STATE OF NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION

PAT L. MCCRORY
GOVERNOR

NICHOLAS J. TENNYSON
SECRETARY

October 1, 2015

N.C. Division of Coastal Management
1367 US 17 South
Elizabeth City, NC 27909

ATTN: Mr. Greg Daisey
NCDOT Coordinator

Subject: **Request for Modification of the CAMA Major Development Permit for the Construction of Wavebreak Structure and Subsequent Study to Serve as Mitigation to Offset Potential Loss of SAV Habitat During Construction of the Replacement of Bridge No 11 over Oregon Inlet on NC 12 in Dare County. TIP No. B-2500 Phase I, Debit $475 from WBS Element 32635.1.3**

References: CAMA Permit No. 106-12 dated September 19, 2012

Dear Sir:

The North Carolina Department of Transportation requests modification to the above referenced permit, as the mitigation plan to offset potential impact(s) to Submerged Aquatic Vegetation (SAV) due to the replacement of Bridge 11 has been finalized.

The attached Phase I SAV Mitigation Plan proposes a 500-foot long wavebreak structure, engineered to attenuate wave energies and provide a suitable wave climate to promote SAV coverage. The mitigation site is located southwest of Bonner Bridge, on a stable shoal that has supported patchy seagrass cover since at least 2012.

Construction of the structure will occur from barges and equipment will not dredge or be dragged on the sound bottom. Impacts to the sound bottom will be limited to include the driving of piles, and the placement of the structure itself. The proposed, 500-foot long Reefmaker structure, is estimated to have a 0.06 ac (2,500 sq. ft.) benthic footprint.

It is anticipated that any SAV impacts during construction will be offset by relocation into the forecast wave shadow of the structure. An “as-built” report will be supplied to DCM after installation.

MAILING ADDRESS:
NC DEPARTMENT OF TRANSPORTATION
PROJECT DEVELOPMENT AND ENVIRONMENTAL ANALYSIS
1598 MAIL SERVICE CENTER
RALEIGH NC 27699-1598

TELEPHONE: 919-707-6100
FAX: 919-212-5785

WEBSITE: WWW.NCDOT.ORG

LOCATION:
1020 BIRCH RIDGE DRIVE
RALEIGH NC 27610-4328

Monitoring
Monitoring of the SAV mitigation site will be conducted for a period of up to 5 years following installation of the wavebreak structure, and will include monitoring of wave energy, seagrass, structure/hard surface, and sediment elevation. A detailed monitoring plan is in the Mitigation Plan.

Proposed Let Date
Construction of the structure may begin as soon as all permits are received.

Regulatory Approvals
CAMA: Request for modification of the existing CAMA permit is hereby made for the above-mentioned activities. Authorization to debit $475 from WBS 32635.1.3 is hereby given for the permit application fee.

Section 404 Permit: A request to the US Army Corps of Engineers for Section 404 approval will be sent under separate cover.

Section 401 Certification: A request to the NC Division of Water Resources for Section 401 approval will be sent under separate cover.

A copy of this request and its distribution list will be posted on the NCDOT Website at: https://connect.ncdot.gov/resources/Environmental. If you have any questions or need additional information, contact Michael Turchy at maturchy@ncdot.gov or 919 707-6157.

Sincerely,

for Richard W. Hancock, P.E., Manager
Project Development and Environmental Analysis Unit

cc: NCDOT Permit Application Standard Distribution List

DCM MP-1

APPLICATION for Major Development Permit

(last revised 12/27/06)

North Carolina DIVISION OF COASTAL MANAGEMENT

1. Primary Applicant/ Landowner Information

Business Name North Carolina Department of Transportation		Project Name (if applicable) B-2500 SAV Mitigation		
Applicant 1: First Name Richard	MI W	Last Name Hancock		
Applicant 2: First Name	MI	Last Name		
If additional applicants, please attach an additional page(s) with names listed.				
Mailing Address 1020 Birch Ridge Drive		PO Box	City Raleigh	State NC
ZIP 27610	Country US	Phone No. 919 - 707 - 6157 ext.	FAX No. - -	
Street Address *(if different from above)*		City	State	ZIP -
Email maturchy@ncdot.gov				

2. Agent/Contractor Information

Business Name N/A				
Agent/ Contractor 1: First Name	MI	Last Name		
Agent/ Contractor 2: First Name	MI	Last Name		
Mailing Address		PO Box	City	State
ZIP		Phone No. 1 - - ext.	Phone No. 2 - - ext.	
FAX No.		Contractor #		
Street Address *(if different from above)*		City	State	ZIP -
Email				

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3. Project Location

County (can be multiple)	Street Address		State Rd. #
Dare	Pamlico Sound: 35.75084041, -75.58649065		NC-12
Subdivision Name	**City**	**State**	**Zip**
N/A	Rodanthe	NC	n/a -

Phone No.	Lot No.(s) *(if many, attach additional page with list)*
N/A - - ext.	N/A, , , ,
a. In which NC river basin is the project located? Pasquotank	b. Name of body of water nearest to proposed project: Pamlico Sound
c. Is the water body identified in (b) above, natural or manmade? ☒Natural ☐Manmade ☐Unknown	d. Name the closest major water body to the proposed project site. Pamlico Sound
e. Is proposed work within city limits or planning jurisdiction? ☐Yes ☒No	f. If applicable, list the planning jurisdiction or city limit the proposed work falls within. N/A

4. Site Description

a. Total length of shoreline on the tract (ft.)	b. Size of entire tract (sq.ft.)
0	2,495,969 sq.ft or 57.3 acres
c. Size of individual lot(s) N/A, , , *(If many lot sizes, please attach additional page with a list)*	d. Approximate elevation of tract above NHW *(normal high water)* or NWL *(normal water level)* subtidal ☒NHW or ☐NWL

e. Vegetation on tract
Halodule wrightii, Zostera marina, Ruppia maritima

f. Man-made features and uses now on tract
No features currently on tract. Tract consists of open water within Pamlico Sound. Area is used for recreational purposes (boating, fishing).

g. Identify and describe the existing land uses adjacent to the proposed project site.
Recreational (Cape Hatteras National Seashore and Pea Island National Wildlife Refuge), open space, open water and commercial (marina).

h. How does local government zone the tract?	i. Is the proposed project consistent with the applicable zoning? (Attach zoning compliance certificate, if applicable)
Open water - Unzoned	☐Yes ☐No ☒NA

j. Is the proposed activity part of an urban waterfront redevelopment proposal? ☐Yes ☒No

k. Has a professional archaeological assessment been done for the tract? If yes, attach a copy. ☐Yes ☒No ☐NA

If yes, by whom?

l. Is the proposed project located in a National Registered Historic District or does it involve a National Register listed or eligible property? ☐Yes ☒No ☐NA

<Form continues on next page>

m. (i) Are there wetlands on the site?	☐Yes ☒No
(ii) Are there coastal wetlands on the site?	☐Yes ☒No
(iii) If yes to either (i) or (ii) above, has a delineation been conducted? *(Attach documentation, if available)*	☐Yes ☐No

n. Describe existing wastewater treatment facilities.

N/A

o. Describe existing drinking water supply source.

N/A

p. Describe existing storm water management or treatment systems.

N/A

5. Activities and Impacts

a. Will the project be for commercial, public, or private use? ☐Commercial ☒Public/Government ☐Private/Community

b. Give a brief description of purpose, use, and daily operations of the project when complete.

Wave attenuation using "reefmaker" wavebreak/sill to promote SAV growth. Site monitoring will include wave energy, SAV cover, epibiota on wavebreak, biological disturbance and sediment elevation. Monitoring will be conducted for five years following completion of the project.

c. Describe the proposed construction methodology, types of construction equipment to be used during construction, the number of each type of equipment and where it is to be stored.

Water based construction using one specialized shallow draft push barge with custom mini excavator and 8” spuds, two shallow draft barges, one landing craft barge with 360° active sonar and internal bilge system, and one standard jetfloat platform with expandable units. Equipment will be stored at 301 Harbor Road, Wanchese, NC 27981.

d. List all development activities you propose.

