January 2016

Transplant Plan for San Ildefonso Corals-Update

Part of the Mitigation Plans for the

Impacts Associated to the Reconstruction of the Culebra Cargo Ferry Terminal in Sardinas Bay

Culebra, Puerto Rico

Prepared For:

Autoridad de los Puertos de Puerto Rico

Prepared By:

ATKINS

Contents

1.0 Introduction 2

2.0 Project Description 3

3.0 Methodology 4

3.1 Coral Removal 4

3.2 Relocation Site 6

4.0 Coral Monitoring 6

4.1 Monitoring frequency 6

4.2 Methodology 6

5.0 Performance Standard 7

6.0 Monitoring Reports 7

7.0 References 7

1.0 Introduction

The Puerto Rico Ports Authority (PRPA) conducted a structural evaluation at the Culebra Cargo Ferry Terminal on August, 2010, where advanced deterioration was observed in the deck slab and concrete beams, which has probably spread to the entire concrete surface. This appears to be a result of storm events, hurricanes and the wave action. Furthermore, if the repair and reconstruction of the cargo terminal is not conducted promptly, structural failure may occur.

As the only heavy commercial cargo transportation port in Culebra, the cargo ferry provides an essential service to the island-municipality residents. An alternatives analysis resulted in the proposed construction of an Auxiliary Cargo Terminal, while the existing cargo terminal is reconstructed. After evaluating potential sites for an Auxiliary Terminal, the San Ildefonso site in Ensenada Honda (***Figure 1***) was chosen for the limited environmental impacts involved, since no dredging is required, the landside is ample, has been previously developed, and has the required

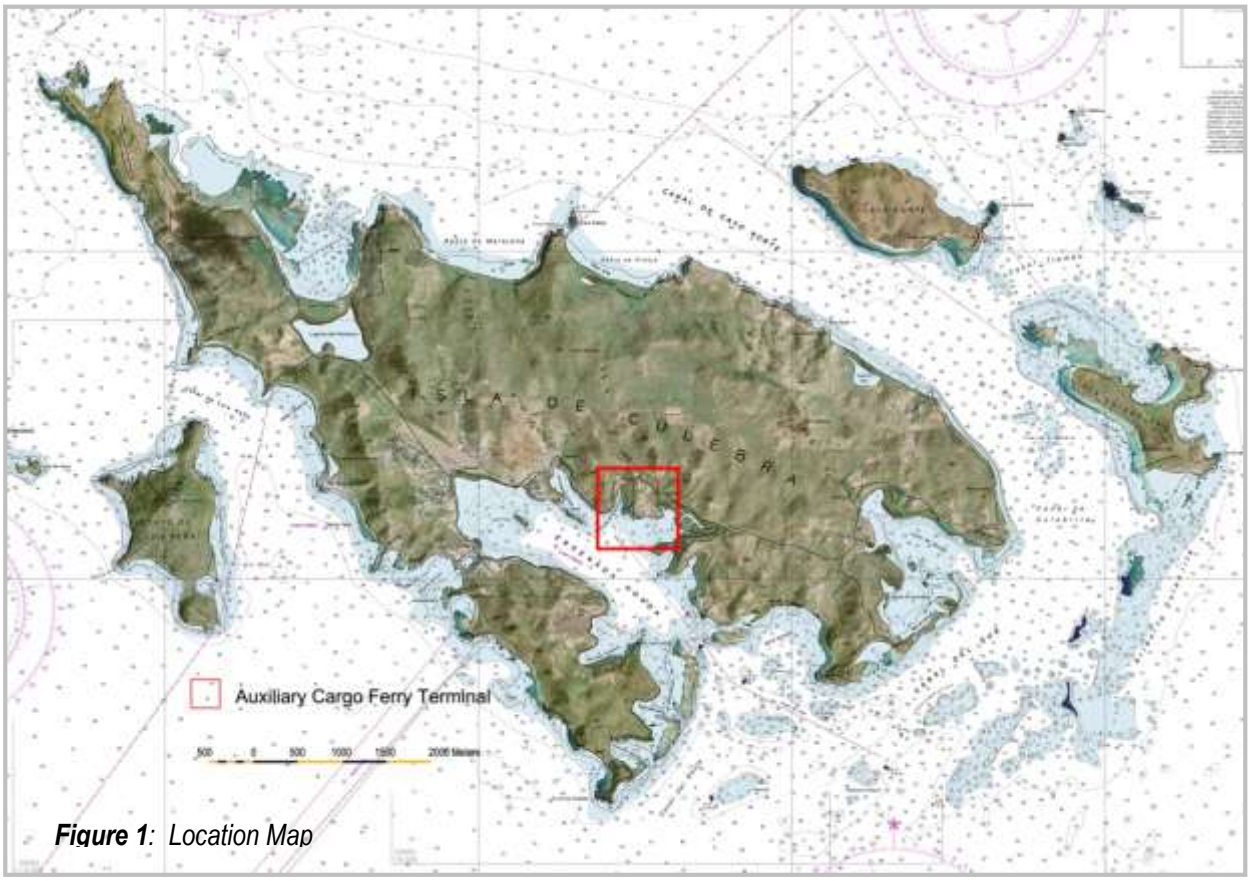

***Figure 1**: Location Map*

power and water service. Nevertheless, there are unavoidable impacts associated with the construction and operation of the proposed action.

A survey of existing corals was conducted in the project footprint at the existing San Ildefonso recreational pier area, since some of the structures will be demolished and replaced. The ultimate goal of these mapping efforts was to estimate impacts to the coral community and to determine potential avoidance/minimization and mitigation options.

A total of 10 colonies from 3 species, including 4 colonies of the ESA-listed *Orbicella* coral, were identified in a total of 5 pilings. This Plan has been prepared in order to mitigate for these impacts.

2.0 Project Description

The proposed Culebra Auxiliary Cargo Ferry Terminal includes the installation of a pre-fabricated floating aluminum platform (pontoon platform) that will match freeboard ferryboat highs and ease loading and unloading activities. An aluminum pre-fabricated vehicular bridge-platform will connect the pontoon platform to land.

The existing recreational dock is a reinforced concrete structure supported by 28 steel encased concrete piles with a 14 inch diameter. Due to existing, unsafe structural conditions it will be demolished and replaced with a new dock built out of a prefabricated aluminum platform and supported by eight steel encased concrete piles 18 inches in diameter. The new dock will occupy the same area as the existing one and will be connected to the new replacement pier and the pontoon platform via an aluminum passenger boarding ramp.

Construction of the Auxiliary Terminal is estimated to last 6 months. During this period, one barge will use retrievable spuds to secure itself in position, temporarily impacting the sandy bottom. Once this auxiliary platform is completed, the scheduled cargo ferry service from Fajardo to Culebra will dock at San Ildefonso while the existing cargo platform in Sardinas Bay is demolished and rebuilt.

3.0 Methodology

From a total of 24 pilings assessed, only 5 pilings, identified as **A10**, **B04**, **C04**, **D06** and **D02** (***Figure 2***) had encrusting of coral colonies with a diameter greater than 10 cm, for a total of 10 colonies from 3 species. Most of these colonies had encrusting organisms of their own (sponge growth, tube worms) or had sections covered in detritus. Four colonies of the Endangered Species Act (ESA) listed *Orbicella* (Threatened) were identified, and will be potentially impacted by the construction.

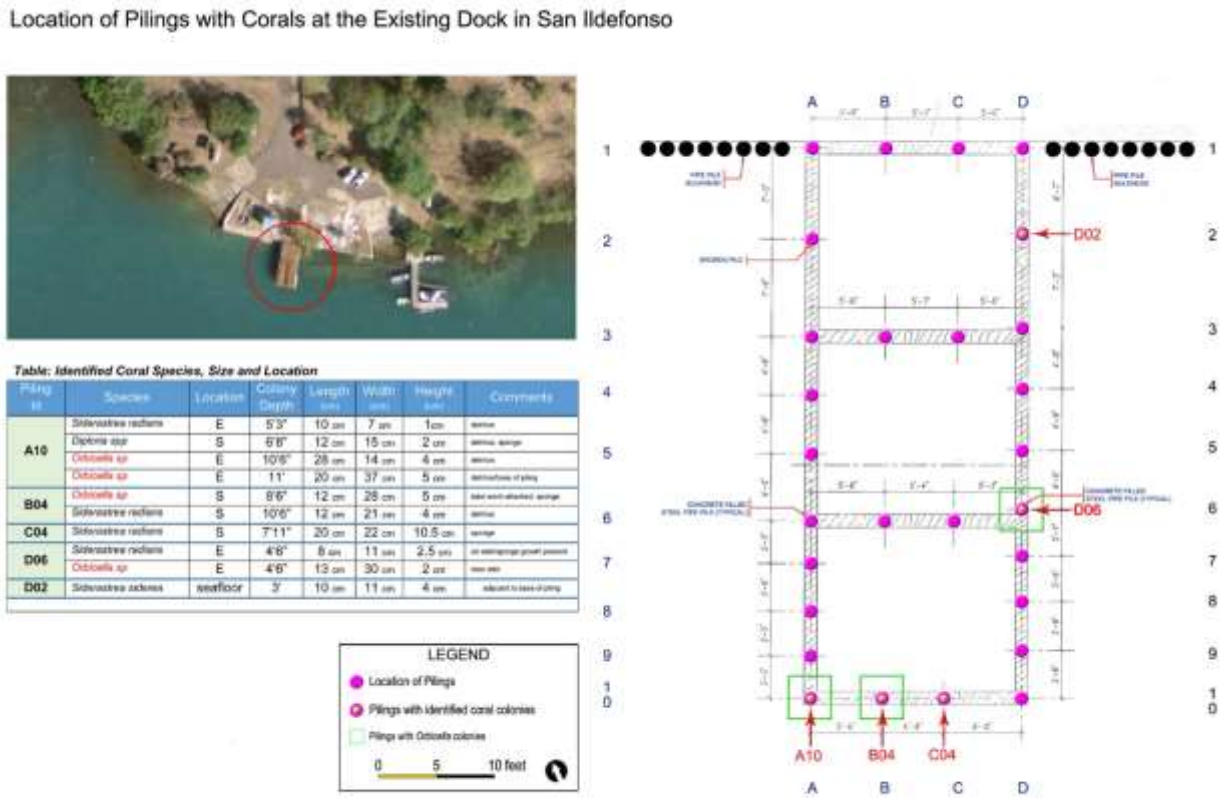

***Figure 2**: Plan view of the existing dock (to be demolished) and the location of its pilings. Pilings identified as A10, B04, C04, D06 and D02 have colonies with diameters greater than 10 centimeters.*

3.1 Coral Removal

Prior to removing the corals, the substrate area for each individual reattachment will be scraped clear of sediment and vegetative cover using spatulae, wire brushes or such to expose clean rock,

concrete or other such suitable substrate. The approximate area to be cleaned for each of the ten colonies will be 10 to 12" in diameter—the approximate diameter of the bottom of a 5-gallon bucket. Each site's location will be documented, so that a "map" of the relocation site can be drawn for future reference.

Divers will locate and remove the target coral colonies identified in this report. New measurements (width, height and depth) and condition (health, growths, etc.) will be collected for each of the colonies. An identification name or number will be designated for each, which will be in a permanent (5 year) label at its final relocation site, PVC with carved letters is recommended. Each coral colony will be detached from the piling using a sledgehammer and chisel; it is preferred that piling fragments be included in the transplant rather than to break (fragment) the colony. Notes will be taken to document the results of the detachment procedure, such as entire colony, partial colony, or number of fragments—all of which will be relocated. Extreme caution will be exercised to prevent contact with the live coral tissue, carefully handling the colonies from the base (the face previously against the piling) or by its edges. Colonies will be promptly placed in plastic bins to minimize direct contact with hands or gloves. Extreme care must be taken to avoid exposure of the detached colonies to air, temperature changes or greater exposure to sunlight than in their former habitat.

Various adhesives are available. Portland cement is suggested, which can be mixed on the surface in a bucket to 3" to 5" high, allowed to begin curing, and then brought to the reattachment site, where the cement bucket is turned upside down and allowed to drop on the clean, hard surface. Once most of the turbidity from the cement has cleared, the colony's base is pressed against the cement "cake". Instead of using the bucket, Portland cement can be mixed and transferred to a gallon zip-lock bag for transfer to the reattachment site. Either way, a permanent tag with the colony's identifier can be placed against (pressed on) the curing cement to ensure a firm, permanent marking.

Following relocation, photos of each transplanted colony will document their setting and permanent marking. A report will provide the transplant details.

3.2 Relocation Site

In accordance with DNER's December 22, 2015 letter, the site where the selected corals will be reattached will be determined soon, prior to construction.

4.0 Coral Monitoring

The monitoring plan will be used to identify compliance with the performance standard. Observing individual coral colonies over time can be a simple way to monitor their health and to identify potential problems in time to remedy them.

The transplant site will be monitored to determine condition for each colony, with parameters such as dimensions, disease, bleaching, predation, sediment smothering, algal overgrowth, etc. Their marker will be replaced if damaged or lost. Each colony will be photographed or videotaped at every monitoring event. These photographs are intended for qualitative, rather than quantitative analysis, due to the difficulty in replicating the distance and camera angle used initially.

4.1 Monitoring frequency

The relocation site will be monitored after transplant, monthly during the first year after relocation and every six months during the following year

4.2 Methodology

1. **Identify the Colony:** Before start any data collection, all the colonies will be identified. Remove encrusting organisms on the tag, replace if necessary.
2. **Identify the species**: Identify the species of each colony.
3. **Record the condition**: Using the information of the following table, describe the colony condition.
4. **Photograph the colony**. Each colony should be photographed or videotaped when its condition is first recorded. Include its tag. Use an angle which best represent the entire colony. The following table lists common conditions for the observations.
5. **Coral Dimensions**. Hight, width and depth, in centimeters.

Conditions Commonly Present in Corals
Bleached coral: white, with tissue remaining
Dead coral: white, cleaned coral skeleton without tissue.
Cleaned coral skeleton without tissue but with algal turf grown over the skeleton.
Dead coral with algal turf: skeleton not visible or conspicuous, older.
Light-colored; bleached but not completely white.
Light ridges
Discolored tissue: unusual color not due to bleaching – purple, pink, bluish, etc.
Freshly grazed coral tissue
Older grazed area, overgrown with algae.
Older grazed area that has been grown over by tissue.
Black band disease
White band disease
Mucus coat, often with adhering sediment or algal growth.
Mustard-colored tissue.
Sediment spot, small sediment-filled spot or hole.

5.0 Performance Standard

A success rate of 80% will be considered satisfactory. Failure to reach this standard may result in additional mitigation efforts to be determined by the regulatory agencies.

6.0 Monitoring Reports

Monitoring reports must be submitted to the Puerto Rico Port Authority after each monitoring event. This should include copy of all data sheets, date of the event, summary of the findings, general condition of the coral colonies, any concern related to the relocation of the corals and recommendation. The report should be submitted within 30 days after the monitoring event.

