Planting with Stone Revetment Design



https://npdestraining.com/wp-content/uploads/2018/04/Streambank_Shoreline_Stablization_Guidance_2010.pdf

Alternative 7 – Rock Revetment with Toe Vegetation Planting

Pros

- Revetment component is a common approach for shoreline stabilization (typically accepted by public)
- Promotion of wetland growth at the toe of the structure

Cons

- Will likely have to be built at a higher elevation to prevent overtopping
- Presents danger to those who wish to climb down to the water
- It is likely that wave energy will not dissipate before reaching the structure making the chances of planted wetland growth very small

Figure A7. Example Stone Revetment with Toe Vegetation Planting Design

http://firstcoastal.com/living-shorelines/

Alternative 8 – Rock/ACBM Revetment & Offshore Reef Units

Pros

- Revetment component is a common approach for shoreline stabilization (typically accepted by public)
- Potential wave attenuation seaward shoreline, dependent upon design
- Promotion of natural wetland growth due to decreased nearshore wave conditions
- Promote/improve marine life at reef units

Cons

- Revetment will likely have to be built at a higher elevation than adjacent shoreline to prevent overtopping
- Likely no room for upland vegetation to grow landward of the revetment
- Will present danger to those who wish to climb over to the water side of both the revetment and reef units.
- Potential for nearshore navigation restrictions
- Reef unit placement will be limited to avoid impact to seagrass

Figure A8. Stone Revetment Along Bayshore Drive Rockport, TX and Example Artificial Reef Units

Appendix B – Geotechnical Investigation Report

• GEOTECHNICAL ENGINEERING
• MATERIALS ENGINEERING & TESTING
• SOILS • ASPHALT • CONCRETE

GEOTECHNICAL SUBSURFACE INVESTIGATION RECOMMENDATIONS FOR THE PROPOSED FULTON BEACH ROAD REPLACEMENT AND RUBBLE MOUND BREAKWATER

FULTON BEACH ROAD
ROCKPORT, TEXAS

RETL REPORT NUMBER: G119161

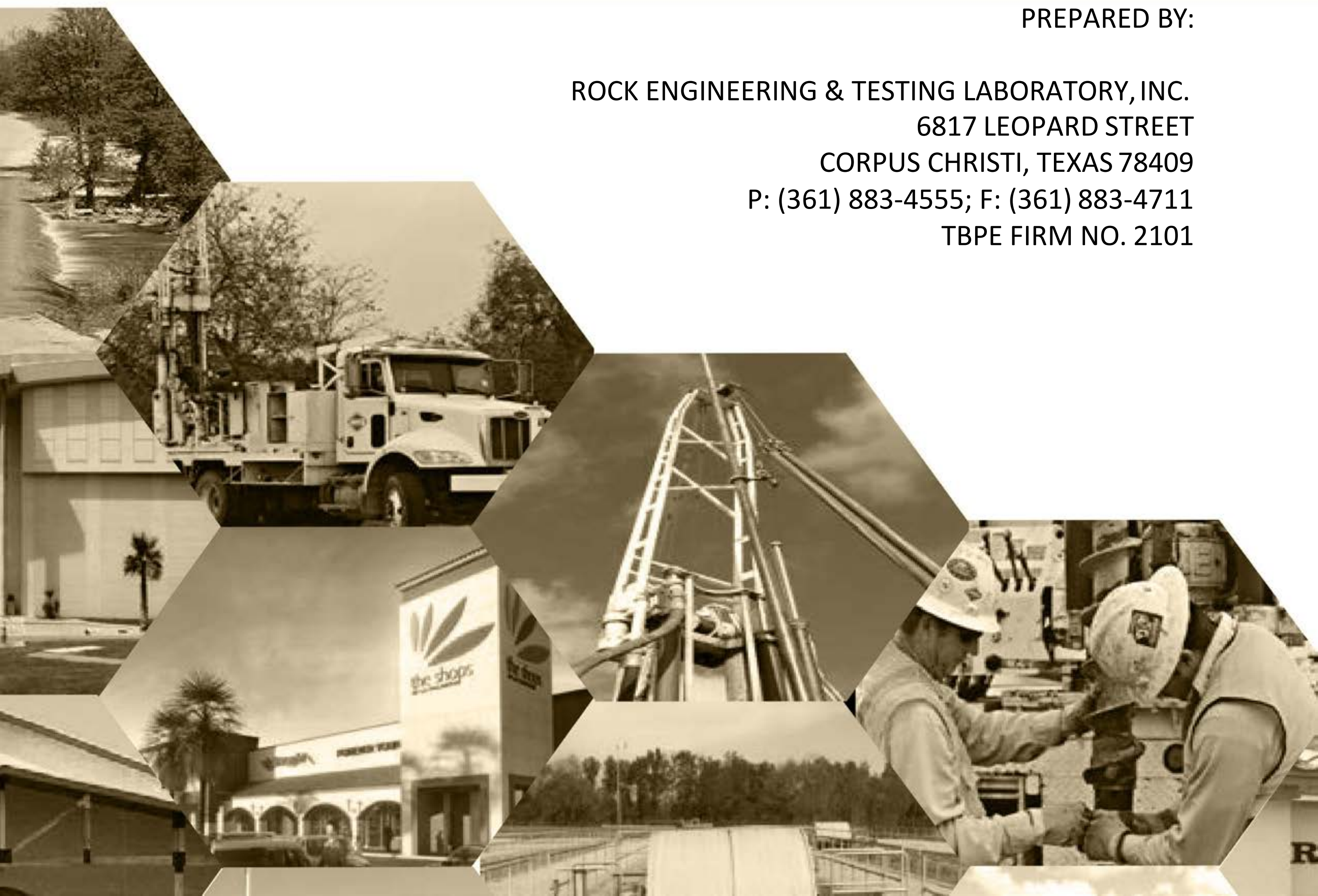
PREPARED FOR:

MOTT MACDONALD
711 NORTH CARANCAHUA
CORPUS CHRISTI, TEXAS 78401

MAY 24, 2019

PREPARED BY:

ROCK ENGINEERING & TESTING LABORATORY, INC.
6817 LEOPARD STREET
CORPUS CHRISTI, TEXAS 78409
P: (361) 883-4555; F: (361) 883-4711
TBPE FIRM NO. 2101



· GEOTECHNICAL ENGINEERING
· CONSTRUCTION MATERIALS ENGINEERING & TESTING
· SOILS • ASPHALT • CONCRETE

May 24, 2019

Mott MacDonald
711 North Carancahua Street, Suite 1610
Corpus Christi, Texas 78401

Attention: Ms. Stephanie Rogers, P.E.

SUBJECT: **SUBSURFACE INVESTIGATION, LABORATORY TESTING PROGRAM, AND FOUNDATION AND PAVEMENT RECOMMENDATIONS FOR THE PROPOSED FULTON BEACH ROAD REPLACEMENT AND RUBBLE MOUND BREAKWATER Rockport, Texas RETL Job No. – G119161**

Dear Ms. Rogers,

In accordance with our agreement, we have conducted a subsurface investigation, laboratory testing program, and foundation and pavement evaluation for the above referenced project. The results of this investigation, together with our recommendations, are to be found in the accompanying report, one electronic copy of which is being transmitted herewith for your records and distribution to the design team.

Often, because of design and construction details that occur on a project, questions arise concerning soil conditions, and Rock Engineering and Testing Laboratory, Inc. (RETL), Texas Professional Engineering Firm No. – 2101, would be pleased to continue its role as Geotechnical Engineer during the project implementation.

RETL also has great interest in providing materials testing and observation services during the construction phase of this project. If you will advise us of the appropriate time to discuss these engineering services, we will be pleased to meet with you at your convenience. If you have any questions, or if we can be of further assistance, please contact us at (361) 883-4555.

Sincerely,

Mark C. Rock, P.E.
Vice President of Operations

ROCK ENGINEERING & TESTING LABORATORY, INC.
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SUBSURFACE INVESTIGATION, LABORATORY TESTING PROGRAM, AND FOUNDATION AND PAVEMENT RECOMMENDATIONS FOR THE PROPOSED FULTON BEACH ROAD REPLACEMENT AND RUBBLE MOUND BREAKWATER ROCKPORT, TEXAS

RETL REPORT NUMBER: G119161

PREPARED FOR

MOTT MACDONALD
711 NORTH CARANCAHUA STREET, SUITE 1610
CORPUS CHRISTI, TEXAS 78401

MAY 24, 2019

PREPARED BY:

ROCK ENGINEERING AND TESTING LABORATORY, INC.
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TEXAS PROFESSIONAL ENGINEERING FIRM NO. 2101

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J.R. EICHELBERGER, III
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LICENSED
PROFESSIONAL ENGINEER

STATE OF TEXAS
MARK C. ROCK
71395
REGISTERED
PROFESSIONAL ENGINEER

J.R. Eichelberger, III, P.E.
Senior Project Engineer
Cell: 210 355 2754

Mark C. Rock, P.E.
Vice President of Operations
Cell: 361 438 8755

TABLE OF CONTENTS

INTRODUCTION

This report presents the results of a soils exploration, laboratory testing program, and foundation and pavement analysis for the proposed Fulton Beach Road roadway replacement and rubble mound breakwater project, located off Fulton Beach Road in Rockport, Texas. This project was performed for Mott MacDonald.