Relocate SAV from structure area to leeward side of wavebreak. Reefmaker precast molds will be set up at construction staging area located at 301 Harbor Road, Wanchese, NC 27981. Reefmaker units and fiberglass pilings will be loaded on barge and floated to site location with minimal bottom disturbance. Pilings will be jetted and vibrated into substrate and 750 ft of reefmaker units will be placed over and locked into pilings. Seagrasses will have predator excluder mesh installed. SAV, epibiota, water level and sediment will be montiored for five years.

e. Are the proposed activities maintenance of an existing project, new work, or both?	New work
f. What is the approximate total disturbed land area resulting from the proposed project?	2,500 ☒Sq.Ft or ☐Acres
g. Will the proposed project encroach on any public easement, public accessway or other area that the public has established use of?	☐Yes ☒No ☐NA

h. Describe location and type of existing and proposed discharges to waters of the state.

n/a

i. Will wastewater or stormwater be discharged into a wetland?	☐Yes ☒No ☐NA
If yes, will this discharged water be of the same salinity as the receiving water?	☐Yes ☐No ☐NA
j. Is there any mitigation proposed? If yes, attach a mitigation proposal.	☐Yes ☐No ☒NA

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6. Additional Information

In addition to this completed application form, (MP-1) the following items below, if applicable, must be submitted in order for the application package to be complete. Items (a) – (f) are always applicable to any major development application. Please consult the application instruction booklet on how to properly prepare the required items below.

a. A project narrative.

b. An accurate, dated work plat (including plan view and cross-sectional drawings) drawn to scale. Please give the present status of the proposed project. Is any portion already complete? If previously authorized work, clearly indicate on maps, plats, drawings to distinguish between work completed and proposed.

c. A site or location map that is sufficiently detailed to guide agency personnel unfamiliar with the area to the site.

d. A copy of the deed (with state application only) or other instrument under which the applicant claims title to the affected properties.

e. The appropriate application fee. Check or money order made payable to DENR.

f. A list of the names and complete addresses of the adjacent waterfront (riparian) landowners and signed return receipts as proof that such owners have received a copy of the application and plats by certified mail. Such landowners must be advised that they have 30 days in which to submit comments on the proposed project to the Division of Coastal Management.

Name N/A	Phone No.
Address	
Name	Phone No.
Address	
Name	Phone No.
Address	

g. A list of previous state or federal permits issued for work on the project tract. Include permit numbers, permittee, and issuing dates.

h. Signed consultant or agent authorization form, if applicable.

i. Wetland delineation, if necessary.

j. A signed AEC hazard notice for projects in oceanfront and inlet areas. *(Must be signed by property owner)*

k. A statement of compliance with the N.C. Environmental Policy Act (N.C.G.S. 113A 1-10), if necessary. If the project involves expenditure of public funds or use of public lands, attach a statement documenting compliance with the North Carolina Environmental Policy Act.

7. Certification and Permission to Enter on Land

I understand that any permit issued in response to this application will allow only the development described in the application. The project will be subject to the conditions and restrictions contained in the permit.

I certify that I am authorized to grant, and do in fact grant permission to representatives of state and federal review agencies to enter on the aforementioned lands in connection with evaluating information related to this permit application and follow-up monitoring of the project.

I further certify that the information provided in this application is truthful to the best of my knowledge.

Date 10-1-2015 Print Name RICHARD W. HANCOCK

for

Signature

Please indicate application attachments pertaining to your proposed project.

☐DCM MP-2 Excavation and Fill Information ☐DCM MP-5 Bridges and Culverts

☐DCM MP-3 Upland Development

☒DCM MP-4 Structures Information

Form DCM MP-4

STRUCTURES

(Construction within Public Trust Areas)

Attach this form to Joint Application for CAMA Major Permit, Form DCM MP-1. Be sure to complete all other sections of the Joint Application that relate to this proposed project. Please include all supplemental information.

1. DOCKING FACILITY/MARINA CHARACTERISTICS

☒*This section not applicable*

a. (i) Is the docking facility/marina:
☐Commercial ☐Public/Government ☐Private/Community

b. (i) Will the facility be open to the general public?
☐Yes ☐No

c. (i) Dock(s) and/or pier(s)
(ii) Number _____
(iii) Length _____
(iv) Width _____
(v) Floating ☐Yes ☐No

d. (i) Are Finger Piers included? ☐Yes ☐No
If yes:
(ii) Number _____
(iii) Length _____
(iv) Width _____
(v) Floating ☐Yes ☐No

e. (i) Are Platforms included? ☐Yes ☐No
If yes:
(ii) Number _____
(iii) Length _____
(iv) Width _____
(v) Floating ☐Yes ☐No
Note: Roofed areas are calculated from dripline dimensions.

f. (i) Are Boatlifts included? ☐Yes ☐No
If yes:
(ii) Number _____
(iii) Length _____
(iv) Width _____

g. (i) Number of slips proposed
_____
(ii) Number of slips existing
_____

h. Check all the types of services to be provided.
☐ Full service, including travel lift and/or rail, repair or maintenance service
☐ Dockage, fuel, and marine supplies
☐ Dockage ("wet slips") only, number of slips: _____
☐ Dry storage; number of boats: _____
☐ Boat ramp(s); number of boat ramps: _____
☐ Other, please describe:
_____

i. Check the proposed type of siting:
☐ Land cut and access channel
☐Open water; dredging for basin and/or channel
☐Open water; no dredging required
☐Other; please describe:
_____

j. Describe the typical boats to be served (e.g., open runabout, charter boats, sail boats, mixed types).
_____

k. Typical boat length: _____

l. (i) Will the facility be open to the general public?
☐Yes ☐No

m. (i) Will the facility have tie pilings?
☐Yes ☐No
(ii) If yes number of tie pilings?
_____

2. DOCKING FACILITY/MARINA OPERATIONS

☒ *This section not applicable*

a. Check each of the following sanitary facilities that will be included in the proposed project.

☐ Office Toilets

☐ Toilets for patrons; Number: _____; Location: _____

☐ Showers

☐ Boatholding tank pumpout; Give type and location: _____

b. Describe treatment type and disposal location for all sanitary wastewater.

c. Describe the disposal of solid waste, fish offal and trash.

d. How will overboard discharge of sewage from boats be controlled?

e. (i) Give the location and number of "No Sewage Discharge" signs proposed.

(ii) Give the location and number of "Pumpout Available" signs proposed.

f. Describe the special design, if applicable, for containing industrial type pollutants, such as paint, sandblasting waste and petroleum products.

g. Where will residue from vessel maintenance be disposed of?

h. Give the number of channel markers and "No Wake" signs proposed. _____

i. Give the location of fuel-handling facilities, and describe the safety measures planned to protect area water quality.

j. What will be the marina policy on overnight and live-aboard dockage?

k. Describe design measures that promote boat basin flushing?

l. If this project is an expansion of an existing marina, what types of services are currently provided?

m. Is the marina/docking facility proposed within a primary or secondary nursery area?

☐Yes ☐No

n. Is the marina/docking facility proposed within or adjacent to any shellfish harvesting area?
☐Yes ☐No

o. Is the marina/docking facility proposed within or adjacent to coastal wetlands/marsh (CW), submerged aquatic vegetation (SAV), shell bottom (SB), or other wetlands (WL)? If any boxes are checked, provide the number of square feet affected.
☐CW _____ ☐SAV _____ ☐SB _____
☐WL _____ ☐None

p. Is the proposed marina/docking facility located within or within close proximity to any shellfish leases? ☐Yes ☐No
If yes, give the name and address of the leaseholder(s), and give the proximity to the lease.

_____
_____

3. BOATHOUSE (including covered lifts) ☒*This section not applicable*

a. (i) Is the boathouse structure(s):
☐Commercial ☐Public/Government ☐Private/Community
(ii) Number _____
(iii) Length _____
(iv) Width _____
Note: Roofed areas are calculated from dripline dimensions.