7.0 References

FF&WCC (2015) Coral Reef Evaluation and Monitoring Project. Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute. Found in: http://myfwc.com/research/habitat/coral/cremp/

FF&WCC (2015) Site Selection and Monitoring Methods. Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute. Found in: http://myfwc.com/research/habitat/coral/cremp/site-selection-monitoring/

Rogers, C.S., Garrison, G., Grober, R., Hillis, Z. & Franke, M. (1994). Coral Reef Monitoring Manual for the Caribbean and Western Atlantic. National Park Services, Virgin Island National Park.

RR (2015) Coral Reef Module, Monitoring and Assessment. Reef Resilience. Found in: http://www.reefresilience.org/coral-reefs/monitoring-and-assessment/

October 2015

Coral Transplant Plan for Sardinas Bay

Part of the Mitigation Plans for the

Impacts Associated to the Reconstruction of the Culebra Cargo Ferry Terminal in Sardinas Bay

Culebra, Puerto Rico

Prepared For :

Autoridad de los Puertos de Puerto Rico

Prepared By:

ATKINS

Contents

1.0 Introduction 2
2.0 Project Description 4
3.0 Methodology 4
3.1 Protocol for Piling Removal 4
3.2 Relocation site 6
4.0 Coral Monitoring 7
4.1 Monitoring Frequency 7
4.2 Methodology 7
5.0 Monitoring Report 9
6.0 References 10

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1.0 Introduction

The Puerto Rico Ports Authority (PRPA) conducted a structural evaluation at the Culebra Cargo Ferry Terminal on August, 2010, where advanced deterioration was observed in the deck slab and concrete beams, which has probably spread to the entire concrete surface. This appears to be a result of storm events, hurricanes and the wave action. Furthermore, if the repair and reconstruction of the cargo terminal is not conducted promptly, structural failure may occur. The PRPA has since been planning the necessary works, seeking financing and regulatory compliance.

Key stakeholders, Federal and State Agencies have been engaged since the structural deterioration findings from 2010 to thoroughly assess any potential damage to the environment through the implementation of attenuation, mitigation and/ or avoidance actions that may cause the reconstruction of the Culebra Cargo Ferry Terminal Project.

A coral assessment was conducted in the existing pilings of the Sardinas Bay Ferry Terminal cargo ramp (***Figure 1***). Field efforts focused on identifying and mapping those coral colonies larger than or equal to 10 centimetres in diameter. The ultimate goal of these mapping efforts was to estimate impacts to the coral community and to determine potential avoidance/minimization and mitigation options. During this survey, ten coral colonies with diameters equal to or larger than 10 centimeters were identified in a total of four pilings. In addition, one colony was identified on the hard bottom substrate beneath the edge of the existing cargo ramp. In order to mitigate for these impacts, a Mitigation Plan for Coral Transplant at Sardinas Bay has been prepared.

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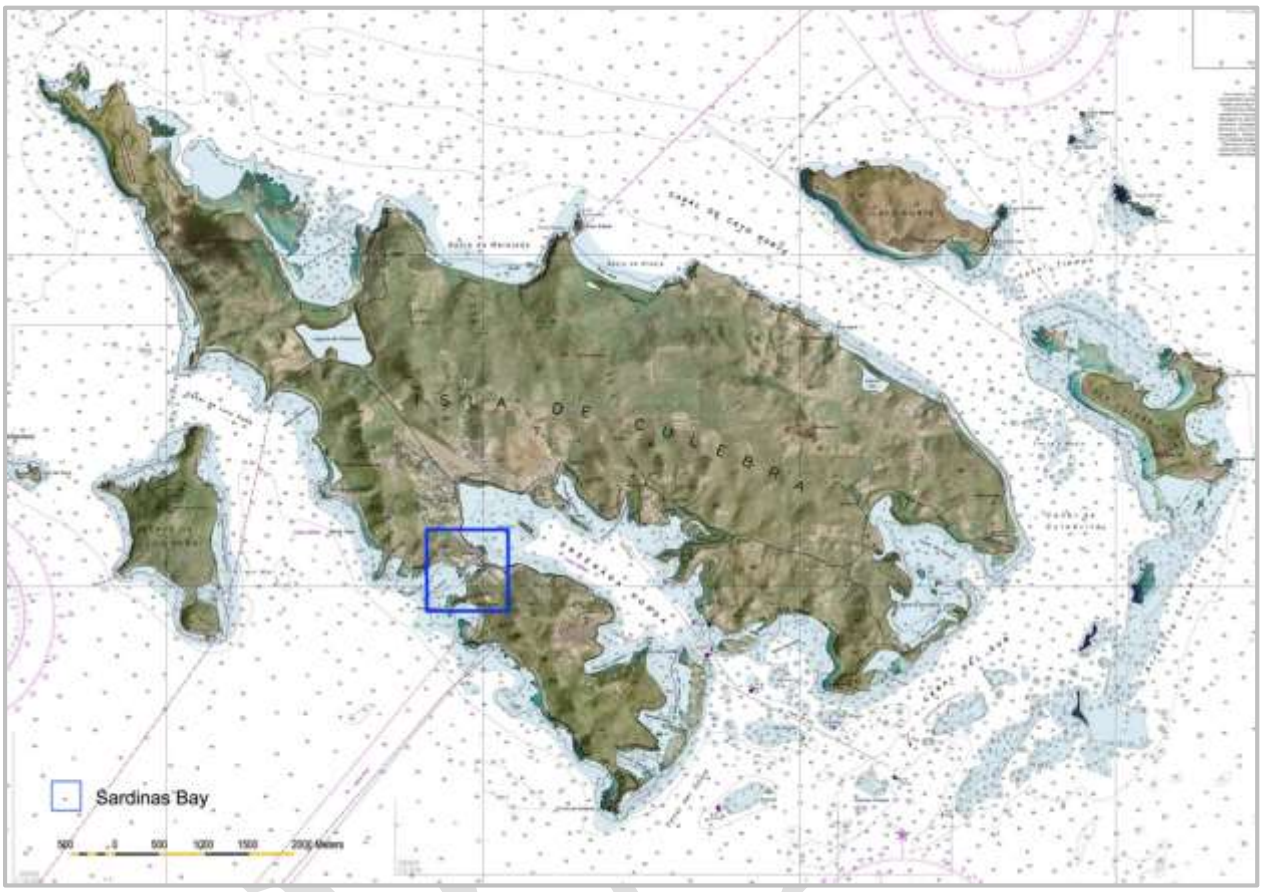

Figure 1: *Location of the Culebra Ferry Terminal in Sardinas Bay*

2.0 Project Description

The proposed Culebra Auxiliary Cargo Ferry Terminal includes the installation of a pre-fabricated floating aluminum platform (pontoon platform) that will match freeboard ferryboat highs and ease loading and unloading activities. An aluminum pre-fabricated vehicular bridge-platform will connect the pontoon platform to land.

The existing recreational dock is a reinforced concrete structure supported by 28 steel encased concrete piles with a 14 inch diameter. Due to existing, unsafe structural conditions it will be demolished and replaced with a new dock built out of a prefabricated aluminum platform and supported by eight steel encased concrete piles 18 inches in diameter. The new dock will occupy the same area as the existing one and will be connected to the new replacement pier and the pontoon platform via an aluminum passenger boarding ramp.

Construction of the Auxiliary Terminal is estimated to last 6 months. During this period, one barge will use retrievable spuds to secure itself in position, temporarily impacting the sandy bottom. Once this auxiliary platform is completed, the scheduled cargo ferry service from Fajardo to Culebra will dock at San Ildefonso while the existing cargo platform in Sardinas Bay is demolished and rebuilt

3.0 Methodology

Ten coral colonies have been identified on pilings 5, 6, 8 and 9 (***Figure 2***) with diameter equal to or greater than 10 centimeters. Although none of the corals identified are listed as Endangered on the Endangered Species Act (ESA), they will be potentially impacted by the construction. As a mitigation measure, the pilings in which these colonies are attached will be cut and relocated. Another colony was identified on the hard bottom substrate beneath the edge of the existing cargo ramp. However, no impacts to this colony is expected.

3.1 Protocol for Piling Removal

This mitigation plan contemplates removing and relocating these 4 pilings with attached colonies close to their original location where they would not be a security risk to beachgoers and/or navigation and will not impact any existing habitats. These pilings will be cut at the mudline, removed and relocated on the proposed site.

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Figure 2: *Proposed location of the relocation area in Sardinas Bay*

Before each pile is cut and removed, each coral colony measuring over ten inches in diameter identified in the survey will be documented and photographed. This will assist the contractor in identifying any damages that may occur to the colonies during the relocation of the pilings. Pilings can be given a number before removal to ease in the identification of each colony once they have been relocated.

The newly relocated pilings with the attached colonies will be monitored monthly for growth and adaptation, recording changes in coral cover, fish populations, species diversity, and disease (*see section* ***4.0 Monitoring***).

3.2 Relocation site

To limit the movement of the demolition/construction barge and the repeated removal of the turbidity barrier during works, these four pilings will be placed at approximately 100 feet north of the cargo ramp. This location was identified due to the nearby presence of a large *Siderastrea siderea* colony at depths of roughly 10 feet, similar to those of their original location in the pilings. The pilings will be placed in an overlapping fashion that would create an artificial reef for corals to attach, as well as creating habitat for fish in the area.

Seagrass beds were observed northwest/west and southwest of the existing cargo ramp structure (***Figure 2***). The seagrass beds located northwest/west of the existing cargo ramp is mostly dominated by *Syringodium filiforme* (manatee grass) mixed with *Thalassia testudinum* (turtle grass) and *Halophila decipiens* (paddle grass). The seagrass bed located southwest of the existing cargo ramp was comprised of *Syringodium filiforme*. The seagrass bed to the northwest is dense *Syringodium filiforme* (50-100%). The edges of the bed are mainly *Halophila decipiens* which is not as dense (25-50%). The area to the south is much less dense *Syringodium* sp. in deeper water (5-25%). These seagrasses will not be impacted by the placement of these pilings nearby.

To prevent sediment resuspension when placing the piles in the new location, a turbidity barrier will be placed surrounding the area during placement. This turbidity barrier shall not enclose the *Siderastrea siderea* colony, as the suspended sediments from the pile relocation would smother the colony with sediments (***Figure 2***). In addition, it will also protect the seagrass beds west of the location for the pilings from re-suspended sediment during the placement of the piles.

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4.0 Coral Monitoring

The monitoring plan will be used to measure changes taking place in the newly relocated coral colonies, as well as monitor the adaptation of the surrounding habitat to the relocated pilings. Observing individual coral colonies over time can be a simple way to monitor bleaching, algal growth, predation, disease, sediment smothering and damage from divers or beachgoers. As individual coral colonies will be monitored, observations will be conducted biannually during the construction period.

Each of the ten coral colonies may be monitored individually to determine its specific growth, disease, bleaching, predation, sediment smothering algal overgrowth. Each will be marked for future monitoring events with an ID marker placed near each colony. The colony should be photographed or videotaped when its condition is first recorded; and a scale should be used during this type of documentation to measure growth on subsequent monitoring events. These photographs are intended for qualitative, rather than quantitative analysis, due to the difficulty in replicating the distance and camera angle used initially.

4.1 Monitoring Frequency

The relocation site will be monitored every month during one year after relocation. Monthly observations are generally the most effective for assessing the cause and effect of changes in individual coral colonies. If observation are done less often, damage that has occurred since the last survey may be difficult to see. Algae may grow rapidly over freshly broken areas, sometimes within a week.

4.2 Methodology

1. **Mark the Colony.** Before beginnig any data collection, all colonies will be marked. The colonies can be marked by using a plastic cable or tie wrap with number-coded “cattle tag” attached to a 3-inch hardened masonry nail that has been driven into the substrate near the colony. Any encrusting organisms that grow on the tags can be scraped off to reveal the number.

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2. **Identify the species**: Identify each coral colony species.
3. **Record the condition**: Using the information provided in the following table, describe the colony condition.

Abbreviation	Condition	Abbreviation	Condition
BLEA	Bleached coral: white, with tissue remaining	FR	Freshly grazed coral tissue
DCW	Dead coral: white, cleaned coral skeleton without tissue.	GR	Older grazed area, overgrown with algae.
DCS/TURF	Cleaned coral skeleton without tissue but with algal turf grown over the skeleton.	RG	Older grazed area that has been grown over by tissue.
DCA	Dead coral with algal turf: skeleton not visible or conspicuous, older.	BBD	Black band disease
LIGHT	Light-colored; bleached but not completely white.	WBD	White band disease
LR	Light ridges (noted on *D. strigosa*)	MUCUS	Mucus coat, noted on P. asteroids; often with adhering sediment or algal growth; *S. siderea* has tufts or globs of adhering mucus.
DISCOL	Discolored tissue: unusual color not due to bleaching – purple, pink, bluish, etc. (*S. siderea* has a violet color which appears luminescent during bleaching events)	MUSTARD	Mustard-colored tissue on *P. astreoides*
		SS	Sediment spot; small sediment-filled spot or hole.

4. **Photograph the colony**. Each colony should be photographed or videotaped when its condition is first recorded. Include a slate in the photo with an identification number, date and scale (a color chart in the photo may help document subtle changes over time). Take the photo from the angle which can best represent the entire colony.
5. **Coral Growth.** The growth rate of a coral colony in highly variable and it depends on the species. The method you choose depends of what kind of coral will be monitored.
   - ***Branching corals:*** *To provide a baseline for measuring growth in branching corals, wrap a plastic cable tie around a branch with a tag to identify the sample. Using flexible plastic ruler, periodically measure the distance from the baseline to the end of the branch to determine the net linear extension.*
   - ***Head corals:*** *Drive a nail into the substrate next to the head, into a dead portion of the coral or use any other location closer to the head. Tag the nail or the selected area and use it as a reference point from which to make measurements.*
   - ***Photograph:*** *With relative flat head and plate corals, estimate the growth by digitizing the photograph image to calculate the area of living coral and comparing data from successive photographs. Growth may be evident in measurements taken every six months. However, make sure to take the photos from the exact same angle and*

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distance each time, and place a scale along the edge of the photo-quadrat for referencing size.

5.0 Monitoring Report

A monitoring report must be submitted to the Puerto Rico Port Authority after each monitoring event. This should include copy of all data sheets, date of the event, summary of the findings, general condition of the coral colonies, any concern related to the relocation of the corals and recommendation. The report should be submitted 30 days after the monitoring event.

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6.0 References

NOAA Coral Health and Monitoring Program (CHAMP) http://www.coral.noaa.gov/

http://fl.biology.usgs.gov/Monitoring_Manual.pdf

http://myfwc.com/research/habitat/coral/cremp/

http://myfwc.com/research/habitat/coral/cremp/site-selection-monitoring/

http://www.reefresilience.org/coral-reefs/monitoring-and-assessment/

Rogers, C.S., Garrison, G., Grober, R., Hillis, Z. & Franke, M. (1994). Coral Reef Monitoring Manual for the Caribbean and Western Atlantic. National Park Services, Virgin Island National Park.