Authorization

The work for this project was performed in accordance with RETL proposal number P012119A dated February 1, 2019. The original scope of work and fee was approved and incorporated into a Mott MacDonald, LLC Subcontract Agreement approved by Mr. Kendall Kilpatrick, EVI for Mott MacDonald, LLC on April 19, 2019.

Purpose and Scope

The purpose of this exploration was to evaluate the soil and groundwater conditions at the site and to provide allowable bearing pressures along the alignment of the proposed breakwater and pavement recommendations for the proposed project.

The scope of the exploration and analysis included the subsurface exploration, field and laboratory testing, engineering analysis and evaluation of the subsurface soils, provision of recommendations, and preparation of this report for the proposed project.

The scope of services did not include an environmental assessment. Any statements in this report, or on the boring logs, regarding odors, colors, unusual or suspicious items or conditions are strictly for the information of the client.

General

The exploration and analysis of the subsurface conditions reported herein are considered sufficient in detail and scope to provide foundation and pavment recommendations for the proposed project. The information submitted for the proposed project is based on project details provided by Mott MacDonald, LLC and the soil information obtained at the boring locations. If the designers require additional soil parameters to complete the design of the proposed project, and this information can be obtained from the soil data and laboratory tests performed within the scope of work included in our proposal for this project, RETL will provide the additional information requested as a supplement to this report.

The Geotechnical Engineer states that the findings, recommendations, specifications or professional advice contained herein have been presented after being prepared in a manner consistent with that level of care and skill ordinarily exercised by reputable members of the Geotechnical Engineer's profession practicing contemporaneously under similar conditions in the locality of the project. RETL operates in general accordance with "*Standard Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction*, (ASTM D3740)." No other representations are expressed or implied, and no warranty or guarantee is included or intended.

This report has been prepared for the exclusive use of Mott MacDonald, LLC for the specific application for the proposed Fulton Beach Road roadway replacement and rubble mound breakwater project, located at Fulton Beach Road in Rockport, Texas.

DESCRIPTION OF SITE

The proposed project site is 1,800 feet along the alignment of Fulton Beach Road adjacent to Aransas Bay in Rockport, Texas. Boring locations B-1 through B-3 were performed in areas covered with grass and the remaining borings were performed through the existing Fulton Beach Road. The site is relatively level. Evidence of underground utilities was observed at this site. The ground surface conditions at the boring locations did not pose any difficulties to the drill crew moving their equipment across the site.

FIELD EXPLORATION

Scope

The field exploration, to evaluate the engineering characteristics of the subsurface materials, included reconnaissance of the project site, performing the boring operations and obtaining disturbed samples. During the sample recovery operations, the soils encountered were classified and recorded on the boring logs in accordance with "*Standard Guide for Field Logging of Subsurface Exploration of Soil and Rock*, (ASTM D5434)."

Eleven borings were performed at this site for the purpose of providing geotechnical information. The table below provides the boring identification, boring depth, boring location and GPS coordinates at each boring location.

Boring	Sampling Depth (ft)	Location	GPS Coordinates
B-1	10'	Breakwater	N 28.05432° W 97.03343°
B-2	10'	Breakwater	N 28.05686° W 97.03387°
B-3	10'	Breakwater	N 28.05908° W 97.03415°
B-4	5'	Roadway	N 28.05425° W 97.03351°
B-5	5'	Roadway	N 28.05489° W 97.03367°
B-6	5'	Roadway	N 28.05555° W 97.03372°
B-7	5'	Roadway	N 28.05612° W 97.03385°
B-8	5'	Roadway	N 28.05694° W 97.03391°
B-9	5'	Roadway	N 28.05753° W 97.03406°
B-10	5'	Roadway	N 28.05827° W 97.03409°
B-11	5'	Roadway	N 28.05905° W 97.03427°

The GPS coordinates, obtained at the boring locations using a Garmin model Etrex Venutre GPS, are provided in this report and on the boring logs. RETL, in coordination with Mott MacDonald, LLC determined the scope of the field work. RETL staked the borings in the field and performed the drilling operations. A Boring Location Plan is provided in the Appendix.

The borings performed for this project were used to determine the classification and strengths of the subgrade soils. The information provided on the boring logs includes boring locations, boring depths, soil classifications, soil strengths, and laboratory test results. The boring logs are included in the Appendix.

Drilling and Sampling Procedures

The test borings were performed using a drilling rig equipped with a rotary head turning hollow stem and solid flight augers to advance the boreholes. Disturbed soil samples were obtained using split-barrel sampling procedures in general accordance with the procedures for, "*Penetration Test and Split-Barrel Sampling of Soils,* (ASTM D1586)."

The samples were placed in plastic bags, marked according to boring number, depth, and any other pertinent field data, stored in special containers, and delivered to the laboratory for testing.

Field Tests and Observations

Standard Penetration Tests (SPT) – During the sampling procedures, SPT were performed to obtain the standard penetration value of the soil at selected intervals. The standard penetration value (N) is defined as the number of blows of a 140-pound hammer, falling 30-inches, required to advance the split-barrel sampler 1-foot into the soil. The sampler is lowered to the bottom of the previously cleaned drill hole and advanced by blows from the hammer. The number of blows is recorded for each of three successive 6-inch penetrations. An automatic hammer was utilized when performing the SPT. An automatic hammer is typically taken to have an efficiency of one. The "N" value is obtained by adding the second and third 6-inch increment number of blows. The results of standard penetration tests indicate the relative density of cohesionless soils and comparative consistency of cohesive soils, thereby providing a basis for estimating the relative strength and compressibility of the soil profile components.

Water Level Observations – Water level observations were obtained during the test boring operations. Water level observations are noted on the boring logs provided in the Appendix. In relatively pervious soils, such as sandy soils, the indicated depths are usually reliable groundwater levels. In relatively impervious soils, a suitable estimate of the groundwater depth may not be possible, even after several days of observation. Seasonal variations, temperature, land-use, proximity to the ocean, tide levels and recent rainfall conditions may influence the depth to the groundwater. The amount of water in open boreholes largely depends on the permeability of the soils encountered at the boring locations.

Ground Surface Elevations – The ground surface elevations at the boring locations were not provided at the time of this report. Therefore, the depths referred to in this report are measured from the ground surface at the boring locations during the time of our field investigation unless specified otherwise.

LABORATORY TESTING PROGRAM

In addition to the field investigation, a laboratory testing program was conducted to determine additional pertinent engineering characteristics of the subsurface materials necessary in analyzing the behavior of the foundation and pavement systems for the proposed project.

The laboratory testing program included supplementary visual classification (ASTM D2487) and water content tests (ASTM D2216) on the samples. In addition, selected samples were subjected to Atterberg limits tests (ASTM D4318) and percent material finer than the #200 sieve tests (ASTM D1140).

The laboratory testing program was conducted in general accordance with applicable ASTM Specifications. The results of these tests are to be found on the accompanying boring logs provided in the Appendix.

SUBSURFACE CONDITIONS

General

The types of foundation and pavement bearing materials encountered in the test borings have been visually classified and are described in detail on the boring logs. The results of the standard penetration tests, water level observations, and other laboratory tests are presented on the boring logs in numerical form. Representative samples of the soils were placed in polyethylene bags and are now stored in the laboratory for further analysis, if desired. Unless notified to the contrary, the samples will be disposed of three months after issuance of this report.

The stratification of the soil, as shown on the boring logs, represents the soil conditions at the actual boring locations. Variations may occur between, or beyond the boring locations. Lines of demarcation represent the approximate boundary between different soil types, but the transition may be gradual, or not clearly defined.

It should be noted that, whereas the test borings were drilled and sampled by experienced drillers, it is sometimes difficult to record changes in stratification within narrow limits. In the absence of foreign substances, it is also difficult to distinguish between discolored soils and clean soil fill.

Soil Conditions

The subsurface conditions at the site contained existing pavement constituents at borings B-4 through B-11. The pavement was not encountered at borings B-1 through B-3. The natural in-situ soils consist of predominately sand and clayey sand soils that extend to the deepest boring termination depth of 10-feet.

The thicknesses of the existing pavement constituents are provided in the following table.