4. GROIN (e.g., wood, sheetpile, etc. If a rock groin, use MP-2, Excavation and Fill.) ☒*This section not applicable*

a. (i) Number _____
(ii) Length _____
(iii) Width _____

5. BREAKWATER (e.g., wood, sheetpile, etc.) ☐*This section not applicable*

a. Length 500 ft

b. Average distance from NHW, NWL, or wetlands
N/A

c. Maximum distance beyond NHW, NWL or wetlands
N/A

6. MOORING PILINGS and BUOYS ☒*This section not applicable*

a. Is the structure(s):
☐Commercial ☐Public/Government ☐Private/Community

b. Number _____

c. Distance to be placed beyond shoreline _____
Note: This should be measured from marsh edge, if present.

d. Description of buoy (color, inscription, size, anchor, etc.)

_____
_____
_____
_____

e. Arc of the swing _____

7. GENERAL

a. Proximity of structure(s) to adjacent riparian property lines
0.93 mile

Note: For buoy or mooring piling, use arc of swing including length of vessel.

b. Proximity of structure(s) to adjacent docking facilities.
4 miles

c. Width of water body
11.5 miles

d. Water depth at waterward end of structure at NLW or NWL
1-3 ft

e. (i) Will navigational aids be required as a result of the project?
☒Yes ☐No ☐NA
(ii) If yes, explain what type and how they will be implemented.
To be determined by USCG.

8. OTHER

☐*This section not applicable*

a. Give complete description:
See SAV mitigation plan and permit modification narrative.

October 1, 2015
Date

B-2500 SAV Wavebreak Mitigation Structure
Project Name

North Carolina Department of Transportation
Applicant Name

for Richard W. Hancock
Applicant Signature

STIP B-2500

BONNER BRIDGE

PHASE I SAV MITIGATION PLAN

PAMLICO SOUND, OREGON INLET

DARE COUNTY

NORTH CAROLINA

September 2015

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1.0 INTRODUCTION & BACKGROUND

The Herbert C. Bonner Bridge is reaching the end of its service life and needs to be replaced. The Bonner Bridge provides the only highway connection for Hatteras Island to the mainland in Dare County, North Carolina via NC 12 and US 64 (**Appendix A, Figure 1)**. The Bonner Bridge will be replaced with a new bridge that will provide access to Hatteras Island across Oregon Inlet. The bridge replacement project is known as State Transportation Improvement Project (STIP) B-2500, replace bridge 270011 (Herbert C. Bonner Bridge) over Oregon Inlet, NC Improvements. In 2012 CSA Ocean Sciences, Inc. was contracted by the North Carolina Department of Transportation (NCDOT) to conduct seagrass mitigation to compensate for losses anticipated to occur during the replacement of the Bonner Bridge over Oregon Inlet (Fonseca, 2015). This project is part of a larger long-term effort to determine the best strategy and methodology for seagrass or submerged aquatic vegetation (SAV) restoration and mitigation in North Carolina.

Submerged aquatic vegetation helps stabilize coastal shorelines through rhizome binding of sediment in shallow nearshore regions, suspended sediment trapping, and wave and current attenuation. SAV distribution is driven by water depth, light penetration, nutrient loading, salinity, exposure to waves and currents, biological disturbance and fishing practices, and in particular, vulnerability to extreme storm events. Because SAV have stabilizing effects on the coastlines around the areas they inhabit, substantive changes in the SAV community will strongly shape the physical integrity of the coastline. Also, because SAV provides critically important food and shelter for fisheries, changes in SAV will affect the fisheries of the future (NCCOS, 2012).

Replacement of the Bonner Bridge will permanently impact approximately 2.66 acres of SAV areas for which mitigation will be required. Mitigation measures will include removal of the existing bridge that will unshade 1.38 acres of suitable habitat, and the remaining 1.28 acres will be mitigated near the project area at the SAV mitigation site described in this plan. This 17-acre mitigation site will generate 1.3 acres of lift in SAV cover coupled with an additional 0.3 acres of hard surface habitat suitable for colonization by algae, oysters and other sessile communities.

1.1 PROJECT OBJECTIVE

The objective of this mitigation project is to reduce the amount of wave energy within the project site to allow for a more continuous cover of SAV (specifically the seagrasses *Halodule wrightii* and *Zostera marina*) to expand, providing increased seagrass acreage and associated ecosystem services. These services include water quality improvement, aquatic habitat creation, reduced sediment movement and plant community establishment. The wave break proposed in this mitigation plan will also create new linkages between intertidal and aquatic environments.

1.2 EXISTING CONDITIONS

The mitigation site (Site S2) is located immediately west of the existing Bonner Bridge (**Appendix A, Figure 2**), and was selected as the preferred site following an April 28, 2015 field verification. It is located on a stable shoal that has supported patchy seagrass cover since at least 1998. During the April 28, 2015 field verification, a point-intercept survey was conducted at sites S2, S2A and S4 to determine the beginning and end point of seagrass along each transect and ultimately the SAV percent cover. Site S2 demonstrated a modest seasonal fluctuation in seagrass cover, increasing 15 percent since the previous survey conducted in 2012, but only to 26 percent cumulative cover (**Table 1**). Site S2A was rejected because of an emerging clay lens observed in the potential planting area (SAV does not grow well in clay). Site S2 was selected

over Site S4 because of the potential for more change in seagrass cover with gap closure among the existing patches.

Table 1. Seagrass and elevation survey results

Site	Percent Cover (2015)	Percent Cover (2012)	Average Patch Size (2015) (ft^2)	Seafloor Elevation (ht. above MSL in ft)
Site S2	26	11	26.9	-1.48
Site S2A	3	7	31.2	-2.66
Site S4	54	53	84.6	-2.89

The proposed site will be staked and signed to demarcate the proposed structure location during the public notice period; additional signage will be posted at Oregon Inlet Fishing Center.

2.0 PROPOSED MITIGATION PLAN

This project is intended for mitigation for SAV impacts associated with Phase I of B-2500, the Bonner Bridge replacement project. A unique and proven engineered structure is proposed to attenuate wave energies and provide a suitable wave climate to promote SAV coverage. The wavebreak will be a permanent, 'living' structure.

The proposed structure is a 500-foot long wavebreak. The length was determined by iteratively adjusting the wall length and running wave and seagrass forecasting models (see below) on each successive wall length until an increase in seagrass cover meeting the mitigation acreage of 1.28 acres was achieved.

The nearest portion of the structure is approximately 900 feet east of the closest existing tidal channel and approximately 2,200 feet from the deepest portions of that channel. Given this distance and the observed stability of the shoal over time (Google Earth imagery; 2004, 2006, 2008, 2009, 2011, 2014 and recent NCDOT high resolution imagery 2012, 2015), this distance is judged to be adequate to avoid any influence of the channel.

The proposed design involves installing a continuous series of innovative wave attenuation structures, termed "EcoSystem Units", by Reefmaker (http://www.reefmaker.com/marine-ecosystems). Each wave attenuator "unit" is comprised of a stack of concrete molded trays set with natural rock material such as granite. These systems are designed to fully attenuate wave energy while still allowing for the exchange of water and the passage of organisms through and around the structure's individual components. Moreover, they are designed for use in high energy wave environments and to survive the passage of large storms such as hurricanes. The proposed structures are comprised of individual units that are four feet tall and approximately five feet wide (**Appendix B, Exhibits 1, 2, and 3)**. The benefits of this system include its ability to decrease the wave energy in the target location and to increase hard surface area serving as epibiota habitat while reducing the benthic footprint compared to other techniques.

The Reefmaker systems have a much smaller benthic footprint (25 square feet per unit) to reach the desired height and have less impact upon installation than a traditional rock wavebreak. A traditional rock wavebreak of similar size with 2:1 slopes would have a 10,000 square foot benthic footprint. The proposed, 500-foot long Reefmaker structure, is estimated to have a 2,500 square foot benthic footprint. The design of the Reefmaker "EcoSystem Units" also provides considerable surface area for oyster settlement and other biofauna (**Table 2**). Based on preliminary design it is anticipated that approximately two units will be submerged below the normal high water level.