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October 2015

Turbidity Monitoring Plan during the Construction of the Auxiliary Terminal in San Ildefonso

Part of the Mitigation Plans for the

Impacts Associated to the Reconstruction of the Culebra Cargo Ferry Terminal in Sardinas Bay

Culebra, Puerto Rico

Prepared For :

AUTORIDAD de los PUERTOS de PUERTO RICO

Prepared By:

ATKINS

Contents

Introduction 3

Project Description 5

Description of Construction Operation 6

Turbidity Monitoring Plan during Construction at San Ildefonso 8

State Regulatory Frame 8

Portable Turbidity Meter 8

Permanent Turbidity Monitoring Station 9

Monitoring Protocol 14

Locations for the Permanent Monitoring Stations 15

Monitoring Documentation 16

References 17

Under Revision

Introduction

The Puerto Rico Ports Authority (PRPA, State proponent) conducted a structural evaluation at the Culebra Ferry Terminal on August, 2010, where advanced deterioration was observed in the deck slab and concrete beams, which has probably spread to the entire concrete surface. Said deterioration appears to be a result of storm events, hurricanes and wave action. If the reconstruction of the cargo terminal is not conducted promptly, structural failure may occur. The PRPA has since been planning the necessary works, seeking financing and regulatory compliance.

The National Environmental Policy Act (NEPA) directs federal agencies to thoroughly assess the environmental consequences of "major federal actions significantly affecting the environment." Before any Federal Agency, in this case the Federal Emergency Management Agency (FEMA, Federal proponent), can fund or implement an action that may affect the environment, agency decision-makers must study the potential impacts that the proposed action and alternatives will have on the human and natural environment, and make that information available to the public.

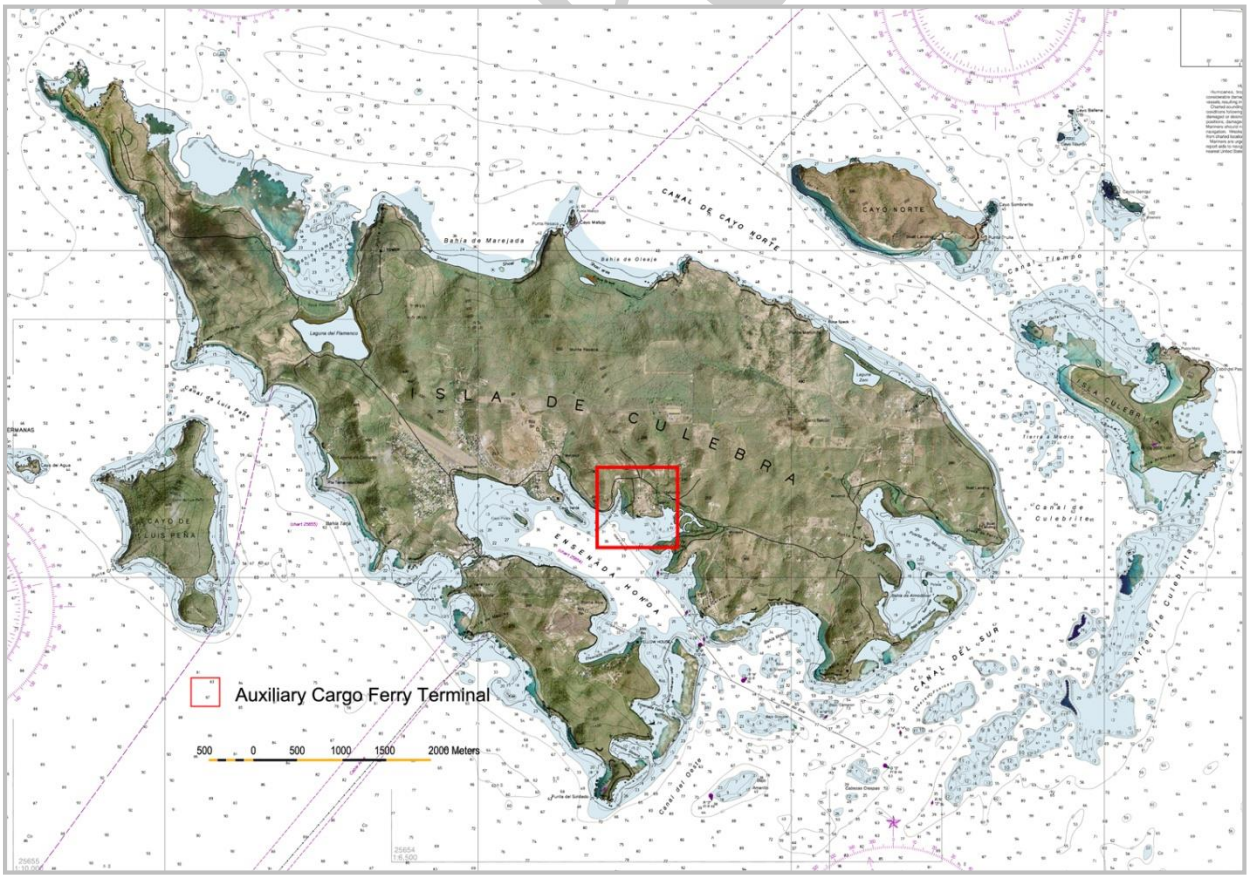

Figure 1: *Location of the Auxiliary Cargo Ferry Terminal in San Ildefonso.*

Revision

After evaluating potential sites for an Auxiliary Terminal, the San Ildefonso site in Ensenada Honda (***Figure 1***) was chosen for the limited environmental impacts involved, since no dredging is required, the landside is ample, has been previously developed, and has the required power and water service. There are unavoidable impacts associated with the construction and operation of the proposed action.

Since 2010, Federal and State Agencies, and key stakeholders, have been engaged to thoroughly assess any potential adverse impact to the environment that may be caused by the reconstruction of the Culebra Cargo Terminal, and to recommend attenuation, mitigation and/ or avoidance actions. Sediment resuspension in the water column is expected to occur during the removal and drilling of the cargo-platform piles. The following turbidity control and monitoring plan has been prepared in order to mitigate potential impacts caused by sediment resuspension during construction.

Therefore, this Turbidity Monitoring Plan for the Construction of San Ildefonso Auxiliary Cargo Ramp has been prepared in accordance with the FEMA 44 CFR Part 10 Regulations, the Department of Homeland Security's Management Directive 5100.1, and the Council on Environmental Quality 40 CFR Part 1500-1508 Regulations thus complying with the NEPA process.

Under Revision

Project Description

The proposed Culebra Auxiliary Cargo Ferry Terminal includes the installation of a pre-fabricated floating aluminum platform (pontoon platform) that will match freeboard ferryboat highs and ease loading and unloading activities. This floating pontoon platform will have a length of 40 feet by a width of 56 feet, with a total gross area of 2,240 square feet (208.2 square meters) and will be anchored to the bottom using 6 round concrete piles with a 30 inch diameter, which will be driven approximately 20 to 30 feet below msl. These concrete piles will hold the floating platform in place. An aluminum pre-fabricated vehicular bridge-platform, measuring approximately 35 feet long by 22 feet wide, with a total gross area of 770 square feet (71.5 square meters) will connect the pontoon platform to land.

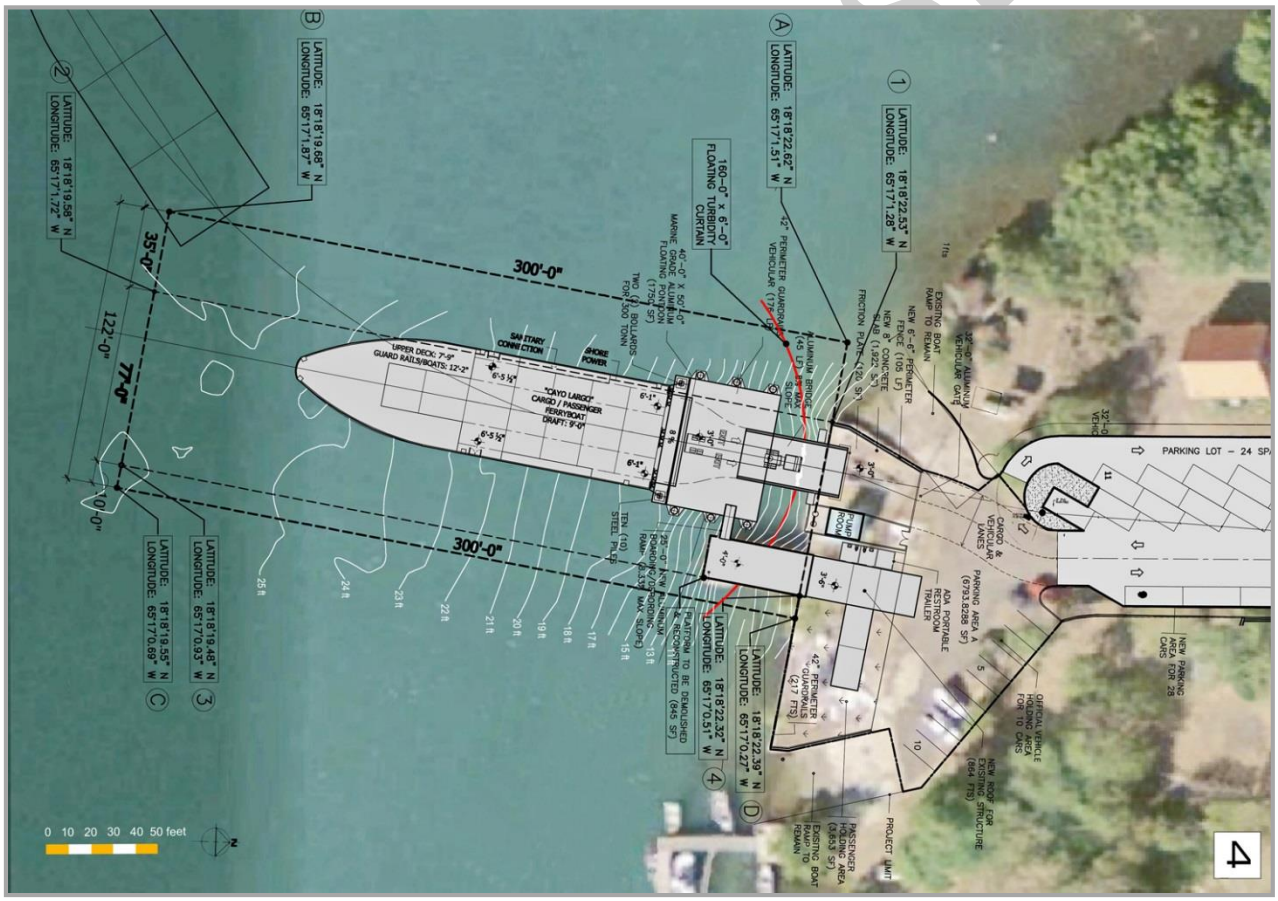

Figure 2: *Proposed Layout Plan of the Auxiliary Cargo Ferry Terminal in San Ildefonso.*

The existing recreational dock is a reinforced concrete structure measuring approximately 17 feet in width by 44 feet in length and supported by 28 steel encased concrete piles with a 14 inch diameter. Due to existing, unsafe structural conditions it will be demolished and replaced with a new dock built out of a prefabricated aluminum platform and supported by eight steel encased concrete piles 18 inches in diameter. The new dock will occupy the same area as the existing one. The existing piles will be removed at the mudline. The new dock will be connected to the new replacement pier and the pontoon platform via an aluminum passenger boarding ramp that will measure 20 feet in length by 4 feet in width (80 square feet, or 7.4 square meters). This boarding ramp will allow passengers to board and disembark the cargo ferry separately from vehicular loading and unloading.

To protect the floating pontoon platform from the cargo ferry during docking maneuvers, a pile cap and fender measuring approximately 56 feet in length by 6 feet in width (336 square feet, or 31.2 square meters) will be built, supported by eleven round concrete piles with a diameter of 30 inches. The stern of the cargo ferry will be tied to the steel bollards in the pile cap. This pile cap beam will be located at an approximate distance of 64 feet from the existing seawall at an approximate depth of -17 feet msl. To protect the existing historical seawall, a pile cap beam measuring feet 29 long by 3 feet wide supported by six concrete piles with a diameter of 18 inches will be constructed at a distance of approximately 5 feet from the existing seawall. **Figure 2: Proposed Layout Plan,** shows the elements of the construction of the **Auxiliary Cargo Ferry Terminal in San Ildefonso.**

Description of Construction Operation

The construction in San Ildefonso is estimated to take 7 months. During this period, one spud barge will be use as a deck barge for equipment, materials and general construction operations platform.

Turbidity barriers will be installed by the contractor delimiting the turbidity control area of the construction. **Figure 3 and 4, Turbidity Barrier Type**.