Existing Pavement Constituents			
Boring Number	**Thickness of HMAC (in)**	**Thickness of Base (in)**	**Total Pavement Thickness (in)**
4	3.5”	12”	15.5”
5	3.5”	11.5”	15”
6	5.5”	10.5”	16”
7	4”	10”	14”
8	4.5”	13.5”	18”
9	4”	12”	16”
10	6”	9”	15”
11	3.75”	14.25”	18”

The subsurface conditions encountered at the boring locations are summarized in the following paragraph.

From the ground surface, or beneath the existing pavements, and extending to a depth of 10-feet, the deepest boring termination depth performed for this project, a stratum of loose to medium density poorly graded sand and clayey sand soils was encountered. Standard penetration tests ranged from Weight of Hammer (WOH) to 29 blows per foot. Atterberg limits test results indicate that the clay soils encountered are low in plasticity. The tested liquid limit was 31-percent and plasticity index was 12. Minus #200 sieve tests performed on selected soil samples obtained indicated that these soils contain approximately 2 to 20-percent silt and clay size particles.

Detailed descriptions of the soils encountered at the boring locations are provided on the boring logs included in the Appendix.

Groundwater Observations

Groundwater (GW) observations and the depth the boring caved are provided in the following table:

GROUNDWATER (GW) OBSERVATIONS		
BORING	**DURING DRILLING**	**UPON COMPLETION**
B-1	2.5’	Wet & Caved at 2.5’
B-2	2.5’	GW at 2’ & Caved at 2.5’
B-3	4’	GW at 3.83’ & Caved at 4’
B-4	2.5’	Wet & Caved at 2.5’
B-5	3	Wet & Caved at 3’
B-6	2.5’	Wet & Caved at 2.5’
B-7	3’	Wet & Caved at 3’
B-8	3’	GW @ 3’ & Caved at 3.5’
B-9	3’	Wet & Caved at 3’
B-10	2.5’	Wet & Caved @ 2.5’
B-11	3.5’	Wet & Caved at 3.5’

Based on observations made in the field and moisture contents obtained in the laboratory, it appears as if groundwater is near the 2 ½ to 4-foot depth at the time of our field investigation. Groundwater near the ground surface occurs in the vicinity of this project particularly after significant rainfall events where stormwater runoff fills in the air voids in the surficial sand soils. High groundwater conditions can continue until the groundwater has an opportunity to drain to the bay. RETL encourages the contractor to verify the depth to groundwater prior to bidding to account for the need to dewater excavations for utilities, foundations, etc. at this site. Problems with high water levels in non-cohesive soil regimes can be exacerbated by the contractor's activities particularly when using vibratory effort during compaction operations. The contractor should be aware of the high water table and encouraged to utilize construction means and methods to minimize construction activities that can draw water up or cause the non-cohesive soils from going "quick". If any soft areas are identified, the soils should be removed and recompacted in place.

Water levels in open boreholes may require several hours to several days to stabilize depending on the permeability of the soils and that groundwater levels at this site may be subject to seasonal conditions, recent rainfall, tide levels and drought or temperature effects and proximity to large bodies of water.

FOUNDATION DISCUSSION FOR THE BREAKWATER

Based on information provided to RETL, a breakwater structure will be constructed near or at the location of borings B-1, B-2, and B-3 which were performed along the shoreline between the roadway and Aransas Bay.

Multiple breakwaters will be constructed at the site adjacent to the roadway either in the water slightly offshore or on the shore depending on the location. The breakwaters will have a footprint measuring approximately 70-feet long by 26-feet (measured at the base of the breakwater. The sides will slope at a 2 Horizontal to 1 Vertical with the crest measuring 4-feet. The breakwater will be approximately 4½-feet measured from the base to the crest. The maximum ground contact pressure is estimated to be on the order of 675 psf, neglecting the force of buoyancy.

It is RETL's opinion that during the initial placement of the first course of stone approximately one-half to 1-foot of displacement of the bay bottom will occur. **Once the initial settlement occurs the ultimate bearing pressure is on the order of 800 psf resulting in a safety factor for the effective unit weight of the stone breakwater on the supporting substrate on the order of 1.2.**

Immediate settlements, settlements that will occur within a week, warrant that the contractor top off the breakwater with additional stone after a minimum of one week after the initial construction of the breakwater to the proposed grades. Assuming that the soils are sand soils to depths of 2-times the average width of the cross-sectional dimension of the breakwater, long term consolidation settlements are not expected, it should be noted that the borings at the breakwater locations were only drilled to the 10-foot depth and the depth that the soils will see an increase in stress is approximately 26-feet. A more detailed settlement analysis can be performed, but, based on the dimensions of the breakwater, will require additional data from supplemental field investigation.

PAVEMENT CONSIDERATIONS

It is understood that the proposed roadway profile grade line will be raised approximately 1-foot. In designing the proposed roadway, the existing subgrade conditions must be considered together with the expected traffic use and loading conditions.

A flexible pavement section consisting of a hot mix asphaltic concrete surface course over crushed limestone base material is currently being considered for the new roadway.

The conditions that influence pavement design can be summarized as follows:

- Bearing values of the subgrade. These can be represented by a California Bearing Ratio (CBR) for the design of flexible pavements.
- Vehicular traffic, in terms of the number and frequency of vehicles and their range of axle loads.
- Probable increase in vehicular use over the life of the pavement.
- The availability of suitable materials to be used in the construction of the pavement and their relative costs.

Specific laboratory testing to define the subgrade strength (i.e. CBR) has not been performed for this analysis. **Based upon local experience, the estimated CBR value for the natural surficial poorly graded sand soils encountered at this site is 10.**

Since traffic counts and design vehicles have not been provided, it is only possible to provide a non-engineered pavement section suitable for light and heavy duty service based on pavement sections, which have provided adequate serviceability for similar type facilities.

The recommended light and heavy duty flexible pavement sections, using locally available materials, are provided in the following tables:

Light Duty Flexible Pavement (Passenger Cars & Light Trucks)	
Hot Mix Asphaltic Concrete	2"
Crushed Limestone Base Material (TxDOT Item 247 Type A; Gr. 1-2)	10"
Scarified and Compacted Existing Pavement Materials	12"

Heavy Duty Flexible Pavement	
Hot Mix Asphaltic Concrete	3"
Crushed Limestone Base Material (TxDOT Item 247 Type A; Gr. 1-2)	12"
Scarified and Compacted Existing Pavement Materials	12"

It is important that any existing organic and compressible soils be removed and the exposed subgrade be properly prepared prior to pavement installation.

The existing pavement shall be treated per TxDOT Standard Specification 2014; Item 251, 4.2.1, Scarifying. Once the existing roadway materials have been scarified, the existing pavement constituents shall be spread across the roadway subgrade crown width and compacted to a minimum density of 95-percent of the standard Proctor (ASTM D698) and within 2-percentage points of the optimum moisture content.

Upon completion of scarifying and compacting the existing scarified roadway constituents, new crushed limestone base materials shall be placed. The crushed limestone base material shall meet the requirements set forth in Texas Standard Specifications 2014; Item 247, Type A, Grade 1-2 and should be placed in maximum 8-inch thick loose lifts and compacted to a minimum density of 98% of the maximum dry density as determined by the modified Proctor test (ASTM D 1557) and within ± 1.5 percentage points of the optimum moisture content.

Hot mix asphaltic concrete should meet the requirements set forth in Texas Standard Specifications 2014 Item 340; Type D, or C, surface course.

Due to the high water table, it may be necessary for the contractor to modify its methods to avoid vibratory compaction mode when using large construction compaction equipment in an effort to keep the groundwater from coming to the surface and making compaction of the subgrade soils difficult if not impossible. In addition, significant rainfall events will result in groundwater close to the ground surface and may warrant alternative construction means and methods in order to proceed with construction.

Allowances for proper drainage and proper material selection of base materials are most important for performance of asphaltic pavements. Ruts and birdbaths in asphalt pavements allow for quick deterioration of the pavement primarily due to saturation of the underlying base materials and subgrade soils.

Routine Maintenance of Rigid and Flexible Pavement Systems

The pavement sections provided in this report are non-engineered pavement sections that have performed satisfactorily for similar applications planned for the project. During lifetime of the pavement, routine maintenance such as crack sealing and seal coats for flexible pavements will be required. Without proper maintenance, moisture infiltration into the base material and subgrade will result in rapid deterioration of the pavement system. RETL recommends that the owner protects their investment by incorporating an aggressive maintenance program.

CONSTRUCTION CONSIDERATIONS

Earthwork and Foundation Acceptance

Exposure to the environment may weaken the soils at the pavement bearing levels if excavations remain open for long periods of time. Therefore, it is recommended that the pavement excavations be extended to final grade and the pavement be constructed as soon as possible to minimize potential damage to the bearing soils. The pavement bearing levels should be free of loose soil, ponded water or debris and should be observed prior to placing pavement constituents by the Geotechnical Engineer, or his designated representative.