Table 2. 500-foot Reefmaker structure surface area calculations

Wave Attenuator Units (vertical)	Surface Areas (sq. ft (ac))	Total Pilings/Units
2	11,413 (0.26)	101
2.5	14,696 (0.34)	101
3	17,978 (0.41)	101

The design and location of the wavebreak was developed by forecasting the wave conditions (Malhotra and Fonseca, 2007) and the associated change in seagrass cover that was expected to occur with the presence of the structure. The relationship of wave energy to predicted percent seagrass cover of the seafloor (Fonseca and Bell, 1998; re-fit with a yet more conservative regression model) was utilized to predict the percent seagrass cover of the seafloor with and without the wavebreak structure present. Change in seagrass cover by creation of the 500-foot wavebreak was based on the area of wave energy reduction ranging from 10 to 20 percent of ambient/normal wave energy. This range was judged to provide a conservative estimate of wave energy reduction over which to forecast seagrass cover while ensuring the target area (1.28 acres) would be met. **Figure 3 (Appendix A)** shows the forecast for wave energy reduction to 10 percent of the ambient/normal wave energy, creating a wave shadow of approximately 57.3 acres. The forecast increase in seagrass acreage for the 10 percent assessment in this shadow area is approximately 0.91 acres. **Figure 4 (Appendix A)** shows the forecast for wave energy reduction to 20 percent of the ambient/normal wave energy, creating a wave shadow of approximately 17.3 acres. The forecast increase in seagrass acreage for the 20 percent assessment in this shadow area is approximately 1.65 acres. The midpoint of the forecast change in seagrass cover in this 10 to 20 percent range of wave energy reduction is a net addition of 1.3 acres.

Construction of the wavebreak structure will impact some existing seagrass patches. These seagrass patches will be relocated to gaps among patches on the lee side of the wavebreak structure to potentially accelerate the anticipated gap closure among the seagrass patches. The effect of the relocation will be tracked as part of the monitoring survey. Specifically, prior to installation of the wavebreak, a point-intercept survey will be conducted within the footprint of the wall and construction access corridor (e.g., construction barge). Three parallel lines running the entire length of the structure and corridor will be surveyed by this method and the percent cover of seagrass computed to document the amount of seagrass moved. The performance of the relocated seagrass will be monitored separately from other surveys, but will employ the same methods.

In addition, the SAV environment within the vicinity of the existing Bonner Bridge will improve upon the bridge's removal in that shading to these habitats will be eliminated. The SAV habitat within the existing bridge location and the area of new bridge construction will be monitored as outlined in Section 4.0.

3.0 CONSTRUCTION IMPLEMENTATION AND METHODOLOGY

The construction of the Bonner Bridge seagrass mitigation wavebreak structure involves the following construction phases:

Phase 1 – Reefmaker Casting

- Setting up the casting molds
- Pouring concrete and creating the Reefmaker units at the land base staging site **(Figure 5 [Appendix A])** - 301 Harbor Road Wanchese, N.C. 27981)
- Concrete pouring and setting activities will remain in upland staging area

Phase 2 – Material Transport

- Materials including pilings, Reefmakers and hardware will be loaded onto the shallow draft barges and transferred to the site location from the land based staging area (**Table 3**)

Table 3. Types of vessels used during construction to minimize bottom disturbance

Vessel	Number of Each Vessel Type	Size (Ft.)	Draft (In.)	Specialized Equipment
Landing Craft Barge	1	42 X 13	8.0	• 360°sonar • Internal Bilge • Drill Hole • Lifting Device
Shallow Draft Barge	2	20 X 40	12.0	• Manual Positioning
Shallow Draft Barge	1	24 X 45	12.0	• Customized Mini Excavator with 42’ Extension Arm
Skiff	3	22 X 10	8.0	• Custom Jack Plates • Marine Tug Push Knee
Standard Jetfloat Platform	1	4 X 4	1.0 – 6.0	• Expandable Units

Phase 3 – Structure Installation

The 24 X 45 shallow draft barge with a 42-foot custom mini excavator will be used in conjunction with specialized 8.0-inch spuds to minimize benthic impacts (**Photos 1 and 2**). A separate expandable standard jetfloat platform will be erected and attached to the working shallow draft barge. Pilings will be jetted and vibrated to depths of 20 to 30 feet. The units will be systematically assembled using the mini excavator 42-foot arm. The Reefmaker unit hardware will be installed following placement. Due to the dynamics of Oregon Inlet, potential entanglement of aquatic species and issues concerning worker safety, turbidity curtains will not be used during construction.

Photo 1. Shallow Draft Barge

Photo 2. Customized Mini Excavator

NCDOT will install and maintain any signal lights and signals prescribed by the U.S. Coast Guard, through regulations or otherwise, on authorized facilities. NCDOT will submit a *Private Aids to Navigation Application* to the U.S. Coast Guard. The construction schedule is dependent on receipt of permits, procurement of contractors, and appropriate weather conditions.

SAV and Benthic Habitat minimization and avoidance measures

During material transport and construction extra caution will be taken not to disturb the bottom habitat. A specialized landing craft barge will be used during transport and construction phases to assist with supplies and emergency response (**Photo 3**). The barge will be equipped with 360° sonar and an internal bilge system that will be used to monitor water level depths to avoid any impact to existing SAV during construction.

Photo 3. Landing Craft Barge

Threatened and Endangered Species Protection

During construction all precautions will be taken and activities monitored not to impact Threatened and Endangered Species. Threatened and Endangered Species Protection measures are addressed in the original CAMA permit additional conditions sections 35 and 36. These conditions specify:

> 35) In accordance with commitments made by the permittee, the discretionary measures for the piping plover and three species of sea turtles that are described in the permit application that include the terms and conditions outlined in the July 10, 2008 United States Fish and Wildlife Service (USFWS) Biological and Conference Opinions shall be implemented.
>
> 36) In accordance with commitments made by the permittee, all conditions outlined in the USFWS Guidelines for Avoiding the West Indian Manatee: Precautionary Measures for Construction Activities in North Carolina Waters shall be implemented.

4.0 MONITORING

Various aspects of the proposed project will be monitored solely for purposes of identifying contributing factors affecting success of the SAV establishment, coalescence of existing patches, and overall persistence. These variables will be monitored through statistically robust design and sampling and documented in order to advance the science and improve the future of SAV mitigation success in North Carolina.

SAV Mitigation Site Monitoring

Mitigation site monitoring will be conducted for up to five years after installation of the wavebreak structure. The methodology for SAV restoration monitoring includes the following:

- *Wave Energy:* Pressure sensors will be deployed 25 meters in front of and 25 meters behind the wavebreak to validate wave simulation models. Sensors are cylindrical (approximately two inches in diameter by 10 inches long) and will be mounted horizontally on the seafloor approximately six inches above the substrate on an embedded (into the seafloor) solid base. These sensors will record wave characteristics. They will be set to record bursts of pressure data every 30 minutes at a sampling rate of 4 Hz for 128 seconds. These data will also provide water level and tide documentation. During times of onsite seagrass surveys, these sensors will be systematically but temporarily relocated across the site to provide a spatially articulated assessment of wave energy distribution with regard to prevailing conditions. These wave energy maps of the area around each wavebreak will be used to inform the seagrass survey and determine the onsite relationships between wave energy distribution and seagrass coverage response.

- *Seagrass:* Gap closure among seagrass patches and change in seagrass cover will be evaluated across wave energy regimes (to include at least 57 acres). Four wave energy regimes (treatments) will be defined by a required re-analysis of the wave energy distribution of the final wavebreak design and validation. The wave energy regimes will represent ambient (reference; < 10 percent forecast reduction), low reduction (10 to 33 percent forecast reduction), moderate reduction (34 to 66 percent forecast reduction) and high wave energy reduction (> 66 percent forecast reduction). The percent reduction regimes will be defined from a cumulative frequency analysis of the area covered by the

modeling effort where greater than 10 percent energy reduction was forecast to occur as the result of the wavebreak structure.