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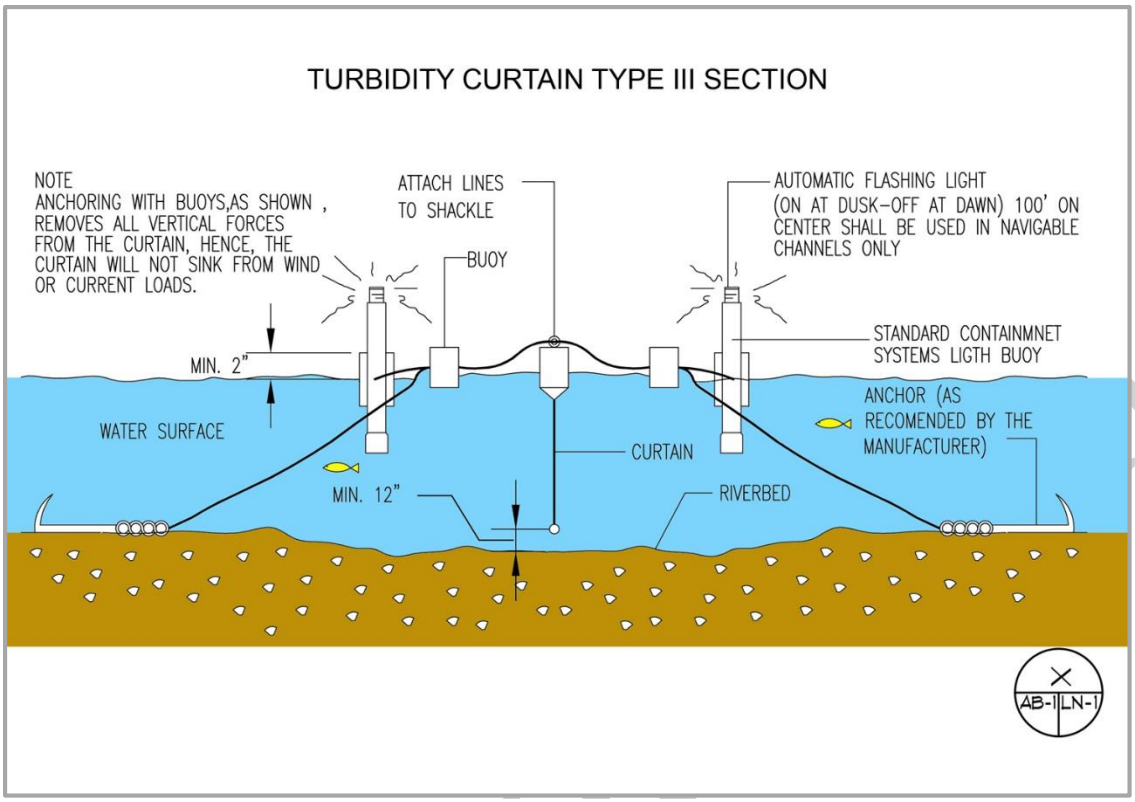

Figure 3: *Turbidity Barrier Type III.*

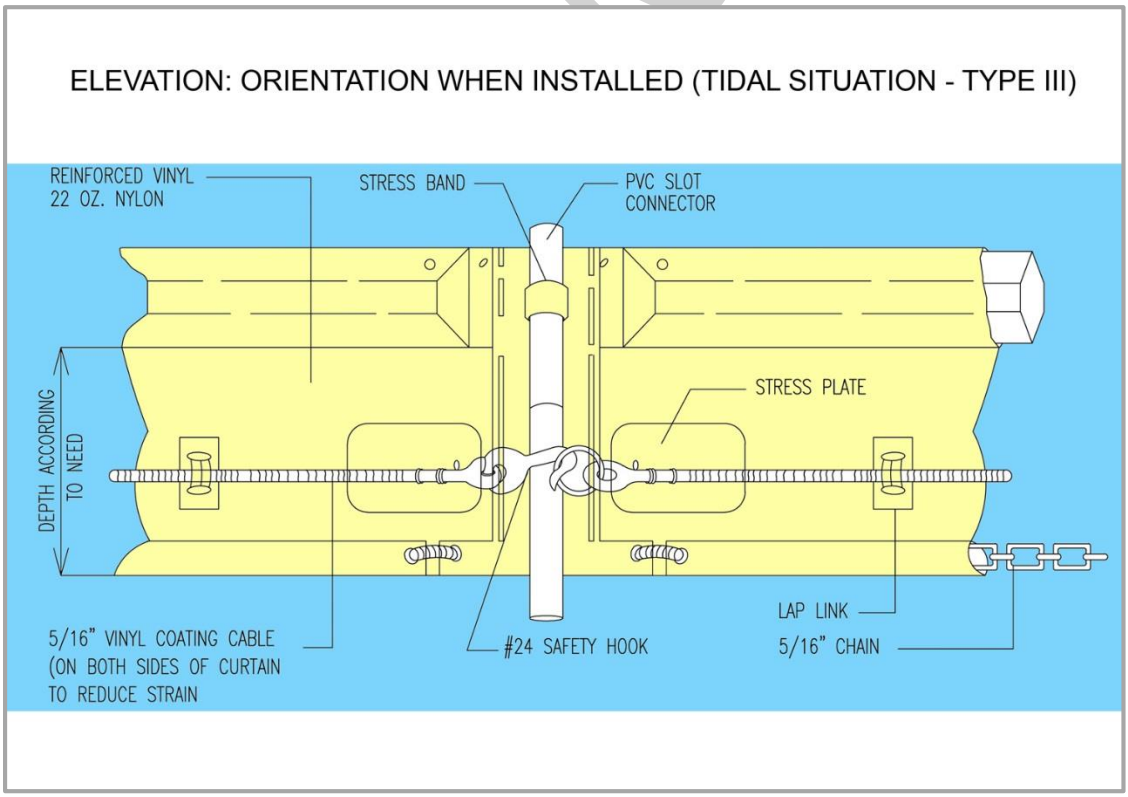

Figure 4: *Turbidity Barrier Detail*

Turbidity Monitoring Plan during Construction at San Ildefonso

State Regulatory Frame

The Puerto Rico Water Quality Standards (WQS), as amended August 19, 2014, defines the waters of the Municipality of Culebra at San Ildefonso as Class SB. Class SB includes the coastal and estuarine waters not classified as Class SA or SC under Rules 1302.1 (A) and (C) of the WQS regulation. Class SB classification will apply from the zone subject to the ebb and flow of tides (mean sea level) up to 500 meters (0.31 mile) seaward from said zone. Beyond said limit, the next less restrictive classification will apply to a maximum of 10.35 miles seaward.

Class SB waters are defined as waters intended for use in primary and secondary contact recreation, and for propagation and preservation of desirable species, including threatened or endangered species.

For the purpose of this monitoring plan only the turbidity standard will be monitored in compliance with the State regulation, which will not exceed 10 nephelometric turbidity units (NTU), except by natural causes.

Portable Turbidity Meter

EPA Method 180.1

EPA method 180.1, “Determination of Turbidity by Nephelometry”, is based upon a comparison of the intensity of light scattered by the sample under defined conditions with the intensity of light scattered by a standard reference suspension. The higher the intensity of scattered light, the higher the turbidity. Readings, in NTUs, are made in a nephelometer designed according to specifications laid out in the method. A primary standard suspension is used to calibrate the instrument. A secondary standard suspension is used as a daily calibration check and is monitored periodically for deterioration using one of the primary standards.

Portable Turbidimeter

Portable turbidimeters are similar to the bench top units, except that they are designed for portable use and are battery operated. Portable turbidimeters are available in a variety of designs, including the single beam and ratio designs. The accuracy of portable instruments is

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comparable to the bench top units, but the resolution of low turbidity reading may only be 0.01 NTU as compared to the 0.001 NTU resolution of bench top units (Hach Corporation, 1995).

Portable turbidimeters are designed for use in the field with grab samples. These instruments are designed to be rugged and capable of withstanding the effects of moving the instrument as well as variable field conditions. However, since these instruments are inherently susceptible to damage or disturbance from dropping, abuse, or environmental conditions such as dust, these units are not appropriate for the process monitoring and reporting tasks normally accomplished by on-line turbidimeters. Portable instruments are useful for measuring turbidity at remote locations such as at sampling points and for special process studies, such as backwash recycle characterization or distribution system analysis that may be accomplished more readily and accurately in the field rather than conducting analysis after transporting a sample to a laboratory.

Turbidity Spectrometer

Calibration and Standardization

Turbidimeter calibration: The manufacturer's operating instructions should be followed. Measure standards on the turbidimeter covering the range of interest. If the instrument is already calibrated in standard turbidity units, this procedure will check the accuracy of the calibration scales. At least one standard should be run in each instrument range to be used. Some instruments allow adjustments of sensitivity so that scale values will correspond to turbidities. If a pre-calibrated scale is not supplied, calibration curves should be prepared for each range of the instrument.

Recommended Instrument

The 2100Q Portable Turbidimeter, compliant with USEPA Method 180.1 design criteria.

Permanent Turbidity Monitoring Station

Another option is the installation of a permanent monitoring station that can be also use for the operational phase at San Ildefonso after construction works are completed.

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For this option a continuous water quality monitoring instrument can be used, which is also portable. There are a variety of continuous water quality monitoring instruments available from different manufacturers which offer different designs, options and combinations of sensors.

For the purpose of this monitoring plan, a single parameter sonde with a reading range from 0 to 1,000 NTU, a resolution of 0.1 NTU, and accuracy of ± 2 % or 0.3 NTU is recommended for turbidity monitoring

These instruments can be deployed for long periods with the adequate cleaning maintenance to prevent errors introduced by biofouling. Some sensors or instrument casings are available in titanium (vs. stainless steel) and can be used in salt water environments. Additionally many manufacturers now offer an anti-bio-fouling kit. Therefore, instrument maintenance should be programed on a monthly basis.

Finally, it is important to consider the functioning of the instrument. Instruments may feature battery packs and internal logging capabilities and memory. All of these options have to be considered when selecting and purchasing the instruments for the stations.

Data Logger or Display Unit

The data loggers bridge the gap between instruments immersed underwater and the telemetry system used to relay water quality data to a database. The data logger will retrieve and store data from the turbidity spectroscope at pre-determined intervals specified in the data logger programming and ensure the data is available to the telemetry unit. When selecting a data logger, it is important to choose one that is compatible with the instrument and telemetry equipment in use. However, handheld display units are usually sold in conjunction with the multi or single parameter instruments and work as data loggers. Handheld display units are useful in the field setting and connect to the instrument via a field cable. The field units allow the user to view the turbidity data in situ or via connection in the station shelter.

Calibration and Standardization

Turbidimeter calibration: The operating instructions from the manufacturer should be followed closely. The measuring standards on the turbidimeter should cover the range of interest established. If the instrument is already calibrated in standard turbidity units, this procedure will check the accuracy of the calibration scales. .

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Recommended Instrument

A single parameter optical monitoring sonde is recommended for this monitoring plan thus most of these instruments are display and data logger compatible.

Examples of YSI and Hydrolab single and multiparameter sondes

Power Supply

The power requirement for a monitoring station shelter varies depending on the equipment to be used. Typically in urban areas, an electrical supply can be established from the power grid by contacting the power provider. If required, the permanent stations can access power from the San Ildefonso Auxiliary Facility.

Contractor will be responsible for the shelter installation planning, construction, maintenance, and functionality of the equipment.

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Suggested Instrument Deployment

Pier Deployment

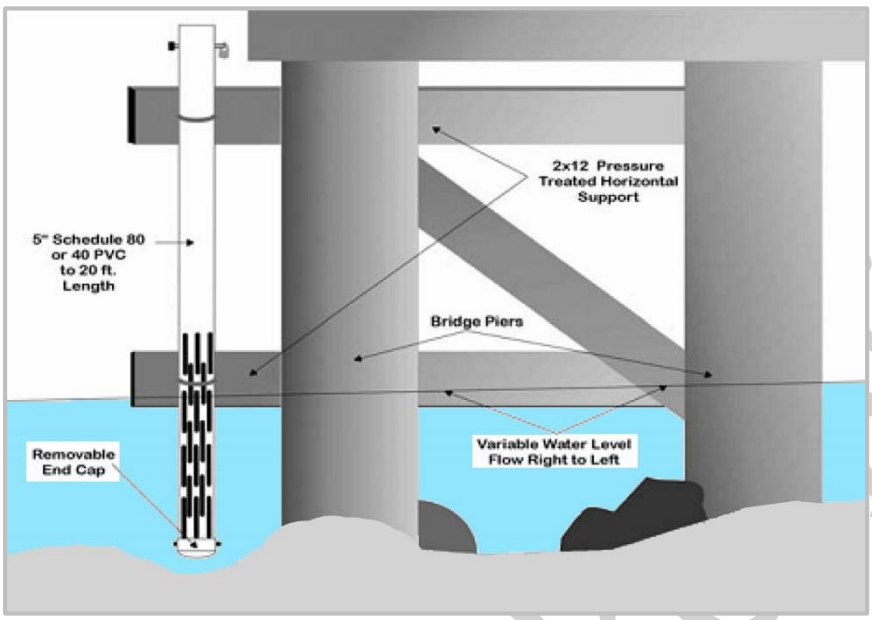

Figure 5 *Pier Suggested Deployment*

The general structure for this type of deployment is a PVC or other durable plastic pipe affixed to the vertical column of the pier. The instrument is fed through the piping to the desired depth within the water column (**Figure 5**). At the end of the pipe, 1 inch holes are cut in the pipe to allow for adequate water flow over the sensors. The instrument can be accessed from the pier by pulling the instrument up through the pipe by the attached aircraft cable.

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Shore Deployment

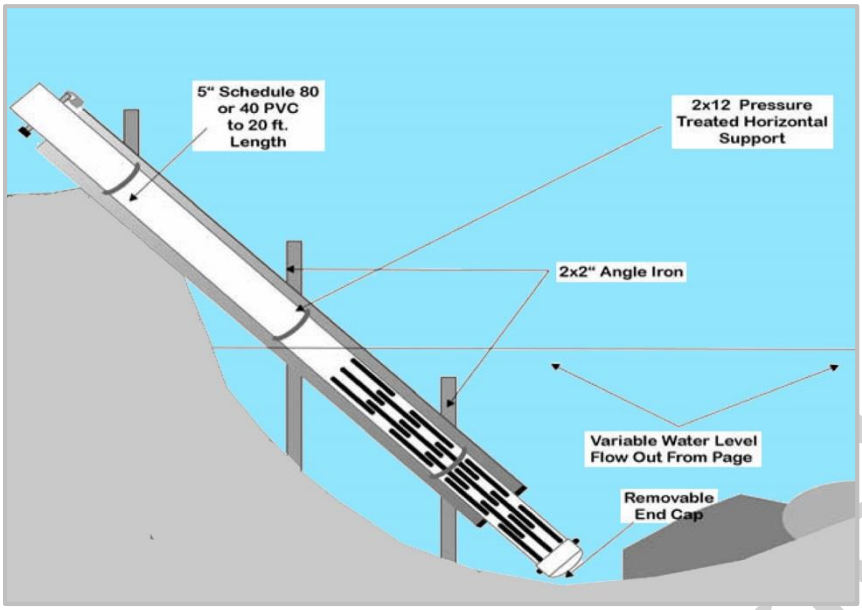

Figure 6 *Shoreline Suggested Deployment*

To avoid impacts to the seagrass meadow, a deployment can be built to better position an instrument in the area of seagrass. The structure is a series of angle-iron supports driven into the seabed, which supports a length of 2"x12" pressure treated wood (**Figure 6**). Attached to the wood is a length of PVC pipe of (5 inches width), which holds the instrument at the desired depth above the sand, but is accessible to personnel on the shore by pulling on the aircraft cable attached to the instrument

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Monitoring Protocol

The Contractor will monitor turbidity units within and outside the turbidity barrier at least twice per day during construction activities that may cause sediment resuspension in Ensenada Honda (**Figure 7**). First turbidity reading will be taken in the morning, once construction activities have started, and in the afternoon before construction activities are ceased.