Pavement constituents should not be placed on soils that have been disturbed by rainfall or seepage. If the bearing soils are softened by surface water intrusion, or by desiccation, the unsuitable soils must be removed and be replaced with properly compacted base material as directed by the Geotechnical Engineer.

The Geotechnical Engineer, or his designated representative, should monitor subgrade preparation. As a guideline, density tests should be performed on the exposed subgrade soils and each subsequent lift of compacted pavement constituents at a rate of one test per 3,000-square feet or a minimum of three in-place nuclear tests per testing interval, whichever is greater. Any areas not meeting the required compaction should be recompacted and retested until compliance is met.

Dewatering Construction Considerations

Based on the groundwater observations made during the drilling operations and based on our experience with other geotechnical investigations performed in the vicinity, it appears that dewatering will be required for excavations greater than approximately 1½-feet below the ground surface at the site. It should be noted that the depth to the groundwater is subject to change due to climatic and site conditions, therefore, it should be made the responsibility of the contractor to verify depths to groundwater. **A unit cost price for dewatering should be included in the contract documents.**

The following discussion is general information that may be useful where dewatering operations are required.

For construction of shallow excavations, open drainage or interceptor ditches can be expedient and relatively inexpensive method for lowering the groundwater table a slight distance. The interceptor ditch has to penetrate deeper than the elevation of the work area. Water collecting in such ditches normally has to be pumped out of the ditch for disposal. Since gravity flow is relied upon to bring the water to the ditch, the continued inflow is dependent on the water level in the ditch being kept low. With this method, it is common to construct small pits in the ditch, termed sump pits, for locating the necessary pumps (sump pumps).

The drawing down of the water table can also be accomplished by constructing a series of sump pits, or, if greater depth is required, some type of drainage wells around the construction area and pumping the water from these pits or wells.

For dewatering to intermediate depths (to about 30-feet but more if sufficient area is available for installing the necessary equipment) well-point systems are normally used.

To dewater an area, a series of well points is installed around the perimeter of the area. The groundwater level within the perimeter will be lowered when the well-point system is put in operation. The spacing of the well points varies according to the soil type and depth of dewatering. Spacing conventionally varies between 3 and 10-feet.

With the type of pumping equipment conventionally used for well points, the depth of dewatering that can usually be achieved by a single line of well points located around the perimeter of an excavation is about 18 to 20-feet. This is due to the limit on the practical lifting, or suction, capacity of the pumping equipment. Lowering the water table through a greater distance may require the use of a two (or more) stage (multistage) installation. Where a two-stage installation is required, the well points for the first stage of drawdown are located near the extreme perimeter limits of the area that can be excavated and are put into operation. Well points for the second stage are subsequently located within the area that has been excavated, near to the bottom elevation that has been dewatered by the first stage. The second stage well points then lower the water table to the additional depth necessary to complete the excavation in dry conditions.

Subsurface water that flows in an upward direction into an excavation area that is being dewatered imparts a seepage force that tends to loosen the soil, reducing the soil strength. The change in strength should be considered in designing excavation bracing and foundations. Where excavations are to extend more than a few feet below groundwater level, open ditches or pits may not be practical, and more advanced methods may be required.

Other methods of dewatering are available and may be more cost effective than those mentioned above. Additional information concerning dewatering may be obtained from a contractor whose specialty is dewatering.

GENERAL COMMENTS

If significant changes are made in the character or location of the proposed project, a consultation should be arranged to review any changes with respect to the prevailing soil conditions. At that time, it may be necessary to submit supplementary recommendations.

It is recommended that the services of RETL be engaged to test and evaluate the soils in the pavement excavations prior to placing pavement constituents in order to verify that the bearing soils are consistent with those encountered in the borings. RETL cannot accept any responsibility for any conditions that deviate from those described in this report, nor for the performance of the pavement if not engaged to also provide construction observation and testing for this project. If it is required for RETL to accept any liability, then RETL must agree with the plans and perform such observation during construction as we recommend.

All sheeting, shoring, and bracing of trenches, pits and excavations should be made the responsibility of the contractor and should comply with all current and applicable local, state and federal safety codes, regulations and practices, including the Occupational Safety and Health Administration.

APPENDIX

• Geotechnical Engineering
• Construction Materials
Engineering & Testing
• Soils • Asphalt • Concrete

BORING LOCATION PLAN

May 24, 2019
Attn.: Ms. Stephanie Rogers, P.E.
RETL Job No.: G119161

FULTON BEACH ROAD AND RUBBLE MOUND BREAKWATER
Fulton Beach Road
Rockport, Texas

LOG OF BORING B-1

Rock Engineering & Testing Laboratory Inc.
6817 Leopard Street
Corpus Christi, TX
Telephone: 3618834555
Fax: 3618834711

CLIENT: Mott MacDonald, LLC
PROJECT: Fulton Beach Road Replacement
LOCATION: Rockport, Texas
NUMBER: G119161

DATE(S) DRILLED: 4/29/19 - 4/29/19

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater (GW) was encountered at a depth of 2.5-feet during drilling.
Wet and Caved at 2.5-feet upon completion.

SURFACE ELEVATION: N/A

FIELD DATA				LABORATORY DATA							
DEPTH (FT)	SAMPLE NUMBER	SAMPLES	N: BLOWS/FT, P: TONS/SQ FT, T: TONS/SQ FT, Qc: TONS/SQ FT	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
0–6	SS S-1	SS	N= 12	13							**SILTY SAND**, moist, brown, with shell, medium.
	SS S-2	SS	N= 5	22							Same as above, loose.
6–10	SS S-3	SS	N= 3	24						7	**POORLY GRADED SAND WITH SILT**, moist, brown, very loose.
	SS S-4	SS	N= 5	23							Same as above, loose.
10											Boring was terminated at a depth of 10-feet.

N - STANDARD PENETRATION TEST RESISTANCE
Qc - STATIC CONE PENETROMETER TEST INDEX
P - POCKET PENETROMETER RESISTANCE

REMARKS:
Boring depth and location were determined by Mott MacDonald and RETL. Drilling Operations were performed by RETL at GPS Coordinates N 28.05432° W 97.03343°

LOG OF BORING B-2

Rock Engineering & Testing Laboratory Inc.
6817 Leopard Street
Corpus Christi, TX
Telephone: 3618834555
Fax: 3618834711

CLIENT: Mott MacDonald, LLC
PROJECT: Fulton Beach Road Replacement
LOCATION: Rockport, Texas
NUMBER: G119161

DATE(S) DRILLED: 4/29/19 - 4/29/19

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater (GW) was encountered at a depth of 2.5-feet during drilling.
GW at 2-feet and Caved at 2.5-feet upon completion.

SURFACE ELEVATION: N/A

FIELD DATA				LABORATORY DATA							
SOIL SYMBOL	DEPTH (FT)	SAMPLE NUMBER	N: BLOWS/FT P: TONS/SQ FT T: TONS/SQ FT Qc: TONS/SQ FT	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
	1–2	SS S-1	N= 17	24						5	**POORLY GRADED SAND WITH SILT**, moist, gray, medium.
	4	SS S-2	N= 3	22							Same as above, brown, very loose.
	6–7	SS S-3	N= WOH	33							**CLAYEY SAND**, wet, gray, very loose.
	9	SS S-4	N= WOH	32	31	19	12			19	Same as above, very loose. (SC)
	10										Boring was terminated at a depth of 10-feet.

N - STANDARD PENETRATION TEST RESISTANCE
Qc - STATIC CONE PENETROMETER TEST INDEX
P - POCKET PENETROMETER RESISTANCE

REMARKS:
Boring depth and location were determined by Mott MacDonald and RETL. Drilling Operations were performed by RETL at GPS Coordinates N 28.05686° W 97.03387°

LOG OF BORING B-3

Rock Engineering & Testing Labratory Inc.
6817 Leopard Street
Corpus Christi, TX
Telephone: 3618834555
Fax: 3618834711

CLIENT: Mott MacDonald, LLC
PROJECT: Fulton Beach Road Replacement
LOCATION: Rockport, Texas
NUMBER: G119161

DATE(S) DRILLED: 4/29/19 - 4/29/19

DRILLING METHOD(S):
Hollow Stem Auger

GROUNDWATER INFORMATION:
Groundwater (GW) was encountered at a depth of 4-feet during drilling.
GW at 3.83-feet and Caved at 4-feet upon completion.