The effect of biological disturbance on seagrass, specifically gap closure will also be tested. Two bioturbation exclusion treatments will be utilized, one with and one without exclusionary wire mesh (removed after patch coalescence has occurred). Large gap (four to six inch) metal mesh will be laid flush on the seafloor and anchored with approximately one to two-foot long J-shaped rebar stakes. Seagrass shoots would extend through the large gaps allowing their continued growth and expansion (vis a vis "TERF" method http://seagrant.mit.edu/eelgrass/background/transplanting.html; F. Short, UNH). Flush deployment on the seafloor plus anchoring is performed to prevent entanglement by sea life, such as diving birds.

Randomly selected seagrass patches will constitute the individual (replicate) test units. To choose individual test units, a location will be randomly chosen in each forecast wave energy treatment area. The nearest seagrass patch to that location meeting two criteria will be selected as a test unit. The individual seagrass patch must first approximately match the average site patch size (+/- 1 standard deviation). The seagrass patch must also be separated from the next nearest patch by a minimum of the site average gap distance. Ten patches will be selected per wave energy treatment; five will be protected with wire mesh and five will be un-protected. The statistical approach for this experiment on the effect of waves and biological disturbance on patch expansion is a repeated measures two-way analysis of variance with wave energy and patch protection as main effects. The survey will end when patch coalescence begins; at this point the mesh and stakes will be removed and disposed of appropriately.

- *Structure/Hard Surface:* Epibiota on the structure will be monitored through the establishment of randomly-placed, permanent quadrats, stratified by either side of the wavebreak (exposed versus sheltered side) and by elevation on the structure (near seafloor, mid-tide, high-tide) for a total of six monitoring strata. Ten quadrats would be assigned per strata for a total of 60 quadrats. Epibiotic coverage will be evaluated annually using a repeated measures design. The quantification will be determined based on the epibiota that recruit, but is anticipated to include percent cover by community type visually identified to the lowest practicable taxonomy.

- *Sediment Elevation:* Digital elevation models will be created encompassing the full forecast extent of wave attenuation out to and including adjacent reference areas un-affected by the wavebreak to relate seagrass response not only to changes in wave climate but also to quantify any changes in sediment elevation. Sediment accumulation or loss can strongly affect seagrass coverage and thus is needed to provide explanatory capacity for seagrass performance. Because the wavebreak structure will be installed on a flat sand surface, little change in seafloor elevation is anticipated around the structure as the result of changes in wave energy. Wave refraction should be limited (i.e., no change in seafloor elevations) and effects should be limited primarily to wave diffraction. Any changes arising from the structure are anticipated to be minor and immediately adjacent to the wavebreak itself. The wavebreak is also installed at the seafloor surface to prevent sand scour under the structure.

The information obtained through the monitoring of this project will substantially increase the state of seagrass mitigation science by both quantifying the relationship between seagrass cover and

wave energy and by understanding the difference in the expansion rate of patches among armored and unarmored patches. Improving the quantification of wave and seagrass landscape cover will specifically inform future seagrass mitigation efforts using wave attenuation approaches. Similarly, understanding the relative impact of bioturbation versus waves on maintenance of seagrass landscapes will inform future mitigation efforts as to the degree (if any) of bioturbation exclusion needed to effect persistent coverage. Both aspects (waves and bioturbation) address important information gaps for North Carolina (and elsewhere) regarding the relative influence of waves and bioturbation on seagrass patchiness and have high intrinsic value.

Temporary SAV Impact Monitoring

NCDOT will provide an annual update on the SAV areas temporarily impacted by the bridge construction. This annual update will consist of photographs and a written report on the progress of the temporarily impacted areas in re-attaining their pre-project abundance. Within three years after project completion, NCDOT will hold an agency field meeting with DCM to assess if the SAV areas temporarily impacted by this project have re-attained pre-project abundance (distribution or coverage).

Existing Bridge SAV Habitat Monitoring

In addition to the proposed mitigation site, the aquatic area in the vicinity of the existing Bonner Bridge will be monitored upon removal of the bridge to assess whether and/or to what extent the effects of removing shade will be to SAV and their habitat.

5.0 REMEDIATION AND LONG-TERM MANAGEMENT

The wavebreak will be inspected for damage annually during the five year monitoring period. If monitoring data indicate that damage to the structure is having a negative effect on SAV coverage, then a remediation plan will be developed in coordination with DCM. In addition, the annual inspection will verify that the required signage and markings are present and visible.

6.0 MITIGATION SUMMARY

The implementation of this plan is proposed as mitigation for approximately 2.66 acres of impact from the B-2500 Bonner Bridge replacement project to existing SAV by creating and affecting the local marine environment in the vicinity of the bridge, as an attempt to make it more conducive to the establishment and enhancement of SAV. Table 4 includes a summary of the proposed mitigation and the estimated acreages of each component.

Table 4. Mitigation summary

Unshaded Area From Existing Bridge (ac)	SAV Increase (Uplift) Due to Wave Attenuation of 10 to 20% (ac)	Hard Surface Habitat Area (sq. ft (ac))	Wavebreak Shadow (ac)	Increase in Seagrass (lift in ac)
1.38	0.91 - 1.65	11,413 (0.3)	17 to 57	1.3

7.0 REFERENCES

Fonseca, Mark and Susan S. Bell. 1998. "Influence of Physical Setting on Seagrass Landscapes near Beaufort, North Carolina, USA." Marine Ecology-Progress Series. 171: 109-121.

Fonseca. 2015. Memo on 9 June, 2015 from Mark Fonseca to Kathy Herring at NCDOT RE: Bonner Bridge Seagrass Mitigation Project (State Project 32635.1.3; TIP B-2500) Task B (Site Verification) Letter Report.

Google Earth Imagery, 2004, 2006, 2008, 2009, 2011, 2014

Malhotra, A. and M.S. Fonseca. 2007. WEMo (Wave Exposure Model): Formulation, Procedures and Validation. NOAA Technical Memorandum NOS NCCOS #65. 28 pp. http://www.ccfhr.noaa.gov/docs/NOS_NCCOS_65.pdf

NCCOS. 2012. Habitats of coastal North Carolina.

NCDOT. 2012. High Resolution Aerial Photography.

NCDOT. 2015. High Resolution Aerial Photography.

NCDWQ 401 Water Quality Certification Pursuant to Section 401 of the Federal Clean Water Act with ADDITIONAL CONDITIONS for the Proposed Replacement of the Herbert C. Bonner Bridge over Oregon Inlet in Dare County, Federal Aid Project No. BRNHF-0012(48), TIP B-2500 (Phase I). NCDWQ Project No. 20120629. September 7, 2012.

Appendices

Appendix A: Figures

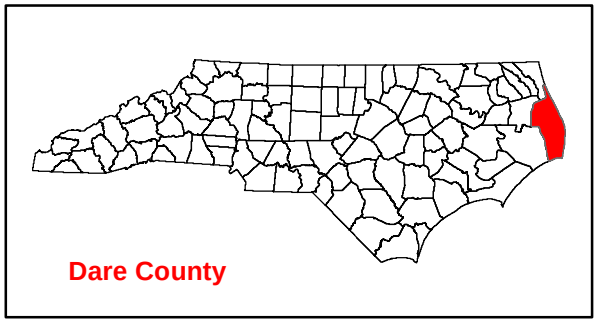
Figure 1. Project Vicinity

Figure 2. Project Location

Figure 3. Percent Change in Seagrass Cover for Representative Wave Energy Difference of 10% or Greater

Figure 4: Percent Change in Seagrass Cover for Representative Wave Energy Difference of 20% or Greater