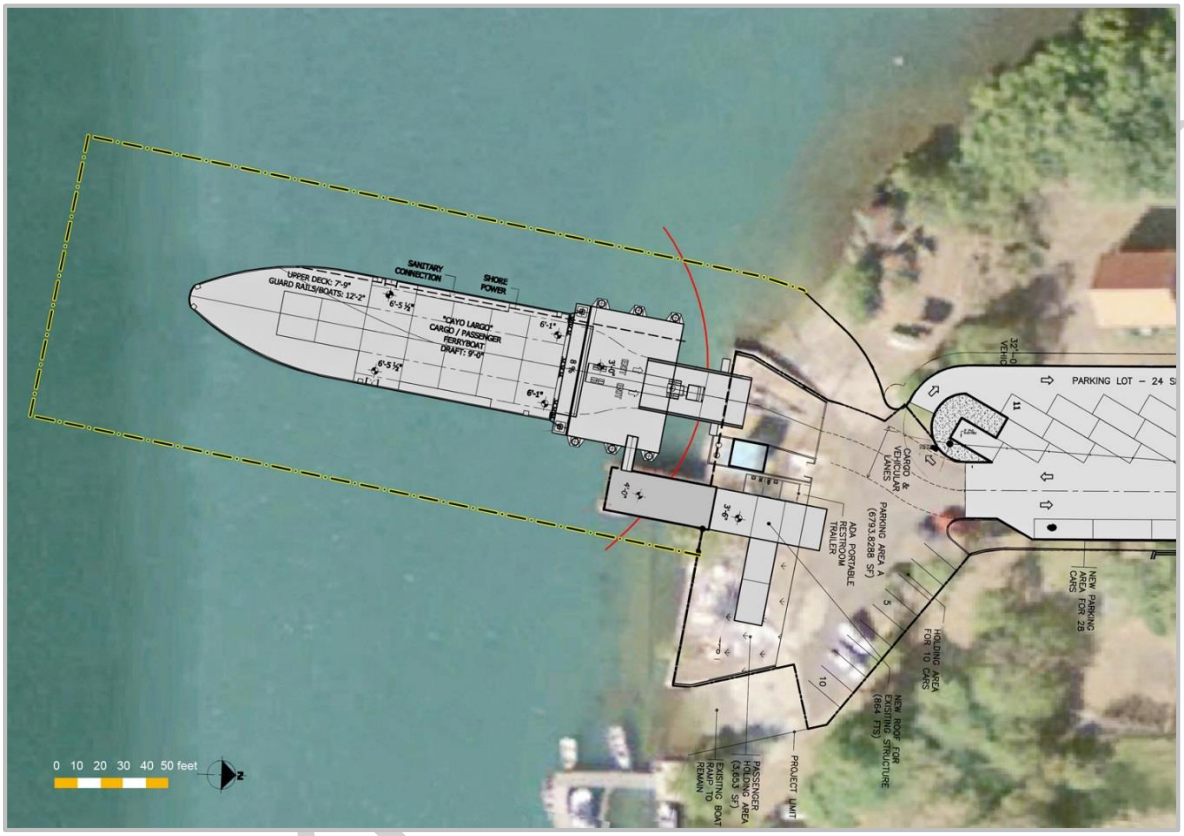

Figure 7: *Turbidity Barrier Layout during construction*

One third reading will be taken at the seagrass bed near the San Ildefonso Auxiliary Terminal, **Figure 8** identifies this area next to the *Thalassia testudinum*. Should the value outside the turbidity barrier exceeds the standard for ambient marine waters of 10 NTU, construction activities will be suspended, unless the excessive turbidity is caused by natural events, as specified in Puerto Rico WQS regulation.

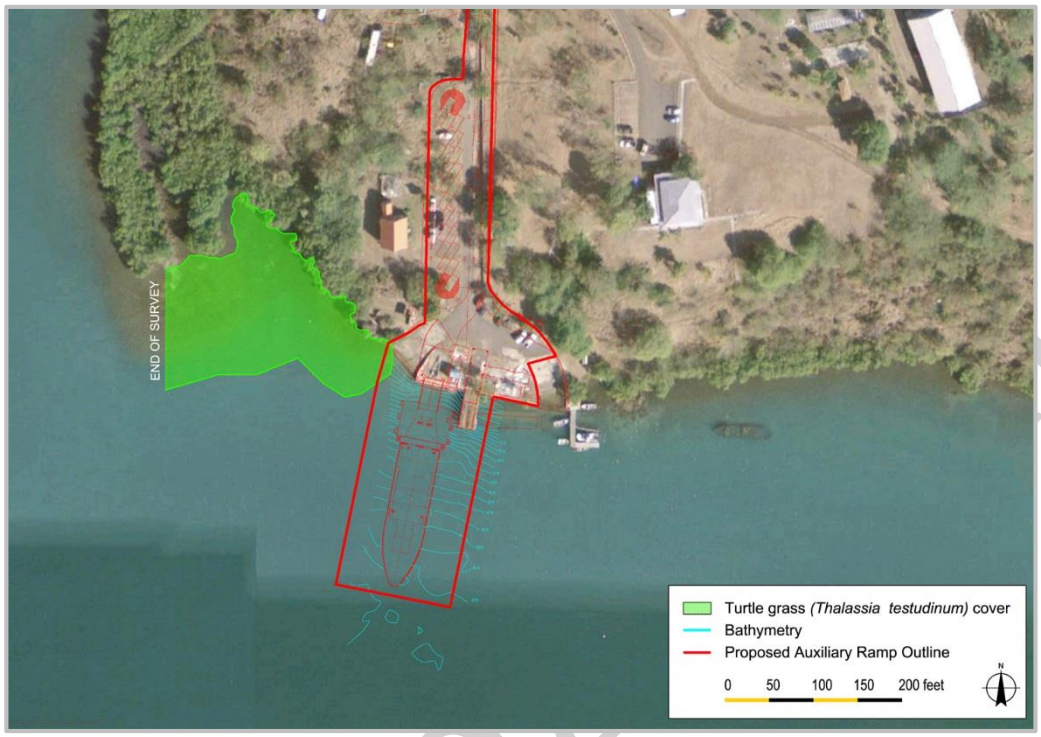

Figure 8: *Site Plan and Seagrass Bed near the Auxiliary Ramp*

Locations for the Permanent Monitoring Stations

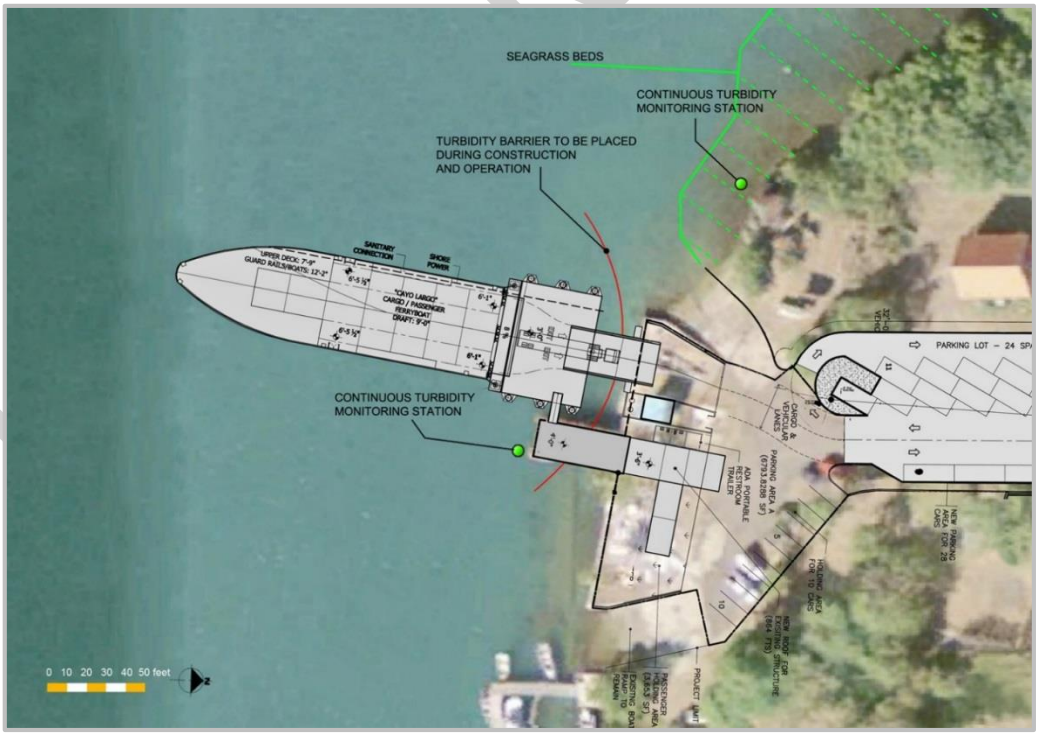

Figure 9 *Recommended location for the permanent monitoring stations*

Monitoring Documentation

The contractor will be responsible for preparing the monitoring protocol documentation which will include the Calibration Protocol, Calibration Log Sheet, and Field Monitoring Data Sheet.

The calibration protocol must establish monitoring frequency at the exact locations, calibration frequency and thresholds for corrective actions in case that the instrument strays during field works.

Monthly Reports

Monthly monitoring reports will be prepared and submitted during the first 10 days of the month. Reports will include a brief description of general weather conditions observed, a table containing turbidity readings, and original monitoring and instrument calibration data sheets.

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References

EPA (1999) EPA Guidance Manual for Compliance with the Interim Enhanced Surface Water Treatment Rule: Turbidity Provisions, EPA 815-R-99-010.

FEMA (2011) 44 CFR §10 – Environmental Considerations

NEPA (2005) 40 CFR 1500.1, Title40, Volume 24, Parts 790 to End, Regulations for Implementing The Procedural Provisions of The National Environmental Policy Act.

NOAA (1998) Fonseca, MF, WJ Kenworthy, and GW Thayer. Guidelines for the conservation and restoration of seagrasses in the United States and adjacent waters. NOAA Coastal Ocean Program Decision Analyses Series No. 12. NOAA, Washington, DC

PREQB (2014) Puerto Rico Water Quality Standards, Act 7837, 2010, amended August 19, 2015, www.jca.pr.gov , searched September 10, 2015.

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October 2015

Water Turbidity and Seagrass Biological Monitoring Plan for the Operation at the Auxiliary Terminal in San Ildefonso

Part of the Mitigation Plans for the

Impacts Associated to the Reconstruction of the Culebra Cargo Ferry Terminal in Sardinas Bay

Culebra, Puerto Rico

Prepared For :

AUTORIDAD de los PUERTOS de PUERTO RICO

Prepared By:

ATKINS

Contents

1.0 Introduction 3
2.0 Description of the Auxiliary Cargo Ferry Operation 5
2.1 Ferry Route 5
2.2 Ferry Operation 6
3.0 Turbidity Monitoring Plan 7
3.1 Regulatory Frame 7
3.2 Turbidity Monitoring Equipment 7
3.2.1 Continuous Turbidity Monitoring Instrument 7
3.2.2 Data Logger or Display Unit 8
3.2.3 Calibration and Standardization 8
3.3 Suggested Instrument Deployment 10
3.3.1 Pier Deployment 10
3.3.2 Shore Deployment 11
3.4 Turbidity Monitoring Protocol 11
4.0 Seagrass Monitoring Plan 13
4.1 Regulatory Frame 13
4.2 Seagrass Biological Monitoring 13
Background 13
4.3 Seagrass Monitoring Protocol 16
4.3.1 Monitoring Frequency 16
4.3.2 Methodology 16
5.0 Monitoring Report 20
6.0 References 21
Appendix A 23

Under Revision

1.0 Introduction

The Puerto Rico Ports Authority (PRPA, State proponent) conducted a structural evaluation at the Culebra Cargo Ferry Terminal on August, 2010, where advanced deterioration was observed in the deck slab and concrete beams, which has probably spread to the entire concrete surface. Said deterioration appears to be a result of storm events, hurricanes and wave action.

As the only heavy commercial cargo transportation port in Culebra, the cargo ferry provides an essential service to the island-municipality residents. An alternatives analysis resulted in the proposed construction of an Auxiliary Cargo Terminal, while the existing cargo terminal is reconstructed. After evaluating potential sites for an Auxiliary Terminal, the San Ildefonso site in Ensenada Honda (***Figure 1***) was chosen for the limited environmental impacts involved, since no dredging is required, the landside is ample, has been previously developed, and has the required power and water service. Nevertheless, there are unavoidable impacts associated with the construction and operation of the proposed action.

The National Oceanographic and Atmospheric Administration/National Marine Fisheries Service (NOAA/NMFS) designates the island of Culebra as Critical Habitat for the green turtle (*Chelonia mydas*) and as a Habitat Focus Areas.

Federal and State Agencies, and key stakeholders have been engaged since 2010 to thoroughly assess any potential adverse impact to the environment that may be caused by the reconstruction of the Culebra Cargo Terminal, and to recommend attenuation, mitigation and/or avoidance actions. According to various assessments conducted at San Ildefonso, sediment resuspension is expected to occur during docking maneuvers at the facility. These lifted sediments, when moving through the water column, could pose a potential threat to the health of seagrass beds near the Auxiliary Terminal. Seagrass beds are the main food sources for the green turtle (*Chelonia mydas)* and the West Indian manatee (*Trichechus manatus manatus*), both protected under the Endangered Species Act.

Therefore, the following *Water Turbidity and Seagrass Biological Monitoring Plan for the Operation of San Ildefonso Auxiliary Terminal* has been prepared in accordance with the requirements under the Regulations of the Federal Emergency Management Agency (FEMA) at

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44 CFR Part 10, the Department of Homeland Security's Management Directive 5100.1, and the Council on Environmental Quality Regulations at 40 CFR Part 1500-1508 to implement the National Environmental Policy Act requirements for FEMA.

This monitoring plan shows the methodology and equipment required to assess turbidity values and changes in health condition of the seagrass meadow due to the operation of the Auxiliary Terminal.