SURFACE ELEVATION: N/A

SOIL SYMBOL	DEPTH (FT)	SAMPLE NUMBER	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: TONS/SQ FT Qc: TONS/SQ FT	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
	1–2	SS S-1		N= 4	5							**POORLY GRADED SAND**, dry, brown, with shell, loose.
	3–5	SS S-2		N= 9	23						2	Same as above, moist, loose.
	6–7	SS S-3		N= 12	25							Same as above, medium.
	8–10	SS S-4		N= 16	21						20	**SILTY SAND**, moist, brown, with shell, medium.
	10											Boring was terminated at a depth of 10-feet.

N - STANDARD PENETRATION TEST RESISTANCE
Qc - STATIC CONE PENETROMETER TEST INDEX
P - POCKET PENETROMETER RESISTANCE

REMARKS:
Boring depth and location were determined by Mott MacDonald and RETL. Drilling Operations were performed by RETL at GPS Coordinates N 28.05908° W 97.03415°

LOG OF BORING B-4

Rock Engineering & Testing Laboratory Inc.
6817 Leopard Street
Corpus Christi, TX
Telephone: 3618834555
Fax: 3618834711

CLIENT: Mott MacDonald, LLC
PROJECT: Fulton Beach Road Replacement
LOCATION: Rockport, Texas
NUMBER: G119161

DATE(S) DRILLED: 4/30/19 - 4/30/19

DRILLING METHOD(S):
Solid Flight Auger

GROUNDWATER INFORMATION:
Groundwater (GW) was encountered at a depth of 2.5-feet during drilling.
Wet and Caved at 2.5-feet upon completion.

SURFACE ELEVATION: N/A

DEPTH (FT)	SAMPLE NUMBER	N: BLOWS/FT P: TONS/SQ FT T: TONS/SQ FT Qc: TONS/SQ FT	MOISTURE CONTENT (%)	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
										ASPHALT, approximately 3.5-inches.
1										**BASE MATERIAL**, approximately 12-inches.
2	SS S-1	N= 13	12							**POORLY GRADED SAND WITH SILT**, moist, brown, with shell, medium.
3	SS S-2	N= 3	31						9	Same as above, very loose.
4–5	SS S-3	N= 2	27							Same as above, some shell.
										Boring was terminated at a depth of 5.5-feet.

N - STANDARD PENETRATION TEST RESISTANCE
Qc - STATIC CONE PENETROMETER TEST INDEX
P - POCKET PENETROMETER RESISTANCE

REMARKS:
Boring depth and location were determined by Mott MacDonald and RETL. Drilling Operations were performed by RETL at GPS Coordinates N 28.05425° W 97.03351°

LOG OF BORING B-5

Rock Engineering & Testing Labratory Inc.
6817 Leopard Street
Corpus Christi, TX
Telephone: 3618834555
Fax: 3618834711

CLIENT: Mott MacDonald, LLC
PROJECT: Fulton Beach Road Replacement
LOCATION: Rockport, Texas
NUMBER: G119161

DATE(S) DRILLED: 4/30/19 - 4/30/19

DRILLING METHOD(S):
Solid Flight Auger

GROUNDWATER INFORMATION:
Groundwater (GW) was encountered at a depth of 3-feet during drilling.
Wet and Caved at 3-feet upon completion.

SURFACE ELEVATION: N/A

SOIL SYMBOL	DEPTH (FT)	SAMPLE NUMBER	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: TONS/SQ FT Qc: TONS/SQ FT	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
												ASPHALT, approximately 3.5-inches.
	1											**BASE MATERIAL**, approximately 11.5-inches.
	2	SS S-1		N= 17	15							**POORLY GRADED SAND WITH SILT**, moist, gray, with shell, medium.
	3	SS S-2		N= 13	25						6	Same as above, brown.
	4–5	SS S-3		N= 0	24							Same as above, trace shell, very loose.
												Boring was terminated at a depth of 5.5-feet.

N - STANDARD PENETRATION TEST RESISTANCE
Qc - STATIC CONE PENETROMETER TEST INDEX
P - POCKET PENETROMETER RESISTANCE

REMARKS:
Boring depth and location were determined by Mott MacDonald and RETL. Drilling Operations were performed by RETL at GPS Coordinates N 28.05489° W 97.03367°

LOG OF BORING B-6

Rock Engineering & Testing Laboratory Inc.
6817 Leopard Street
Corpus Christi, TX
Telephone: 3618834555
Fax: 3618834711

CLIENT: Mott MacDonald, LLC
PROJECT: Fulton Beach Road Replacement
LOCATION: Rockport, Texas
NUMBER: G119161

DATE(S) DRILLED: 4/30/19 - 4/30/19

DRILLING METHOD(S):
Solid Flight Auger

GROUNDWATER INFORMATION:
Groundwater (GW) was encountered at a depth of 2.5-feet during drilling.
Wet and Caved at 2.5-feet upon completion.

SURFACE ELEVATION: N/A

SOIL SYMBOL	DEPTH (FT)	SAMPLE NUMBER	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: TONS/SQ FT Qc: TONS/SQ FT	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
												ASPHALT, approximately 5.5-inches.
	1											**BASE MATERIAL**, approximately 10.5-inches.
	2	SS S-1		N= 21	21							**POORLY GRADED SAND**, moist, gray, with some shell, medium.
	3	SS S-2		N= 21	24						4	Same as above, brown.
	4–5	SS S-3		N= 4	25							Same as above, loose.
												Boring was terminated at a depth of 5.5-feet.

N - STANDARD PENETRATION TEST RESISTANCE
Qc - STATIC CONE PENETROMETER TEST INDEX
P - POCKET PENETROMETER RESISTANCE

REMARKS:
Boring depth and location were determined by Mott MacDonald and RETL. Drilling Operations were performed by RETL at GPS Coordinates N 28.05555° W 97.03372°

LOG OF BORING B-7

Rock Engineering & Testing Laboratory Inc.
6817 Leopard Street
Corpus Christi, TX
Telephone: 3618834555
Fax: 3618834711

CLIENT: Mott MacDonald, LLC
PROJECT: Fulton Beach Road Replacement
LOCATION: Rockport, Texas
NUMBER: G119161

DATE(S) DRILLED: 4/30/19 - 4/30/19

DRILLING METHOD(S):
Solid Flight Auger

GROUNDWATER INFORMATION:
Groundwater (GW) was encountered at a depth of 3-feet during drilling.
Wet and Caved at 3-feet upon completion.

SURFACE ELEVATION: N/A

FIELD DATA				LABORATORY DATA							
SOIL SYMBOL	DEPTH (FT)	SAMPLE NUMBER	N: BLOWS/FT, P: TONS/SQ FT, T: TONS/SQ FT, Qc: TONS/SQ FT	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
	0–0.3										**ASPHALT**, approximately 4-inches.
	0.3–1										**BASE MATERIAL**, approximately 10-inches.
	2	SS S-1	N= 5	21							**POORLY GRADED SAND**, moist, gray, with shell, loose.
	3 (GW ▼)	SS S-2	N= 9	23							**SILTY SAND**, moist, gray, loose.
	5	SS S-3	N= 1	28						14	Same as above, very loose.

Boring was terminated at a depth of 5.5-feet.

N - STANDARD PENETRATION TEST RESISTANCE
Qc - STATIC CONE PENETROMETER TEST INDEX
P - POCKET PENETROMETER RESISTANCE

REMARKS:
Boring depth and location were determined by Mott MacDonald and RETL. Drilling Operations were performed by RETL at GPS Coordinates N 28.05612° W 97.03385°

LOG OF BORING B-8

Rock Engineering & Testing Laboratory Inc.
6817 Leopard Street
Corpus Christi, TX
Telephone: 3618834555
Fax: 3618834711

CLIENT: Mott MacDonald, LLC
PROJECT: Fulton Beach Road Replacement
LOCATION: Rockport, Texas
NUMBER: G119161

DATE(S) DRILLED: 4/30/19 - 4/30/19

DRILLING METHOD(S):
Solid Flight Auger

GROUNDWATER INFORMATION:
Groundwater (GW) was encountered at a depth of 3-feet during drilling.
GW at 3-feet and Caved at 3.5-feet upon completion.

SURFACE ELEVATION: N/A

FIELD DATA				LABORATORY DATA							
SOIL SYMBOL	DEPTH (FT)	SAMPLE NUMBER	N: BLOWS/FT P: TONS/SQ FT T: TONS/SQ FT Qc: TONS/SQ FT	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
	0										**ASPHALT**, approximately 4.5-inches.
	1										**BASE MATERIAL**, approximately 13.5-inches.
	2	SS S-1	N= 17	14							**POORLY GRADED SAND WITH SILT**, moist, brown, with shell, medium.
	3	SS S-2	N= 10	24						6	Same as above.
	4–5	SS S-3	N= 9	24							**SILTY SAND**, moist, gray, with shell, loose.
											Boring was terminated at a depth of 5.5-feet.