Figure 5: Project Construction and Staging



SEPI ENGINEERING & CONSTRUCTION

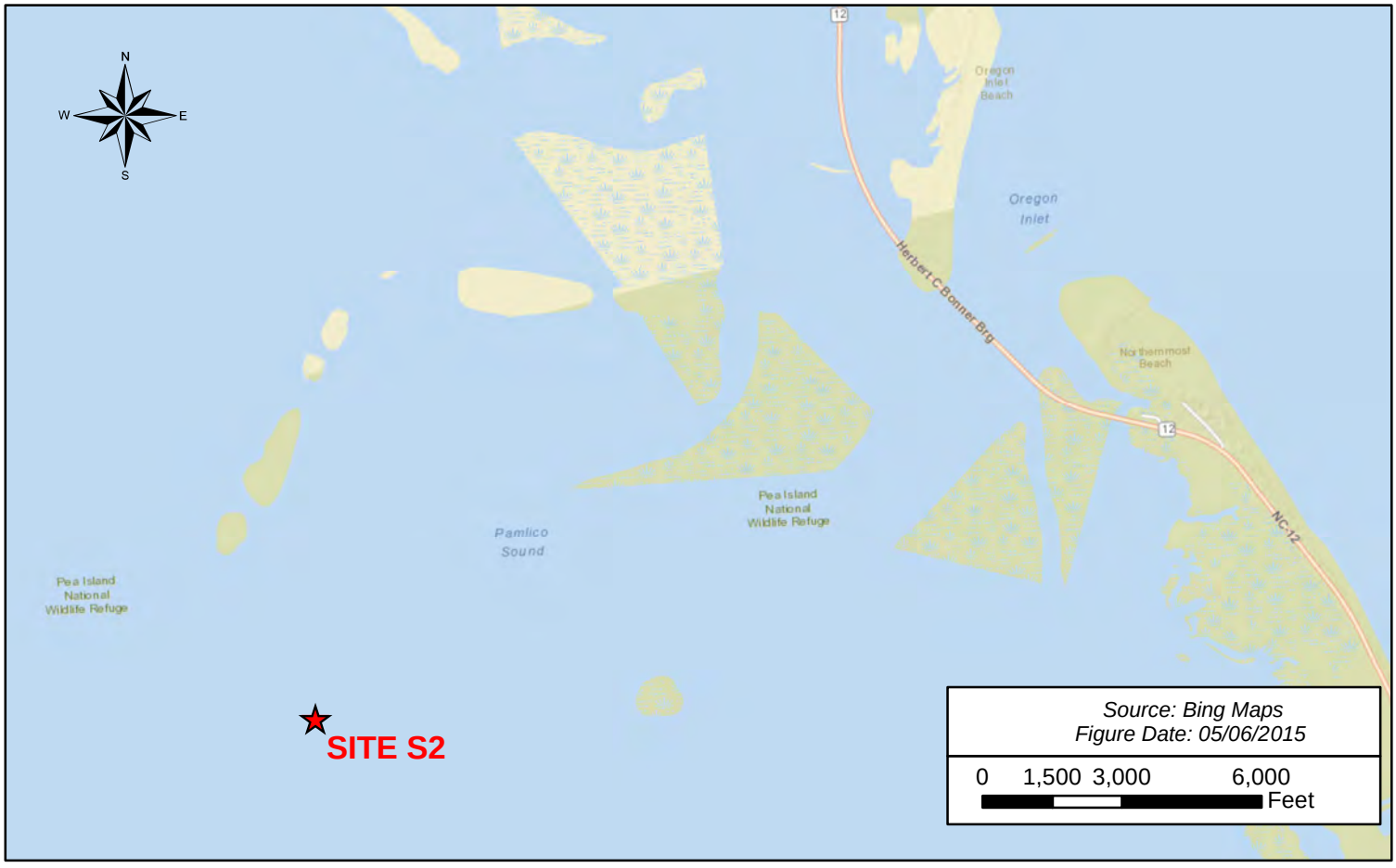
Figure 1:

Project Vicinity

STIP B-2500 BONNER BRIDGE SAV MITIGATION PLAN

DARE COUNTY - NORTH CAROLINA

SEPTEMBER 2015



This Exhibit is for planning purposes only and shown herein does not meet NC 47-30 Requirements and therefore is not for design, construction, or recording or transfer of title. The Exhibit was compiled from available information obtained from the sources listed below.

Sources:
ESRI Base Mapping, September 2015

1 inch = 4,000 feet

GRAPHIC SCALE

0 2,000 4,000 8,000 Feet

Figure 2: Project Location

STIP B-2500 BONNER BRIDGE
SAV MITIGATION PLAN

SEPI ENGINEERING & CONSTRUCTION

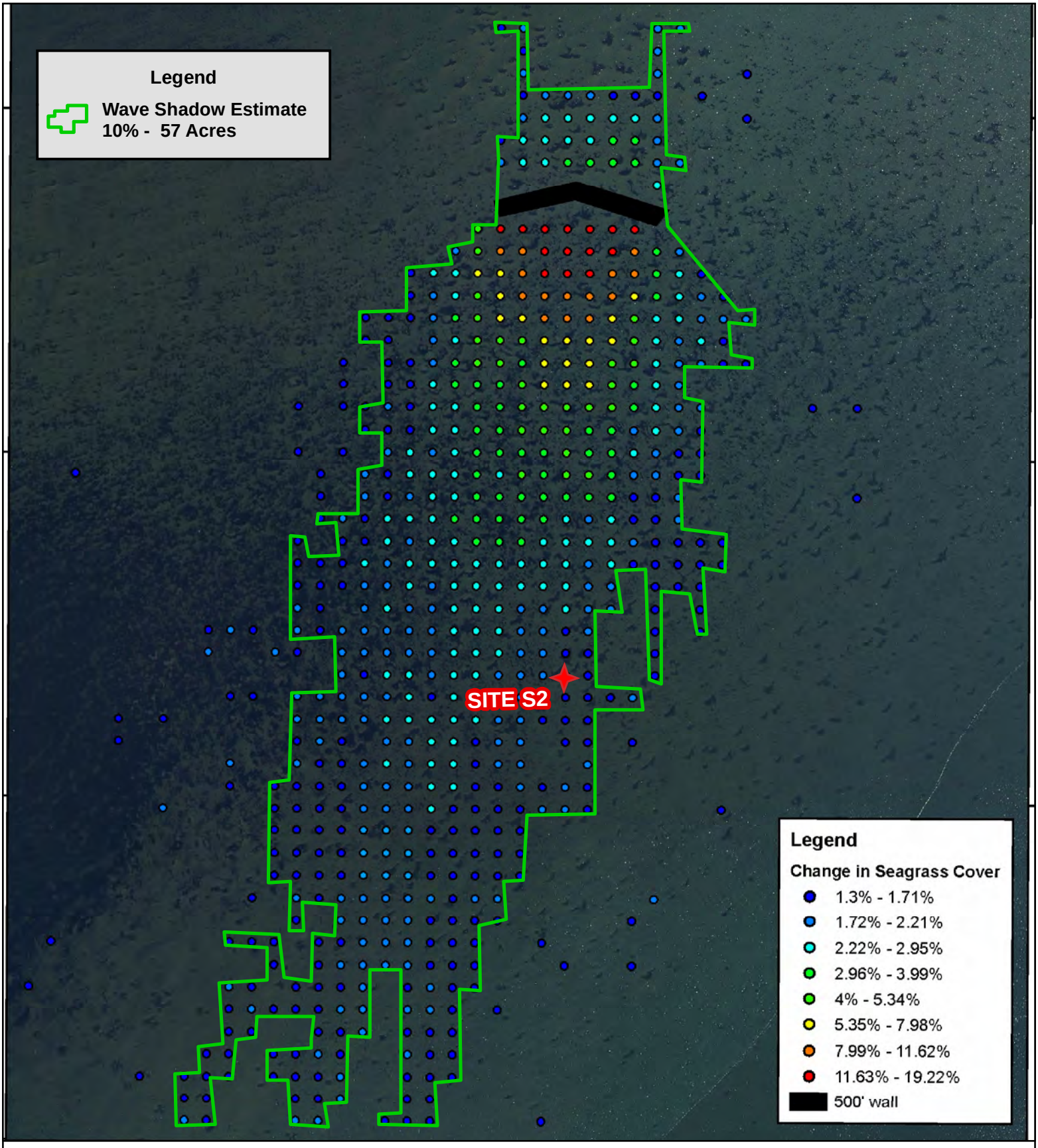


Figure 3: Percent Change in Seagrass Cover for Representative Wave Energy Difference of 10% or Greater

STIP B-2500 BONNER BRIDGE
SAV MITIGATION PLAN

CSA Ocean Sciences Inc.