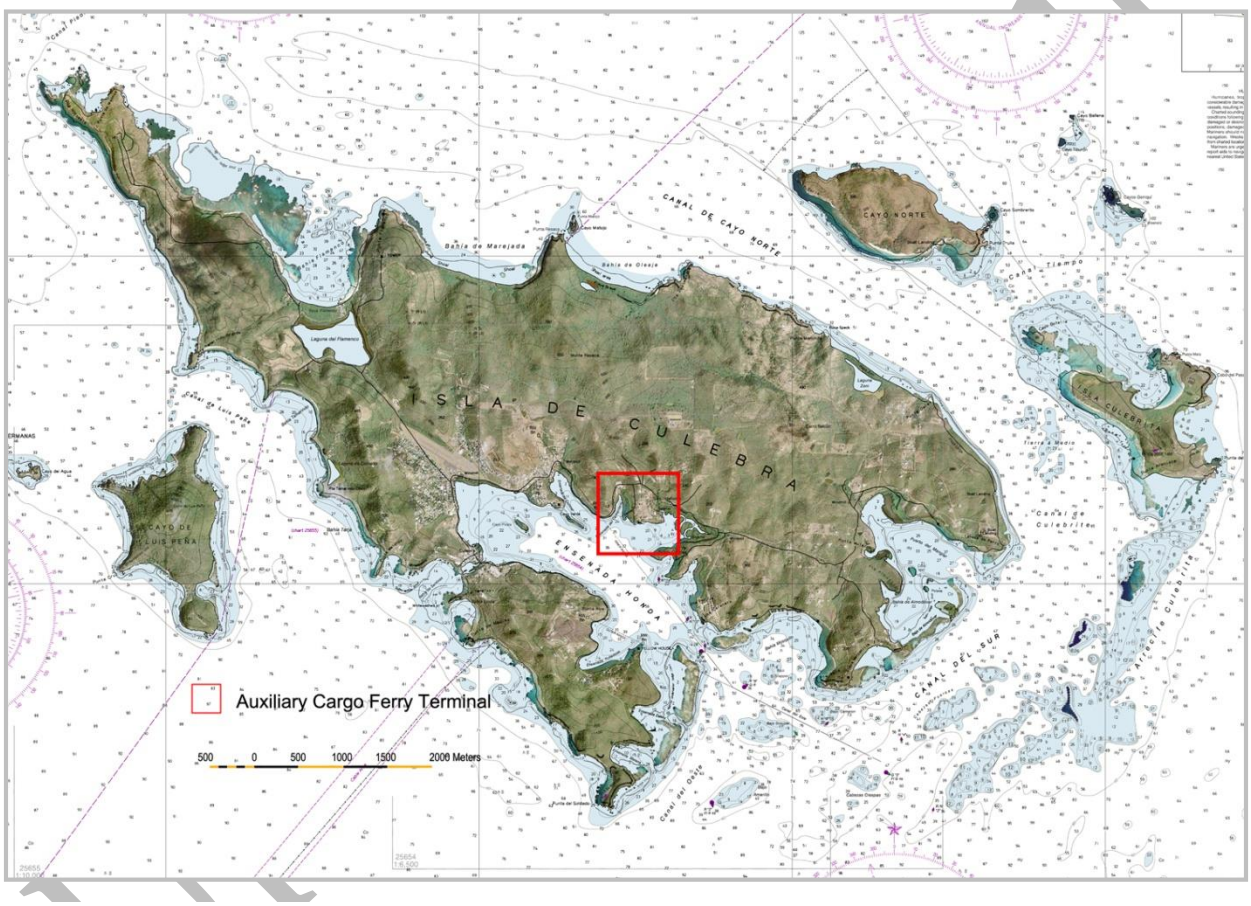

Figure 1: *Location of the Auxiliary Cargo Ferry Terminal in San Ildefonso.*

2.0 Description of the Auxiliary Cargo Ferry Operation

2.1 Ferry Route

Once the Auxiliary Terminal is completed, the scheduled cargo ferry operation will move to San Ildefonso while the existing cargo platform in Sardinas Bay is demolished and rebuilt.

To reach the proposed Auxiliary Terminal in San Ildefonso by sea, the cargo ferry would travel south around Punta del Soldado and turn 40° NE in the "Canal del Oeste" between the lighted buoy (R "2", FI R 4s in the Nautical Chart) that marks "Bajo Amarillo", keeping this heading for approximately 1 nautical mile, where the "Canal del Este" is located. Once reaching Canal del Este, the cargo ferry must turn 325° NW to the entrance of Ensenada Honda, clearly marked by two buoys (G "9", FI G 4s and RN "10"). Once inside Ensenada Honda, the cargo ferry must travel an additional nautical mile before arriving at San Ildefonso on the northern shoreline (***Figure 2, Ferry Route***).

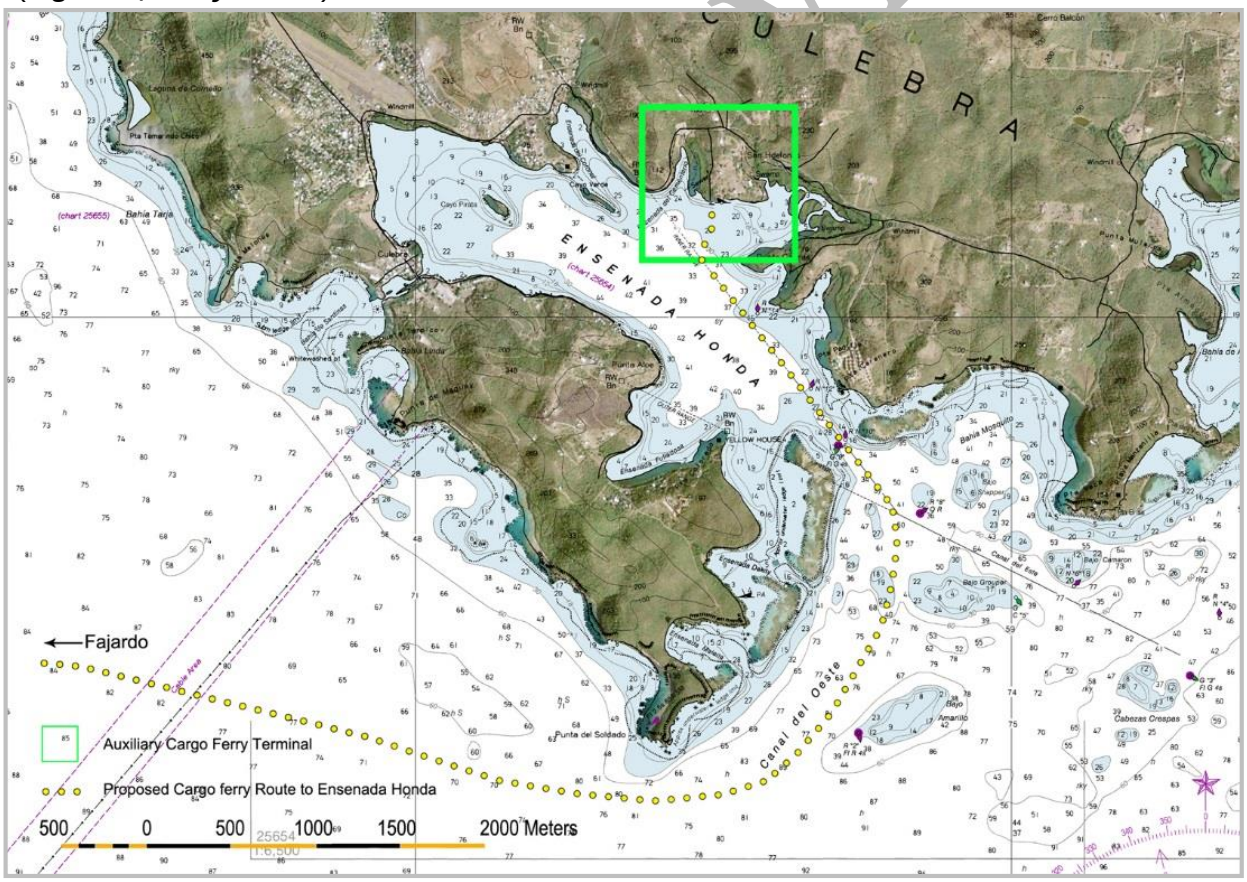

***Figure 2**: Proposed cargo ferry route to the Auxiliary Terminal in Ensenada Honda.*

2.2 Ferry Operation

The cargo ferry makes 2 round-trips on Mondays, Tuesdays and Thursdays, and 3 round-trips on Wednesdays and Fridays for a total of 10 round-trips per week. The cargo ferry service is expected to operate from the Auxiliary Terminal for approximately 7 months.

During docking maneuvers, prop wash created by the cargo ferry at San Ildefonso will cause the resuspension of sediments, which could potentially impact the seagrass beds near the facility. However, it is expected that the uplift of sediments will gradually diminish, since the continuous use of the terminal by the cargo ferry will create a new bottom topography.

Existing habitats near the Auxiliary Terminal are not anticipated to be degraded from these activities. Nevertheless, the resuspension of sediments by prop wash will be monitored at three sites. Two monitoring stations will be located in the operational area (***Figure 3***), while one will be located off site in Ensenada Honda and used as a reference station.

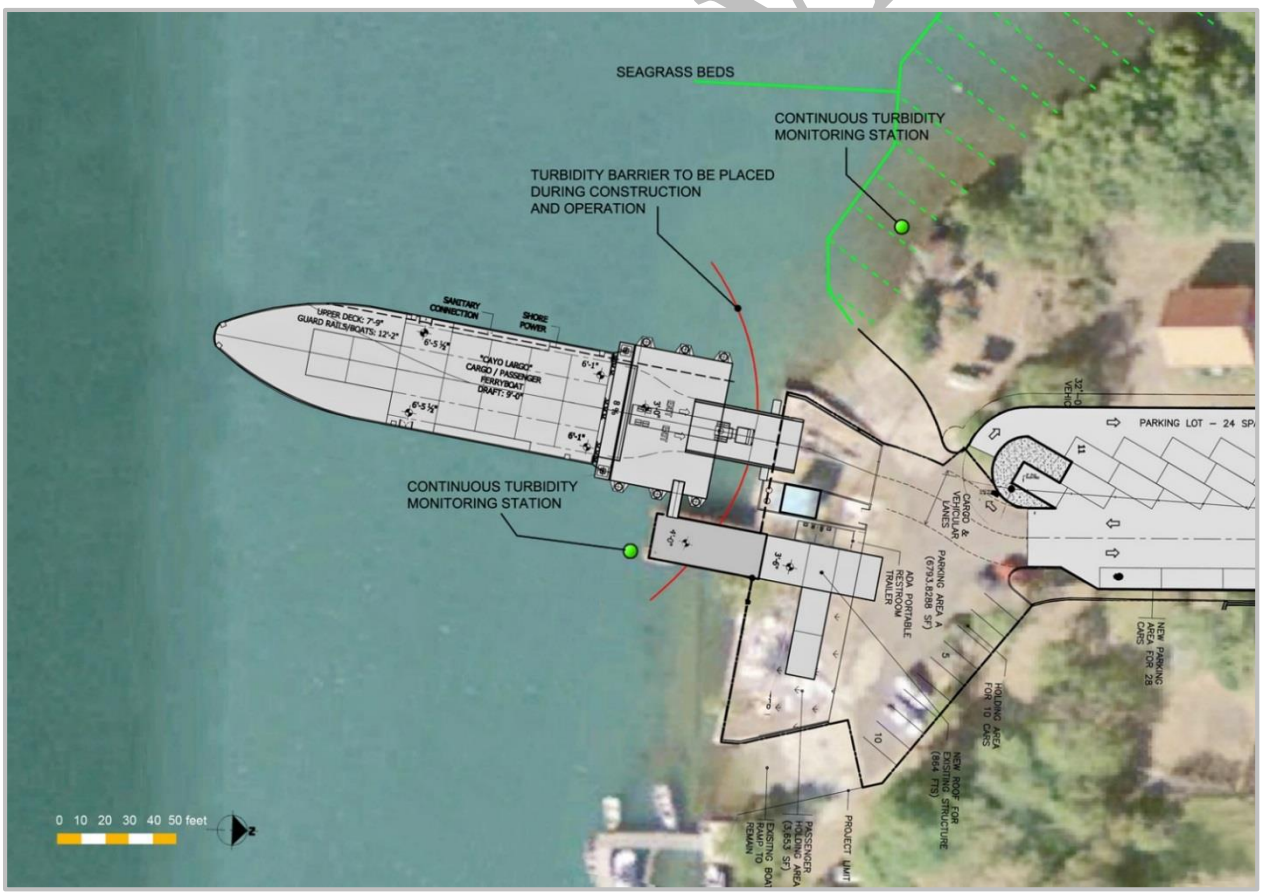

Figure 3: *Proposed Layout Plan for the Auxiliary Terminal with the location of the monitoring stations.*

3.0 Turbidity Monitoring Plan

3.1 Regulatory Frame

The Puerto Rico Water Quality Standards (WQS), as amended August 19, 2014, defines the waters of the Municipality of Culebra in San Ildefonso as Class SB. Class SB includes the coastal and estuarine waters not classified as Class SA or SC under Rules 1302.1 (A) and (C) of the WQS regulation. Class SB classification will apply from the zone subject to the ebb and flow of tides (mean sea level) up to 500 meters (0.31 mile) seaward from said zone. Beyond said limit, the next less restrictive classification will apply to a maximum of 10.35 miles seaward.

Class SB waters are defined as *"waters intended for use in primary and secondary contact recreation, and for propagation and preservation of desirable species, including threatened or endangered species"*.

For the purpose of this monitoring plan, only the turbidity standard will be monitored in compliance with the State regulation, which will not exceed 10 nephelometric turbidity units (NTU), except by natural causes.

3.2 Turbidity Monitoring Equipment

3.2.1 Continuous Turbidity Monitoring Instrument

There are a variety of continuous water quality monitoring instruments available from different manufacturers which offer different designs, options and combinations of sensors. For the purpose of this monitoring plan, a single parameter sonde with a reading range from 0 to 1,000 NTU, a resolution of 0.1 NTU, and accuracy of ± 2 % or 0.3 NTU is recommended for turbidity monitoring

***Above**: Turbidity spectrometers*

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For better accuracy and maintenance, sensor deployment should not be longer than a period of 30 days, even though spectroscopic instruments can sometimes be deployed for longer periods of time. Some sensors or instrument casings are available in titanium (vs. stainless steel) and can be used in salt water environments. Due to the errors introduced from biofouling, many manufacturers now offer an anti-bio-fouling kit.

Finally, it is important to consider the functions provided by the instrument. Instruments may feature different types of battery packs, internal logging capabilities and memory capacities. All of these options have to be considered when selecting and purchasing the instruments for the 3 stations.

3.2.2 Data Logger or Display Unit

The data loggers bridge the gap between instruments immersed underwater and the telemetry system used to relay water quality data to a database. The data logger will retrieve and store data from the turbidity spectroscope at pre-determined intervals specified in the data logger programming and ensure the data is available to the telemetry unit. When selecting a data logger, it is important to choose one that is compatible with the instrument and telemetry equipment in use. However, handheld display units are usually sold in conjunction with the multi or single parameter instruments and work as data loggers. Handheld display units are useful in the field setting and connect to the instrument via a field cable. The field units allow the user to view the turbidity data in situ or via connection in the station shelter.

3.2.3 Calibration and Standardization

Turbidimeter calibration: The operating instructions from the manufacturer should be followed closely. The measuring standards on the turbidimeter should cover the range of interest established. If the instrument is already calibrated in standard turbidity units, this procedure will check the accuracy of the calibration scales.

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Recommended Instrument

A single parameter optical monitoring sonde is recommended for this monitoring plan. Most of these instruments are display and data logger compatible.

***Above**: Examples of YSI and Hydrolab single and multiparameter sondes*

Power Supply

The power requirement for a monitoring station shelter varies, depending on the equipment to be used. In urban areas, an electrical supply can be established from the power grid by contacting the power provider. If required, Stations 1 and 2 can have power access from the Auxiliary Terminal facility.

The contractor will be responsible for the shelter installation planning, construction, maintenance, and functionality of the equipment.

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3.3 Suggested Instrument Deployment

3.3.1 Pier Deployment

The general structure for this type of deployment is a PVC or other durable plastic pipe affixed to the vertical column of the pier. The instrument is fed through the piping to the desired depth within the water column (***Figure 4***). At the end of the pipe, 1 inch holes are cut to allow for adequate water flow over the sensors. The instrument can be accessed from the pier by pulling it up through the pipe by the attached aircraft cable.