N - STANDARD PENETRATION TEST RESISTANCE
Qc - STATIC CONE PENETROMETER TEST INDEX
P - POCKET PENETROMETER RESISTANCE

REMARKS:
Boring depth and location were determined by Mott MacDonald and RETL. Drilling Operations were performed by RETL at GPS Coordinates N 28.05694° W 97.03391°

LOG OF BORING B-9

Rock Engineering & Testing Laboratory Inc.
6817 Leopard Street
Corpus Christi, TX
Telephone: 3618834555
Fax: 3618834711

CLIENT: Mott MacDonald, LLC
PROJECT: Fulton Beach Road Replacement
LOCATION: Rockport, Texas
NUMBER: G119161

DATE(S) DRILLED: 4/30/19 - 4/30/19

DRILLING METHOD(S):
Solid Flight Auger

GROUNDWATER INFORMATION:
Groundwater (GW) was encountered at a depth of 3-feet during drilling.
Wet and Caved at 3-feet upon completion.

SURFACE ELEVATION: N/A

SOIL SYMBOL	DEPTH (FT)	SAMPLE NUMBER	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: TONS/SQ FT Qc: TONS/SQ FT	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
												ASPHALT, approximately 4-inches.
	1											**BASE MATERIAL**, approximately 12-inches.
	2	SS S-1		N= 17	14							**POORLY GRADED SAND WITH SILT**, moist, brown, with shell, medium.
	3	SS S-2		N= 16	24						7	Same as above.
	4											
	5	SS S-3		N= 10	25							Same as above.
												Boring was terminated at a depth of 5.5-feet.

N - STANDARD PENETRATION TEST RESISTANCE
Qc - STATIC CONE PENETROMETER TEST INDEX
P - POCKET PENETROMETER RESISTANCE

REMARKS:
Boring depth and location were determined by Mott MacDonald and RETL. Drilling Operations were performed by RETL at GPS Coordinates N 28.05753° W 97.03406°

LOG OF BORING B-10

Rock Engineering & Testing Laboratory Inc.
6817 Leopard Street
Corpus Christi, TX
Telephone: 3618834555
Fax: 3618834711

CLIENT: Mott MacDonald, LLC
PROJECT: Fulton Beach Road Replacement
LOCATION: Rockport, Texas
NUMBER: G119161

DATE(S) DRILLED: 4/30/19 - 4/30/19

DRILLING METHOD(S):
Solid Flight Auger

GROUNDWATER INFORMATION:
Groundwater (GW) was encountered at a depth of 2.5-feet during drilling.
Wet and Caved at 2.5-feet upon completion.

SURFACE ELEVATION: N/A

SOIL SYMBOL	DEPTH (FT)	SAMPLE NUMBER	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: TONS/SQ FT Qc: TONS/SQ FT	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
												ASPHALT, approximately 6-inches.
	1											**BASE MATERIAL**, approximately 9-inches.
	2	SS S-1	X	N= 16	17							**POORLY GRADED SAND**, moist, brown, with shell, medium.
	3	SS S-2	X	N= 5	20							**CLAYEY SAND**, moist, brown, loose.
	4–5	SS S-3	X	N= 7	25						4	**POORLY GRADED SAND**, moist, brown, with shell, loose.

Boring was terminated at a depth of 5.5-feet.

N - STANDARD PENETRATION TEST RESISTANCE
Qc - STATIC CONE PENETROMETER TEST INDEX
P - POCKET PENETROMETER RESISTANCE

REMARKS:
Boring depth and location were determined by Mott MacDonald and RETL. Drilling Operations were performed by RETL at GPS Coordinates N 28.05827° W 97.03409°

LOG OF BORING B-11

Rock Engineering & Testing Labratory Inc.
6817 Leopard Street
Corpus Christi, TX
Telephone: 3618834555
Fax: 3618834711

CLIENT: Mott MacDonald, LLC
PROJECT: Fulton Beach Road Replacement
LOCATION: Rockport, Texas
NUMBER: G119161

DATE(S) DRILLED: 4/30/19 - 4/30/19

DRILLING METHOD(S):
Solid Flight Auger

GROUNDWATER INFORMATION:
Groundwater (GW) was encountered at a depth of 3.5-feet during drilling.
Wet and Caved at 3.5-feet upon completion.

SURFACE ELEVATION: N/A

SOIL SYMBOL	DEPTH (FT)	SAMPLE NUMBER	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: TONS/SQ FT Qc: TONS/SQ FT	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
												ASPHALT, approximately 3.75-inches.
	1											**BASE MATERIAL**, approximately 14.25-inches.
	2	SS S-1		N= 29	11						12	**POORLY GRADED SAND WITH SILT**, moist, light brown, with shell, medium.
	3	SS S-2		N= 13	▼ 23							Same as above.
	4–5	SS S-3		N= 12	21							Same as above.
												Boring was terminated at a depth of 5.5-feet.

N - STANDARD PENETRATION TEST RESISTANCE
Qc - STATIC CONE PENETROMETER TEST INDEX
P - POCKET PENETROMETER RESISTANCE

REMARKS:
Boring depth and location were determined by Mott MacDonald and RETL. Drilling Operations were performed by RETL at GPS Coordinates N 28.05905° W 97.03427°

Engineering & Testing
Laboratory, Inc.

Rock Engineering & Testing Laboratory
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KEY TO SOIL CLASSIFICATION AND SYMBOLS

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS		SYMBOL	NAME
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	Well Graded Gravels or Gravel-Sand mixtures, little or no fines
		GP	Poorly Graded Gravels or Gravel-Sand mixtures, little or no fines
		GM	Silty Gravels, Gravel-Sand-Silt mixtures
		GC	Clayey Gravels, Gravel-Sand-Clay Mixtures
	SAND AND SANDY SOILS	SW	Well Graded Sands or Gravelly Sands, little or no fines
		SP	Poorly Graded Sands or Gravelly Sands, little or no fines
		SM	Silty Sands, Sand-Silt Mixtures
		SC	Clayey Sands, Sand-Clay mixtures
FINE GRAINED SOILS	SILTS AND CLAYS LL < 50	ML	Inorganic Silts and very fine Sands, Rock Flour, Silty or Clayey fine Sands or Clayey Silts
		CL	Inorganic Clays of low to medium plasticity, Gravelly Clays, Sandy Clays, Silty Clays, Lean Clays
		OL	Organic Silts and Organic Silt-Clays of low plasticity
	SILTS AND CLAYS LL > 50	MH	Inorganic Silts, Micaceous or Diatomaceous fine Sandy or Silty soils, Elastic Silts
		CH	Inorganic Clays of high plasticity, Fat Clays
		OH	Organic Clays of medium to high plasticity, Organic Silts
HIGHLY ORGANIC SOILS		PT	Peat and other Highly Organic soils

TERMS CHARACTERIZING SOIL STRUCTURE

SLICKENSIDED - having inclined planes of weakness that are slick and glossy in appearance

FISSURED - containing shrinkage cracks, frequently filled with fine sand or silt; usually more or less vertical

LAMINATED (VARVED) - composed of thin layers of varying color and texture, usually grading from sand or silt at the bottom to clay at the top

CRUMBLY - cohesive soils which break into small blocks or crumbs on drying

CALCAREOUS - containing appreciable quantities of calcium carbonate, generally nodular

WELL GRADED - having wide range in grain sizes and substantial amounts of all intermediate particle sizes

POORLY GRADED - predominantly of one grain size uniformly graded) or having a range of sizes with some intermediate size missing (gap or skip graded)

SYMBOLS FOR TEST DATA

- ▽ — Groundwater Level (Initial Reading)
- ▼ — Groundwater Level (Final Reading)
- ■ — Shelby Tube Sample
- ⊠ — SPT Samples
- — Auger Sample
- — Rock Core

TERMS DESCRIBING CONSISTENCY OF SOIL

COARSE GRAINED SOILS		FINE GRAINED SOILS		
DESCRIPTIVE TERM	NO. BLOWS/FT. STANDARD PEN. TEST	DESCRIPTIVE TERM	NO. BLOWS/FT. STANDARD PEN. TEST	UNCONFINED COMPRESSION TONS PER SQ. FT.
Very Loose	0 - 4	Very Soft	< 2	< 0.25
Loose	4 - 10	Soft	2 - 4	0.25 - 0.50
Medium	10 - 30	Firm	4 - 8	0.50 - 1.00
Dense	30 - 50	Stiff	8 - 15	1.00 - 2.00
Very Dense	over 50	Very Stiff	15 - 30	2.00 - 4.00
		Hard	over 30	over 4.00

Field Classification for "Consistency" is determined with a 0.25" diameter penetrometer