1 inch = 390 feet

0 195 390 780 Feet

SEPI ENGINEERING & CONSTRUCTION

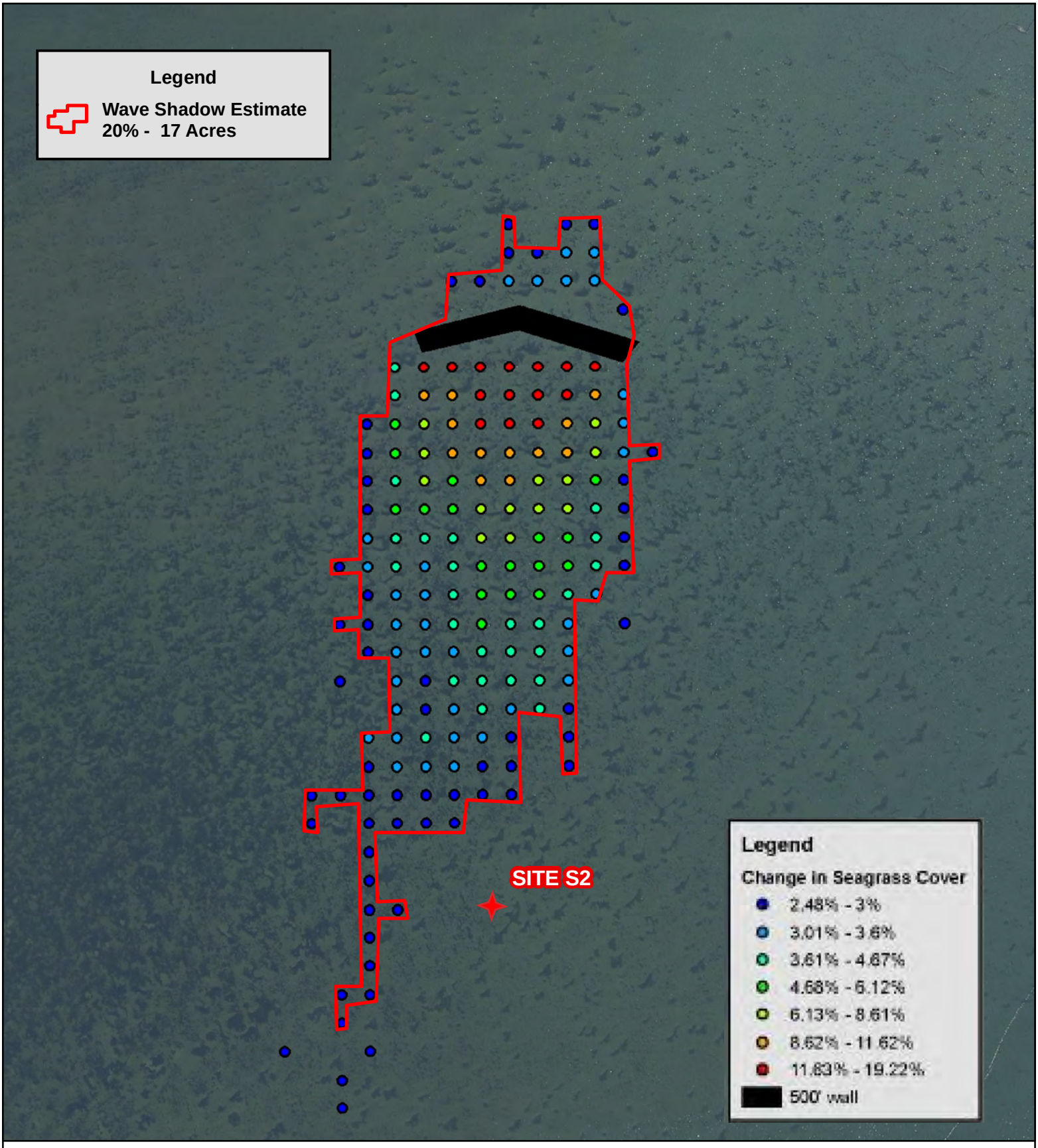


Figure 4: Percent Change in Seagrass Cover for Representative Wave Energy Difference of 20% or Greater

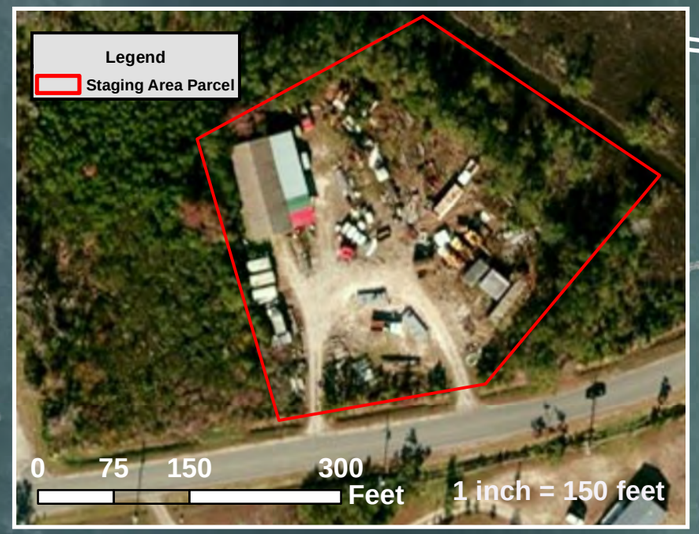
STIP B-2500 BONNER BRIDGE
SAV MITIGATION PLAN

CSA Ocean Sciences Inc.

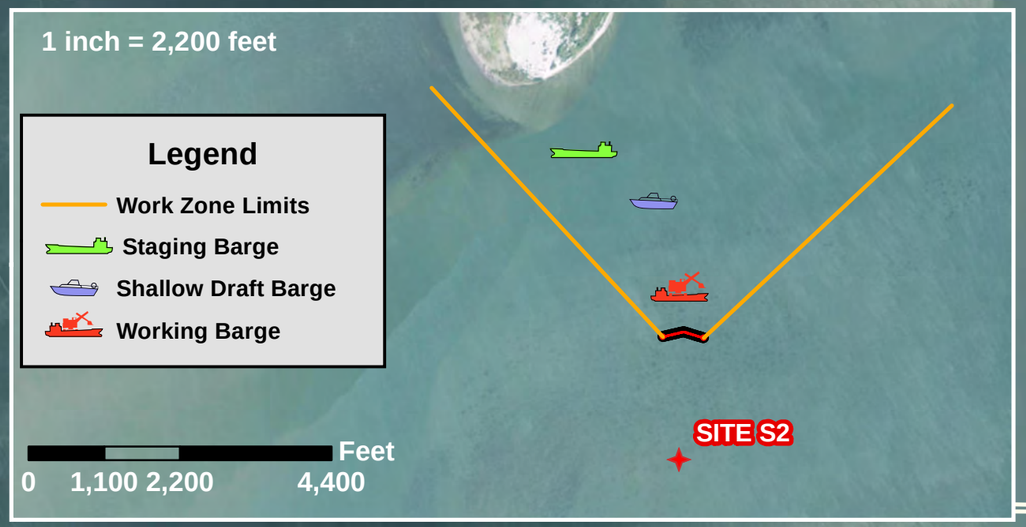
1 inch = 325 feet

0 162.5 325 650 Feet

SEPI ENGINEERING & CONSTRUCTION



STAGING AREA



SITE S2

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Sources:
Aerial and Topographic Mapping