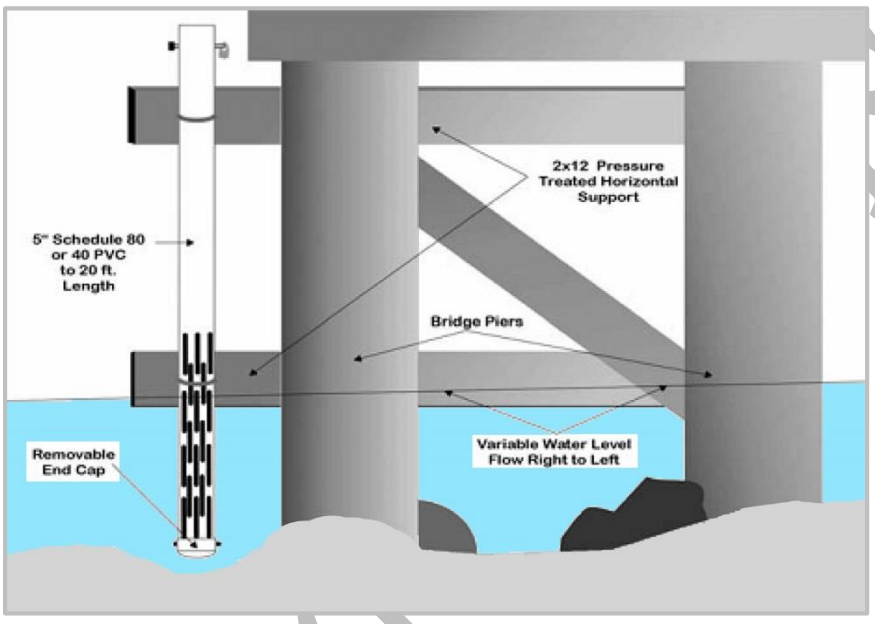

Figure 4*: Suggested pier deployment.*

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3.3.2 Shore Deployment

To avoid impacts to the seagrass beds, a deployment can be built to better position an instrument in seagrass areas. This structure is a series of angled-iron supports driven into the seabed, which supports a length of 2”x12” treated wood (***Figure 5***). A section of PVC piping with a width of 5 inches is attached to the 2”x12” treated wood. This structure holds the instrument at the desired depth above the sand, but is accessible from shore by pulling on the aircraft cable attached to the instrument.

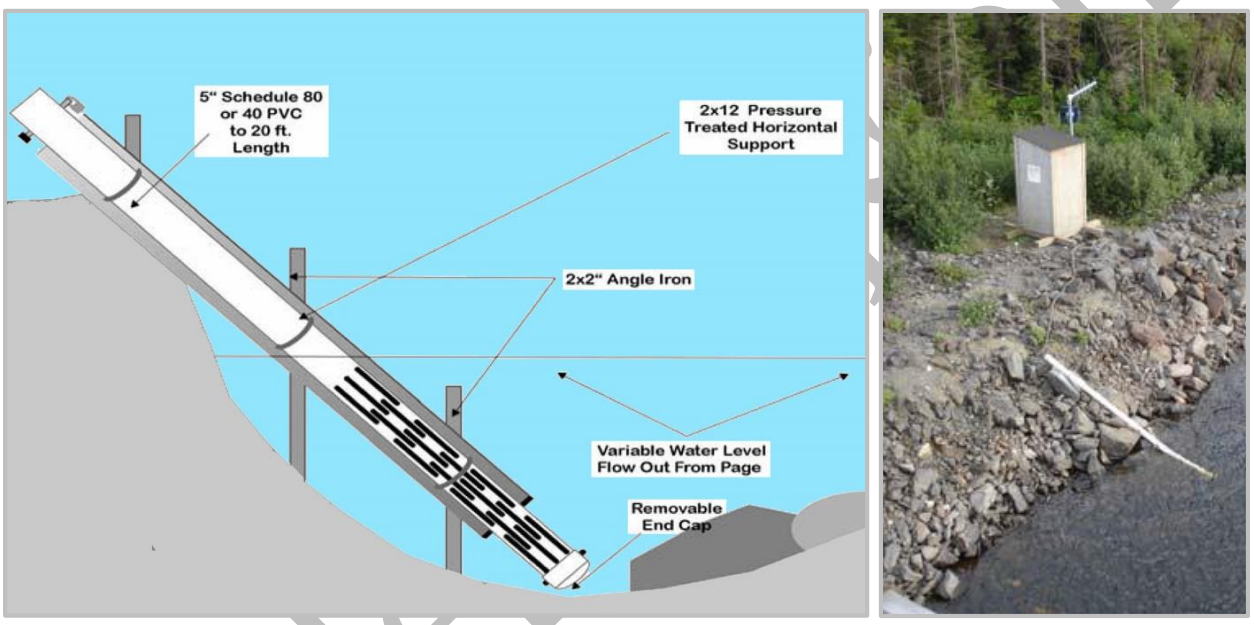


Figure 5 *Suggested shoreline deployment*

3.4 Turbidity Monitoring Protocol

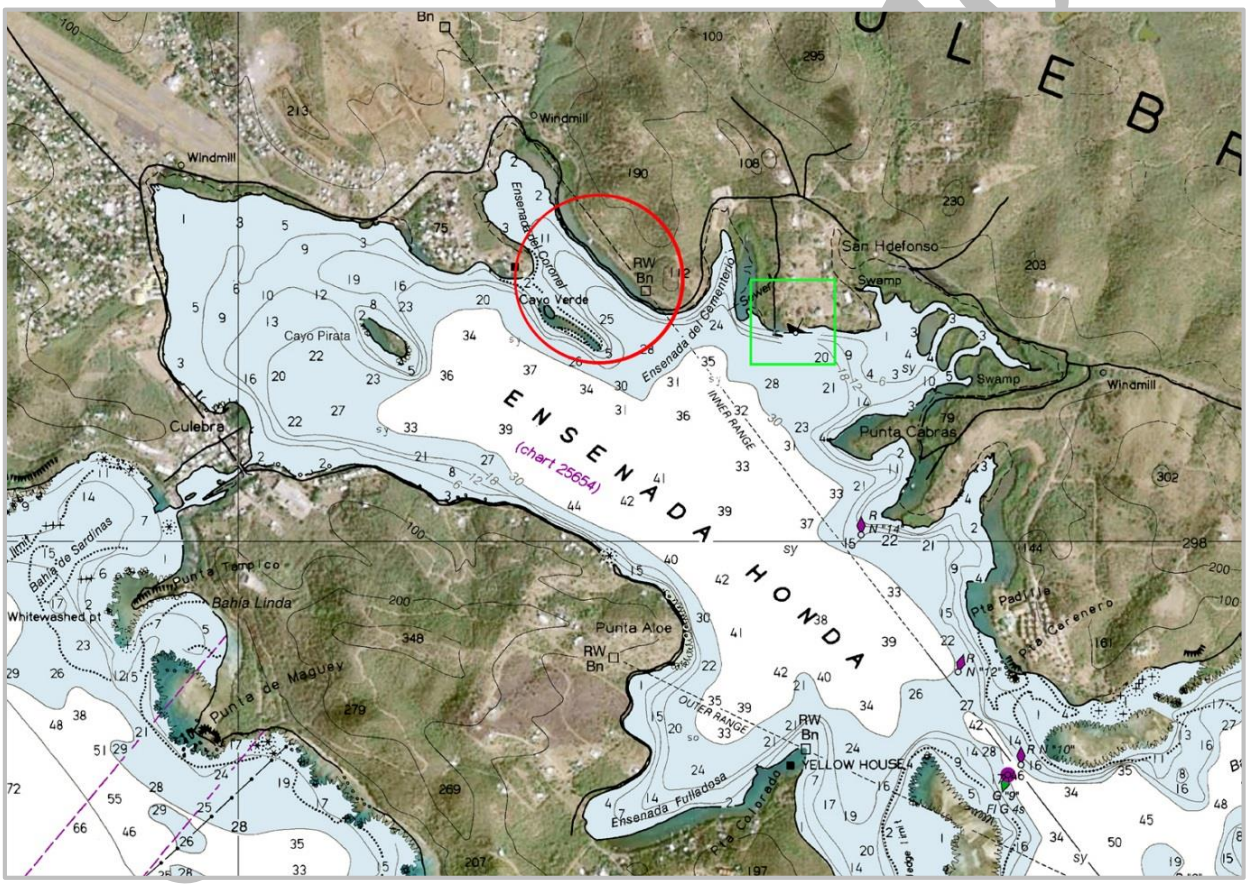
The contractor will monitor turbidity concentrations at the 3 stations to be located within and outside the operational area. Turbidity monitoring will take place before, during and after docking/undocking maneuvers in San Ildefonso. Reading intervals will be of 5 minutes, starting 15 minutes before docking/undocking maneuvers and culminating 45 minutes after the operation has ended.

Under Review

Station 1 will be located at the end of the pier in San Ildefonso, **Station 2** will be located at the Seagrass bed near the Auxiliary Facility, and **Station 3** will be located outside the operation area between Ensenada del Cementerio and the Ensenada Coronel area. (***Figure 6***)

The contractor will be responsible for preparing the monitoring protocol documentation which will include the Calibration Protocol, Calibration Log Sheet, and Field Monitoring Data Sheet.

The calibration protocol must establish monitoring frequency at the exact locations, calibration frequency and thresholds for corrective actions in case that the instrument strays during field works.



4.0 Seagrass Monitoring Plan

4.1 Regulatory Frame

The 50 CFR Part 226 designates the waters surrounding Culebra, Puerto Rico as Critical Habitat necessary for the continued survival and recovery of green (*Chelonia mydas*) and hawksbill (*Eretmochelys imbricata*) turtles in the region. Seagrasses are the principal dietary component of juvenile and adult green turtles throughout the Wider Caribbean region. The seagrass beds of Culebra consist primarily of turtle grass (*Thalassia testudinum)* and includes waters extending seaward 3 nm (5.6 km) from the mean high water line of the island.

4.2 Seagrass Biological Monitoring

Background

When evaluating seagrass biomass, it is not clear of how bed boundaries are interpreted, but it appears to be correlated with exposure to waves and currents. Seagrasses can reduce erosion and enhance sediment accumulation. Seagrass patterns also change, revealing areas of coverage loss and gain at meter scales within short time periods (months), attesting to the consistent ability of seagrasses to stabilize sediments. Seagrasses and their associated epiphytes are highly productive, produce a structural matrix on which many other species depend on, improve water quality, and stabilize sediments.

Because of their requirements for high light levels, seagrasses are restricted to shallow coastal areas where anthropogenic disturbances that damage or kill them are common. Unfortunately, once seagrasses die, the sediments they helped stabilize may be resuspended into the water column, potentially lowering light levels to intensities that may not allow other seagrasses to recover in the same area unless the entire watershed is managed to improve water clarity.[1]

There are 7 species of seagrass recognized in the Caribbean:

- *Thalassia testudinum* (turtle grass): The most abundant seagrass in the Ensenada Honda region. It forms dense rhizome mats below the sediment, creating extensive meadows on shallow sand or mud substrates from the lower intertidal to a maximum 10 to 12 meters (32 to 40 feet) in depth.

[1] Fonseca, MF, WJ Kenworthy, and GW Thayer. 1998. *Guidelines for the conservation and restoration of seagrasses in the United States and adjacent waters.* NOAA

Under Revision

- *Syringodium filiforme* (manatee grass): Usually grows intermixed with *Thalassia testudinum*, but can grow in monospecific meadows or patches from the upper sublittoral to more than 20 meters.
- *Halodule wrightii* (shoal grass) Found throughout the wider Caribbean region. It is found growing on sand and mud from the intertidal down to 5 meters (15 feet).
- *Ruppia maritima* (widgeon grass): Found throughout the Caribbean. It is a shallow water species found in the brackish waters of bays and estuaries between 0 and 2.5 meters (8.2 feet) in depth. This species was not identified during assessments at San Ildefonso.

The 3 species belonging to the genus *Halophila* are small and delicate:

- *Halophila decipiens*: Typically found in deep water at up to 30 meters (98.4 feet) in depth. During assessments, scattered patches of the species were observed in the area of San Ildefonso.
- *Halophila engelmanni:* Found only down to 5 meters is restricted to the Bahamas, Florida, the Greater Antilles and the western Caribbean. *Halophila engelmanni* generally occurs as an understory species, commonly associated with *Syringodium* and *Halodule*, and only occasionally with *Thalassia*. It is generally a shallow water species in turbid waters. A very small plant, *H. engelmanni* rarely exceeds 10 centimeters in height. Its habitat is generally in sandy and muddy substrates, but it can also be found in areas with gravel or rock bottom. Listed as Near Thretened by the IUCN Red list of Threatened Species due to its decline in population. Was not identified at the site.
- *Halophila baillonii*: In the Caribbean region it is only found in the Lesser Antillies. Rare in Puerto Rico.

An area of 0.8 acres of un-impacted *Thalassia* seagrass bed with a dense growth (100% cover) is located at a distance of approximately 13 feet from the seawall of the Auxiliary Terminal (***Figure 7)***. Even though potential damages to this area are least probable, its monitoring is vital to prevent any damage to its health, as stated in the 50 CFR 226.