Appendix C – Seagrass Survey

NAISMITH MARINE SERVICES, INC.
now a part of TBS T. BAKER SMITH A CENTURY OF SOLUTIONS

2007 FM 3036
Rockport, Texas 78382
361.334.5719 (P) 1.866.357.1050 (TF)
www.tbsmith.com

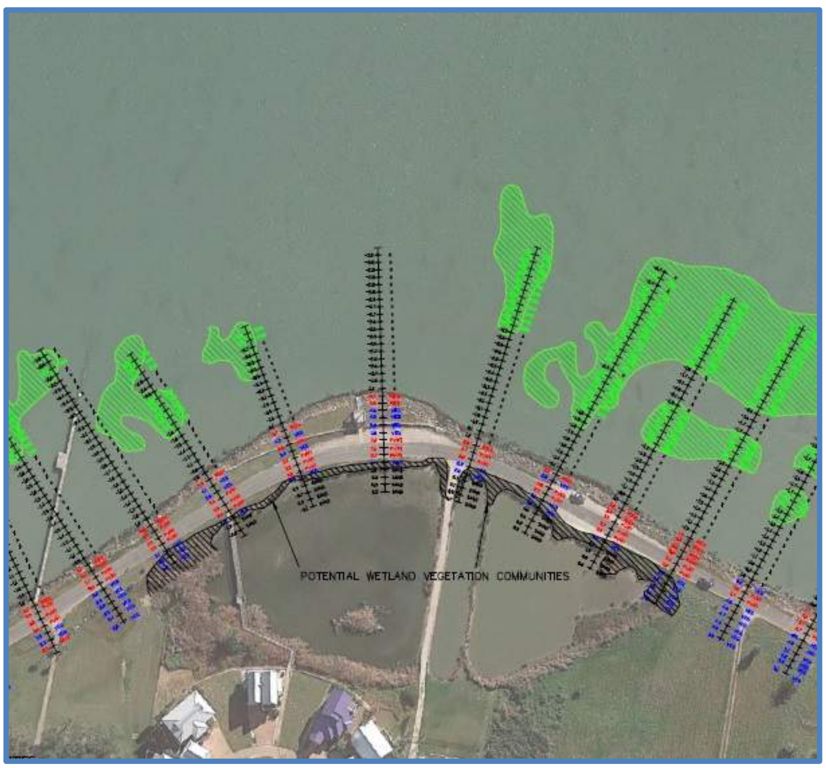
August 1, 2020

Report of Findings

Seagrass & Oyster Wading Survey & Wetland Habitat Mapping

Fulton Beach Road

Aransas County, Texas



Introduction
At the request of Mott Macdonald, Naismith Marine (Naismith) has prepared this report of findings for a seagrass and oyster wading survey and potential wetland habitat mapping effort for a portion of Aransas Bay adjacent to Fulton Beach Road in Aransas County, Texas. The survey area was approximately 101 acres in size and extended from a line parallel to and 30ft landward of Fulton Beach Road to 350 ft from the approximate Mean High Water (MHW) line on the Fulton Beach Road shoreline. The seagrass survey was conducted June 26 to July 13, 2020.

Methods
Transects were setup within the project area perpendicular to the general length of the shoreline at 100 ft spacing. Transects were sampled from the shoreline to a distance of approximately 350ft from the shoreline.

Sample points were established at 10 ft intervals along each transect line. Field personnel navigated along transect lines by wading with RTK GPS (Hemisphere S320). At each sample location the presence or absence of seagrass, live oysters, shell hash and fragments and other substrate types were recorded.

Landward of the MHW line, all areas between the MHW line and a line parallel to and 30ft from the landward edge of pavement on Fulton Beach Road were inspected for the presence of potential wetland areas. Areas exhibiting a dominance of hydrophytic vegetation were delineated using GPS-RTK as "potential wetland vegetation communities". Soil and hydrology indicators were not assessed within these areas and as such, this effort does not meet the criteria necessary for completion of a formal wetland delineation.

Findings
Seagrass was present in 662 samples out of 4,621 total samples taken within the survey area. This equates to approximately 14.3% coverage of seagrass beds within the areas surveyed. Live oysters were present at none of the samples taken (0% coverage), shell hash and fragments were present at 6 out of the samples taken (0.1% coverage) and bare substrate was present at 3,083 of the samples taken (66.7% coverage). Table 1 shows the total sample points containing each type of substrate encountered during the survey.

Table 1		
BARE SUBSTRATE	3,083	99.7%
LIVE OYSTER	0	0.0%
SHOALGRASS (*Halodule wrightii*)	662	14.3%
SHELL HASH/FRAGMENTS	6	0.1%
EMERGENT VEGETATION	482	10.4%
MAN-MADE STRUCTURE	377	8.2%
TOTAL SAMPLES	**4,621**	

Three discrete areas exhibiting a dominance of wetland vegetation were found within the survey area. Because the shoreline is comprised almost entirely of concrete rip-rap, no emergent wetland vegetation exists along the Aransas Bay side of Fulton Beach Road. The three potential wetland areas located on the landward side of Fulton Beach Road are impounded areas. The largest of these three areas may have hydrologic connection to Aransas Bay through culverts underneath Fulton Beach Road and appears to be tidally influenced. Vegetation in this area is dominated by black mangrove (*Avicennia germinans*, OBL), smooth cordgrass (*Spartina alterniflora*) and associated species. The other two smaller impoundments may be part of the road-side ditch system of Fulton Beach Road and are dominated by Olney's three-square bulrush (*Schoenoplectus americanus*, OBL), sandswamp white top (*Dichomena latifolia*, FACW) and associated species. These three areas are most likely subject to USACE section 404 jurisdiction.

Shoalgrass (*Halodule wrightii*) was the only seagrass species encountered during the survey. Figure 1 shows the sample point locations and bay bottom elevation at each sample point. Figure 1 also shows the location and boundaries of the three potential wetland vegetation communities delineated adjacent to Fulton Beach Road.

<u>Conclusions</u>

The results of this survey show that some of the bay bottom within the survey area has well-established seagrass beds. The south portion of the survey areas has very few seagrass beds, with seagrass bed number and density increasing towards the north end of the survey area. The density of seagrass beds along this shoreline appears to be correlated to the width of the shallow-water area adjacent to the Fulton Beach Road shoreline. At the southern extent of the survey area, bay bottom elevations become deeper more quickly so the areas of suitable elevation for seagrass growth are more exposed to wave and wind energy from Aransas Bay. Along the north portions of the survey area, bay bottom elevations are shallower further from the shoreline and as such, these seagrass beds are afforded more protection from the wave and wind energy of Aransas Bay.

No live oyster was found during the survey and the vast majority of the bay bottom within the survey area is comprised of sand.

The shoreline within the survey area is composed almost entirely of concrete rip-rap. Three, impounded potential wetland areas were located on the landward side of Fulton Beach Road. These areas are most likely subject to USACE section 404 jurisdiction. A formal wetland delineation would be necessary to determine whether these areas meet the U.S. Army Corps of Engineers criteria for wetlands.

Seth Gambill

Seth.Gambill@tbsmith.com

NOTES:
1) SEAGRASS SURVEY WAS PERFORMED BY NAISMITH MARINE SERVICES ON JUNE 26, 2020. TO JULY 13, 2020. TOPOGRAPHIC AND HYDROGRAPHIC CONDITIONS ARE SUBJECT TO CHANGE.
2) SEAGRASS POLYGONS DELINEATED USING POINT-SAMPLING DATA & SATELLITE IMAGERY AND WERE NOT DELINEATED IN THE FIELD
3) HORIZONTAL DATUM: NAD83, TEXAS SOUTH CENTRAL ZONE, US FEET.
4) VERTICAL DATUM: NAVD88 REFERENCE MONUMENT "877 4770 B"
N: 13,198,487.9'
E: 2,597,712.7'
ELEV: 3.9' NAVD 88

Naismith Marine Services, Inc.
now a part of TBS T. BAKER SMITH
2007 F.M. 3036
Rockport, Texas 78382
WWW.TBSMITH.COM
TBPLS #10110201

NO.	DATE	REVISION

MOTT MACDONALD
FULTON BEACH ROAD
SEAGRASS SURVEY
FULTON, TX

SCALE: 1"=500'
DWN. BY: WMP

SHEET 1 OF 6

DATE: JUNE 2020

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X – BARE SUBSTRATE
SHG – SHOALGRASS (HALODULE WRIGHTII)
– SHOALGRASS BEDS
VEG – EMERGENT UPLAND VEGETATION
SHLL – SHELL HASH
ROCK/PVMT/CONC/WALL/GRVL/PIER – MAN-MADE STRUCTURE

NOT ALL SURVEY POINTS ARE SHOWN FOR PURPOSE OF LEGIBILITY

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MOTT MACDONALD
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SEAGRASS SURVEY
FULTON, TX