1 inch = 4,000 feet

GRAPHIC SCALE

0 2,000 4,000 8,000 Feet

Figure 5: Project Construction and Staging

STIP B-2500 BONNER BRIDGE
SAV MITIGATION PLAN

SEPI ENGINEERING & CONSTRUCTION

Appendix B: Exhibits

Exhibit 1. Reefmaker “Ecosystem” Units Design – Front Elevation View

Exhibit 2. Reefmaker “Ecosystem” Units Design – Profile View

Exhibit 3. Reefmaker “Ecosystem” Units Design – Plan View

Exhibit 1. Reefmaker "Ecosytem" Units Design - Front Elevation View

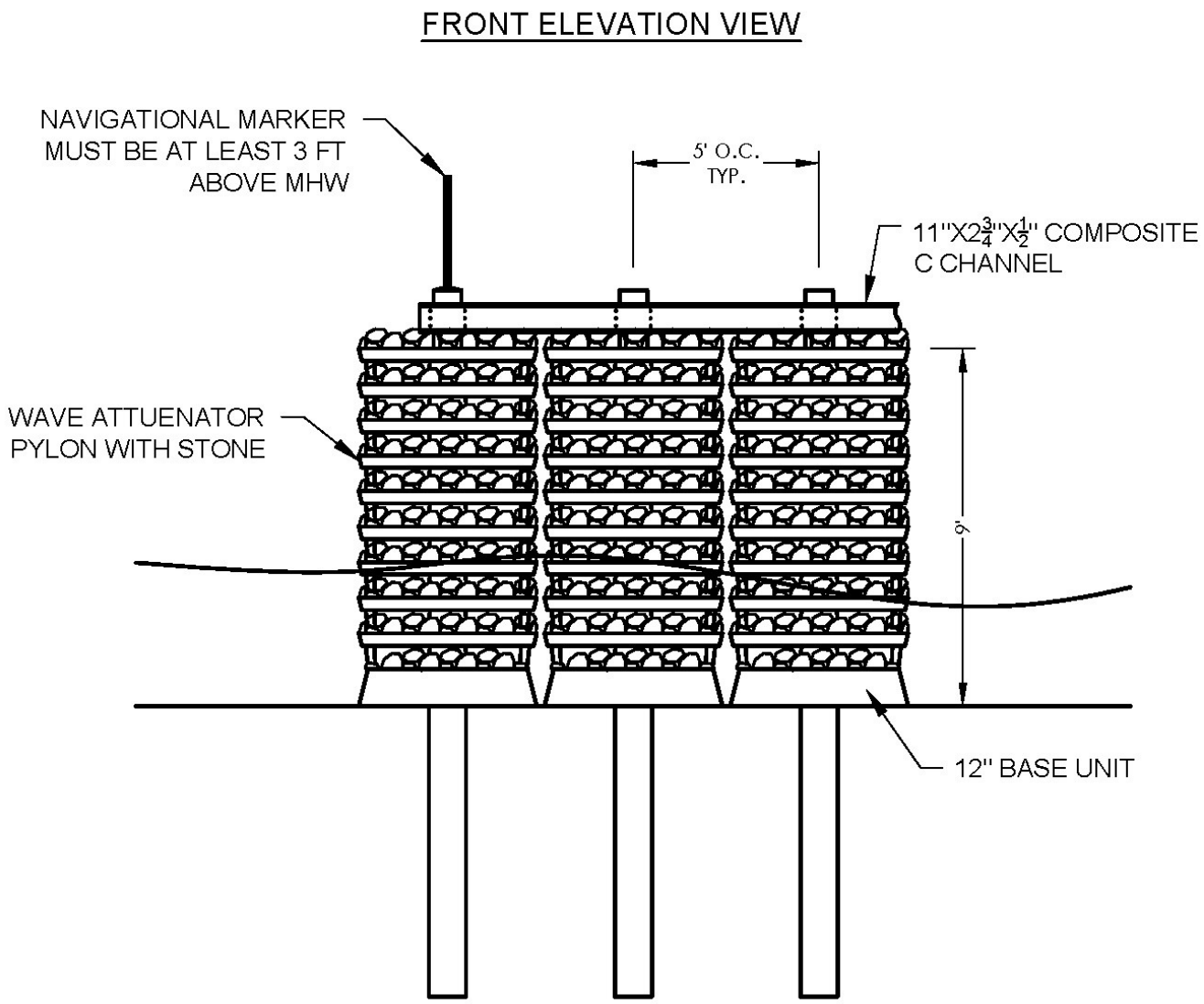

Exhibit 2. Reefmaker "Ecosystem" Units Design - Profile View

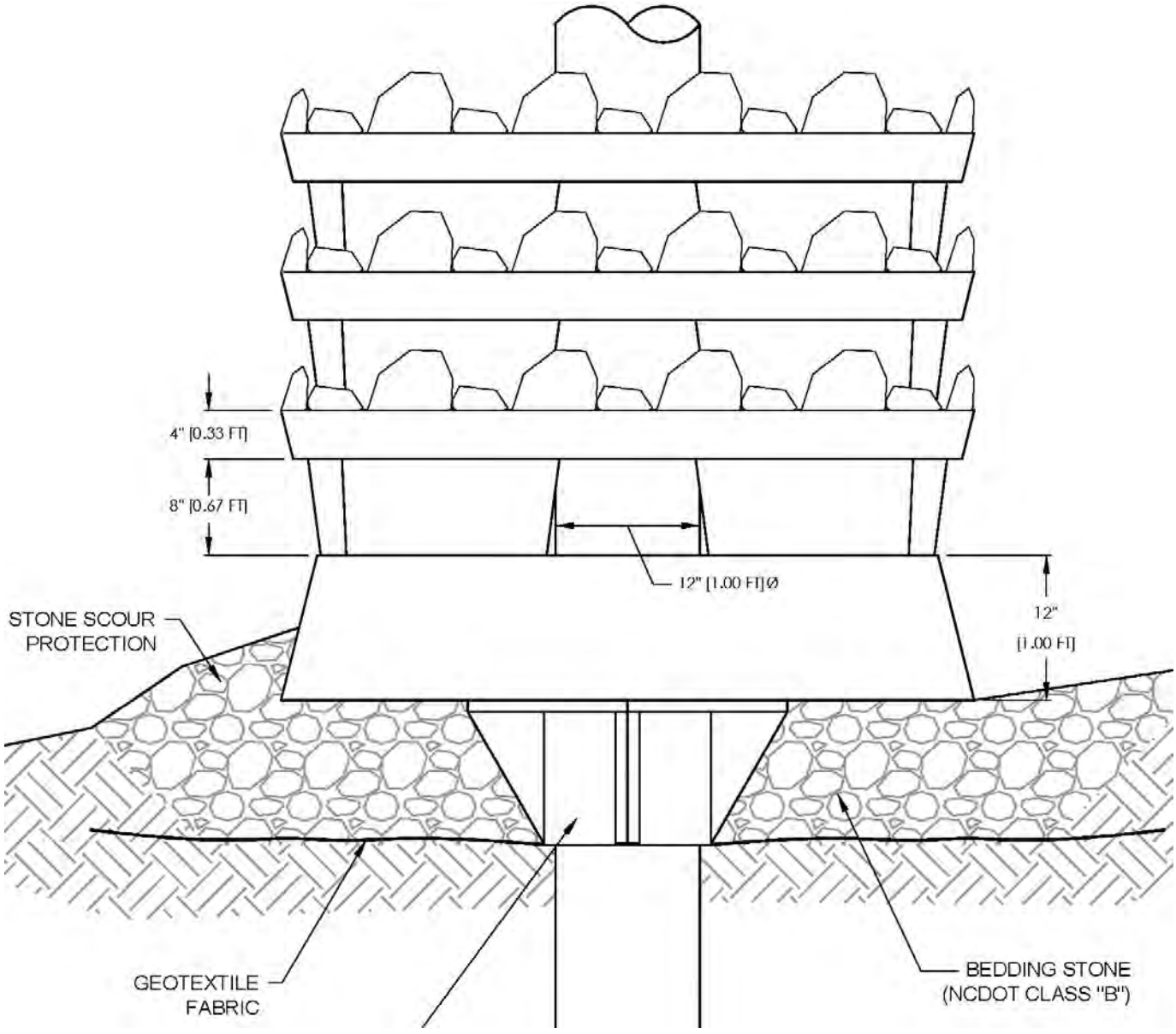

Exhibit 3. Reefmaker "Ecosystem" Units Design - Plan View