SCALE: 1"=100'
DWN. BY: WMP
SHEET 2 OF 6
DATE: JUNE 2020

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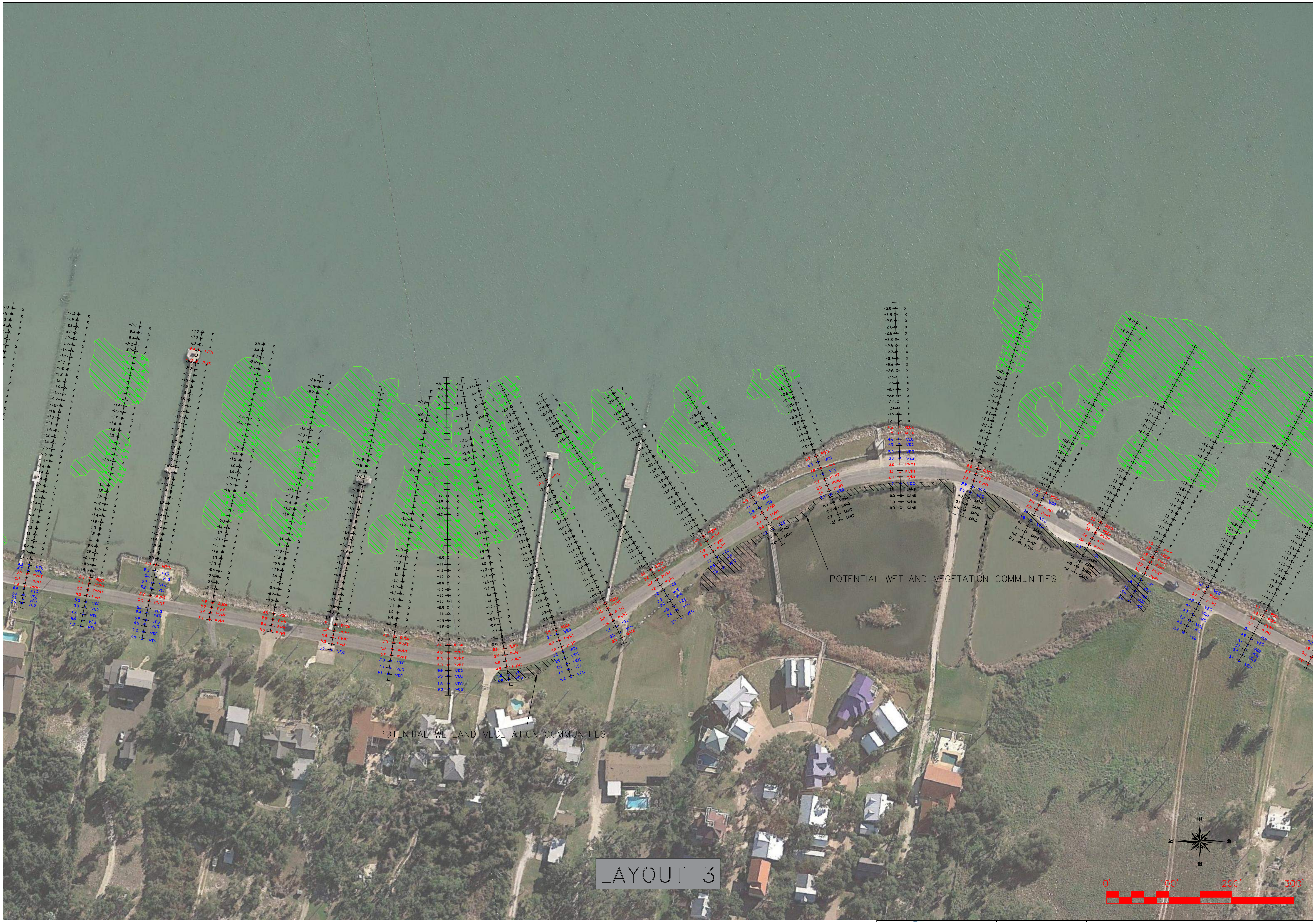
MOTT MACDONALD
FULTON BEACH ROAD
SEAGRASS SURVEY
FULTON, TX

SCALE: 1"=100'	SHEET 3 OF 6	DATE: JUNE 2020
DWN. BY: WMP		



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MOTT MACDONALD
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SEAGRASS SURVEY
FULTON, TX

SCALE: 1"=100'
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SHEET 4 OF 6
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SEAGRASS SURVEY
FULTON, TX

SCALE: 1"=100'
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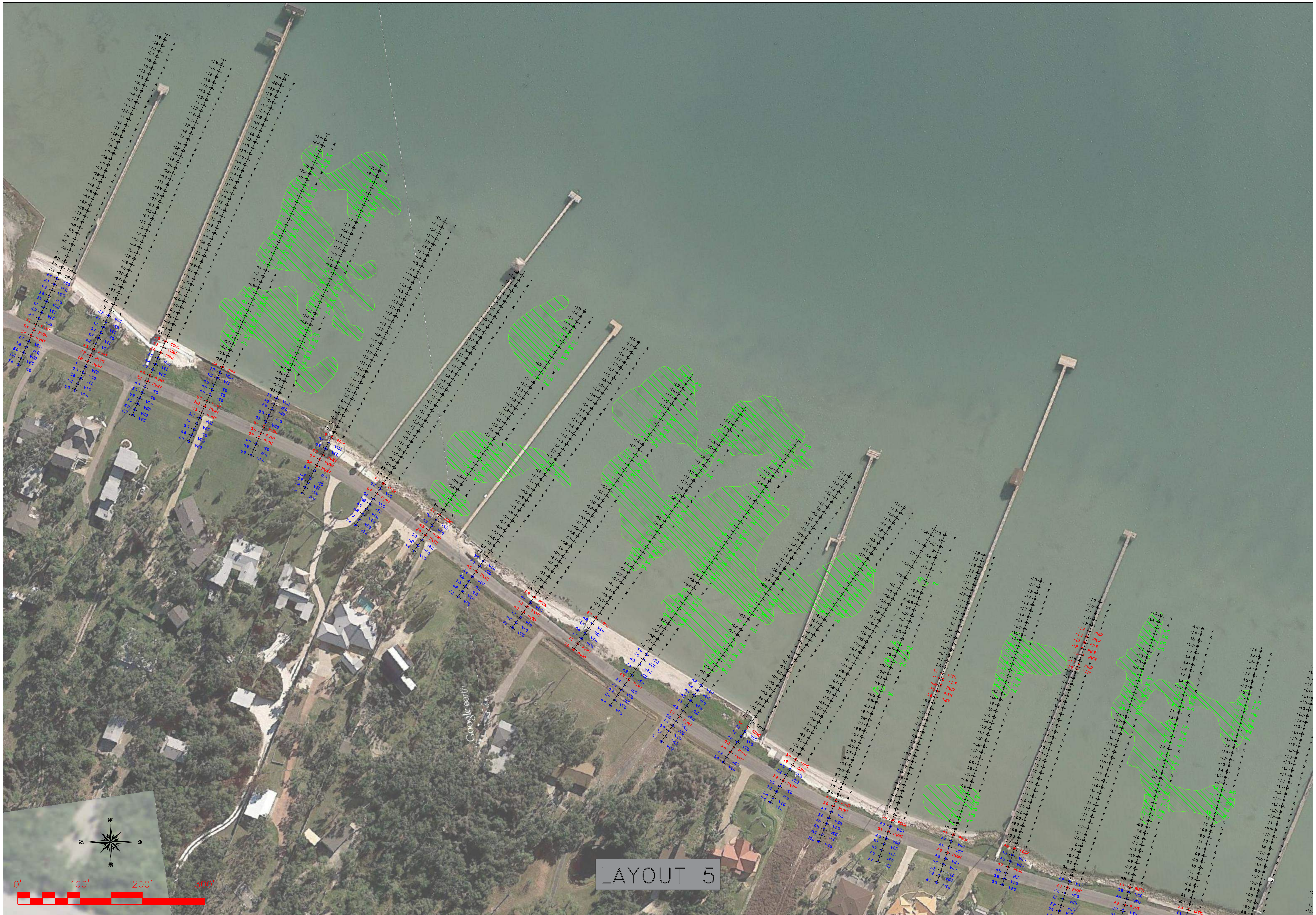
SHEET 5 OF 6
DATE: JUNE 2020



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SHEET 6 OF 6
DATE: JUNE 2020

Aransas County

Fulton Beach Road Living Shoreline Project

CMP Cycle 24

Project Photos

September 26, 2020— Fulton Beach Road, Facing North

September 26, 2020— Fulton Beach Road, Facing North

Fulton Beach Road, Facing North— September 26, 2020

Fulton Beach Road, Facing South— September 26, 2020