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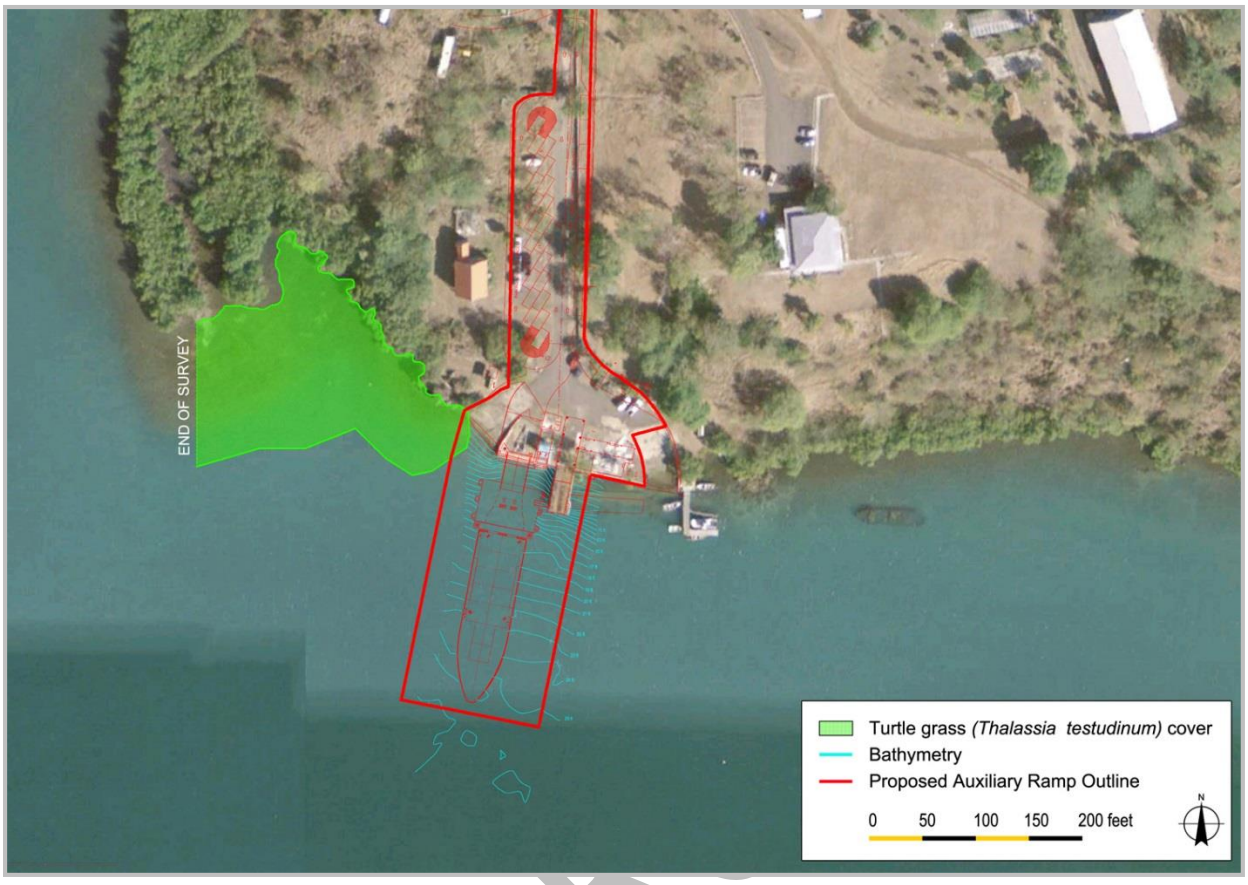
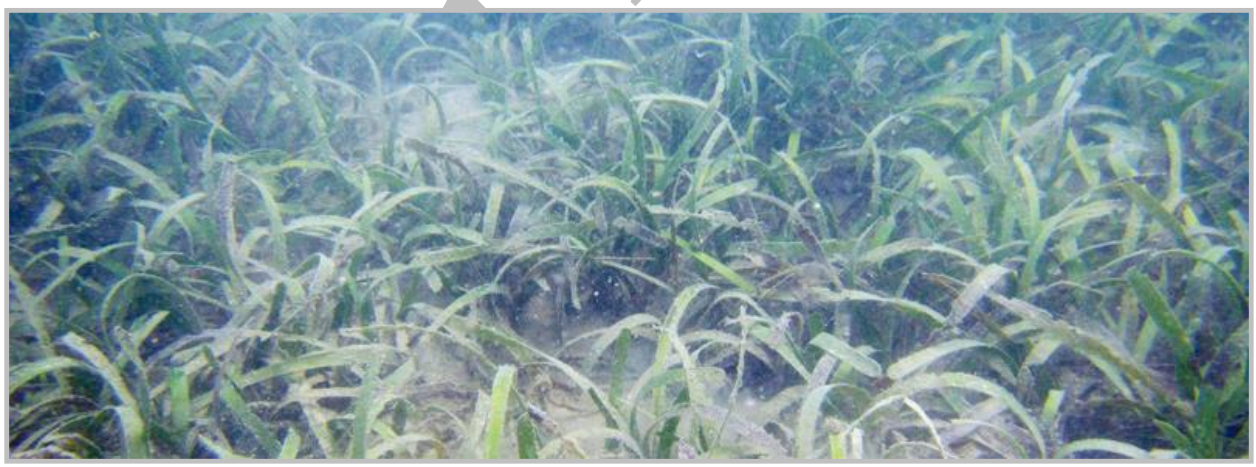


Figure 7: *Seagrass beds near the Auxiliary Terminal*



Above*: General view of the seagrass habitats located west of the proposed Culebra Auxiliary Cargo Terminal at San*

This Monitoring Plan presents the methodology to monitor biological changes to the identified area of impact as result of the operation of the Cargo Ferry at the San Ildefonso Auxiliary Facility.

4.3 Seagrass Monitoring Protocol

4.3.1 Monitoring Frequency

This seagrass bed will be monitored prior to commencing operations at the San Ildefonso Auxiliary Terminal, and then every 3 months until end of operations, when the construction of the Cargo Ramp at Sardinas has been completed. Additional monitoring may be required after the occurrence of extreme weather events, such as storm surge or 100-year raining event.

4.3.2 Methodology

The contractor will plot at least three transects lines on the seagrass meadow aligned parallel to shore (***Figure 8***). Each transect shall be separated from each other by a distance of approximately 10 to 15 feet. Three quadrats of 1 m^2 will be fixed equidistant from each other along each of the three transects, beginning at the nearest point to the operational area down to the farthest point. Each transect and quadrat will be marked with a GPS.

Necessary materials & equipment

- *50m fiberglass measuring tape*
- *Temporary markers (e.g., plastic tent pegs or flags)*
- *9 permanent markers (e.g., 1.5-2' PVC pipe (1/2 in diameter))*
- *Geographic Positioning System (GPS)*
- *Hand held compass*
- *Sketch map for site location*
- *30cm ruler*
- *One 1m² PVC quadrat with 0.1 m grid.*
- *Seagrass datasheet*
- *Notebook and pencil*

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Transect establishment

The establishment of transects should be achieved with minimum disturbance of the surrounding seagrass beds. Each transect will be marked with three permanent markers, one at the beginning, one in the middle and other at the end of the transect. These markers will be kept in place throughout the monitoring period.

For the first transect (closer to the shoreline), place a temporary marker or flag in the sediment within the continuous seagrass bed approximately 1 meter inside. A permanent post/ marker, will be hammered or screwed a into the sediment so that only a few centimeters remain above. This will be marked **T1-A**. A GPS waypoint shall be marked in this location.

To establish the end of the transect, from T1-A take a compass bearing in the direction that crossed over the seagrass bed, staying parallel to the shoreline. The transect should not be over 50 meters in length. At the 50 meter mark or at 1 meter before the seagrass bed ends, hammer or screw a permanent post/ marker. This will be the end of the transect, identified as **T1-C**. Once the two ends of the transect are established, proceed to mark the middle point of the transect, which will be identified as **T1-B**.

For the other transects, repeat the directions above starting at a separation of approximately 10 to 15 feet from the previous transect.

Quadrants establishment

Three quadrats should will be located for each to the three cross-transects. The position of the quadrats will be on the shoreline side of the measuring tape or transect line. The location will be at 1 meter in front of the permanent mark, at the beginning and middle of the transect, and at 2 meters before the end permanent mark of the transect. The dimensions of the quadrat will be 1 x 1 meter (1 m²) with a 0.1 meter grid.

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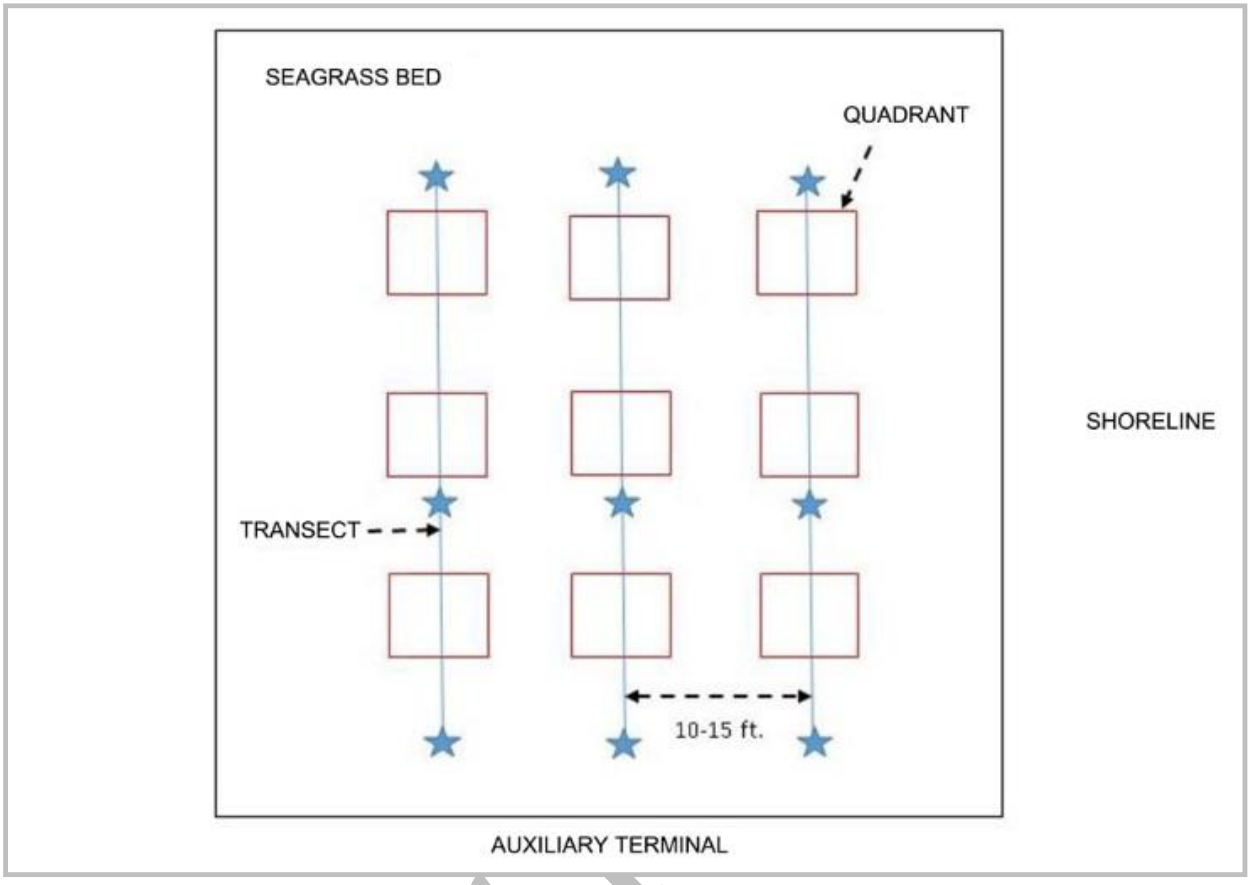

***Figure 8**: Example of transect/quadrant layout*

Parameters to measure for each quadrat

Qualitative observations on seagrass color, epiphytes, percent cover, decay, canopy height and biomass will be noted on the monitoring on each quadrat.

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1. Photographs

Take photographs of the quadrat. Photos are taken first, to avoid re-suspending sediments by walking or swimming in the area, which would affect the photo quality.

- First place the photo quadrat labeler beside the quadrat with the correct transect, cross-transect, and quadrat number on it (e.g., quadrat number is T1-QA; T1 = transect number, QA = quadrat number).

- Take the photograph perpendicular to the bottom, including the entire quadrat frame (if possible), the quadrat label and the tape measure. Try to avoid having any shadows or patches of reflection in the field of view. Ideally, photos should be taken when the seagrasses are exposed at the surface (intertidal plants) and the photographer is standing, or when the seagrasses are submerged (subtidal and flooded intertidal plants) and the photographer is swimming. Intermediate depths make obtaining clear vertical photographs difficult. Mark the "Photograph" box on the datasheet for that quadrat.

- In some instances, such as due to tide levels, you may also need to take another photograph from an oblique angle (e.g., 45 degrees), which includes the entire quadrat frame and the quadrat label. Similarly, try to avoid having any shadows or patches of reflection in the field of view. Mark the Photograph box a second time on the datasheet for that quadrat to indicate a second photo has been taken.

2. *Percent Cover*

Determine the total cover percentage of seagrasses within each quadrat – use the cover percentage photo guide (***Appendix A***). Attached algae and non-mobile live or dead animals should be included as part of the percent cover estimates as “non-seagrass”. Record the cover percentage on your data sheet. If the quadrat lands on an area with no seagrasses, this should be recorded as “zero”. If seagrass is present, record the appropriate cover percentage for all species combined within the quadrat under “Total species cover”.

3. *Percent cover by species*

Identify which seagrass species are found inside the quadrat and record each on the datasheet using the species abbreviations (see the *Regional Supplement for species identifications guides)*. Next, determine the percent cover by species of each of the species and record this on the data sheet. We suggest determining the % cover for the species with the lowest % cover first and then working up from there.

4. *Canopy height and grazing*

Using the ruler, measure in centimeters the height (length of the seagrass leaf blades) for the dominant species (the species with the highest percent cover). Do this randomly by selecting a

Under Revision

clump of seagrass blades from within the quadrat and measuring its height, ignoring the tallest 20% of leaves. Extend the leaves to their maximum length/height, without uprooting, and measure from the substrate to the leaf tip. If seagrass density is very low and a clump of blades cannot be grouped, make measurements on five individual shoots of the dominant species within the quadrat and calculate the average. Record the canopy height (average leaf length) on the data sheet.

Check the seagrass in the quadrat for evidence of grazing, e.g., turtle or manatee feeding trails. Record if there is grazing evidence, and write in the notes what type of grazing you think it is under Comments.

5.0 Monitoring Report

A monitoring report must be submitted to the Puerto Rico Ports Authority after each monitoring event. This should include copy of all data sheets, date of the event, summary of the findings, general condition of the seagrass beds, any concern related to the seagrasses and recommendations.

The report should be submitted 30 days after the monitoring event.

Under Revision

6.0 References

50 CFR § 226. 207-208 (1998) Wildlife and Fisheries Designated Critical Habitat for green turtle and hawksbill turtle.

ATKINS (2014) San Ildefonso Benthic Report.

Fonseca, MF, WJ Kenworthy, and GW Thayer. 1998. Guidelines for the conservation and restoration of seagrasses in the United States and adjacent waters. NOAA Coastal Ocean Program Decision Analyses Series No. 12. NOAA, Washington, DC

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PREQB (2014) Puerto Rico Water Quality Standards, Act 7837, 2010, amended August 19, 2015, www.jca.pr.gov , searched September 10, 2015.

Short, F.T., Mckenzie, L.J., Coles, R.G. Vidler, K.P., Gaeckle, J.L. (2006) SeagrassNet Manual for Scientific Monitoring of Seagrass Habitat. Worldwide edition. University of New Hampshire Publication. 75 pp.

Short, F.T., Carruthers, T.J.R., van Tussenbroek, B. & Zieman, J. 2010. *Halophila baillonii*. The IUCN Red List of Threatened Species 2010: e.T173382A7004500. http://dx.doi.org/10.2305/IUCN.UK.2010-3.RLTS.T173382A7004500.en . Downloaded on **05 October 2015**.

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Short, F.T., Carruthers, T.J.R., van Tussenbroek, B. & Zieman, J. 2010. *Thalassia testudinum*. The IUCN Red List of Threatened Species 2010: e.T173346A6995927. http://dx.doi.org/10.2305/IUCN.UK.2010-3.RLTS.T173346A6995927.en . Downloaded on **05 October 2015**.

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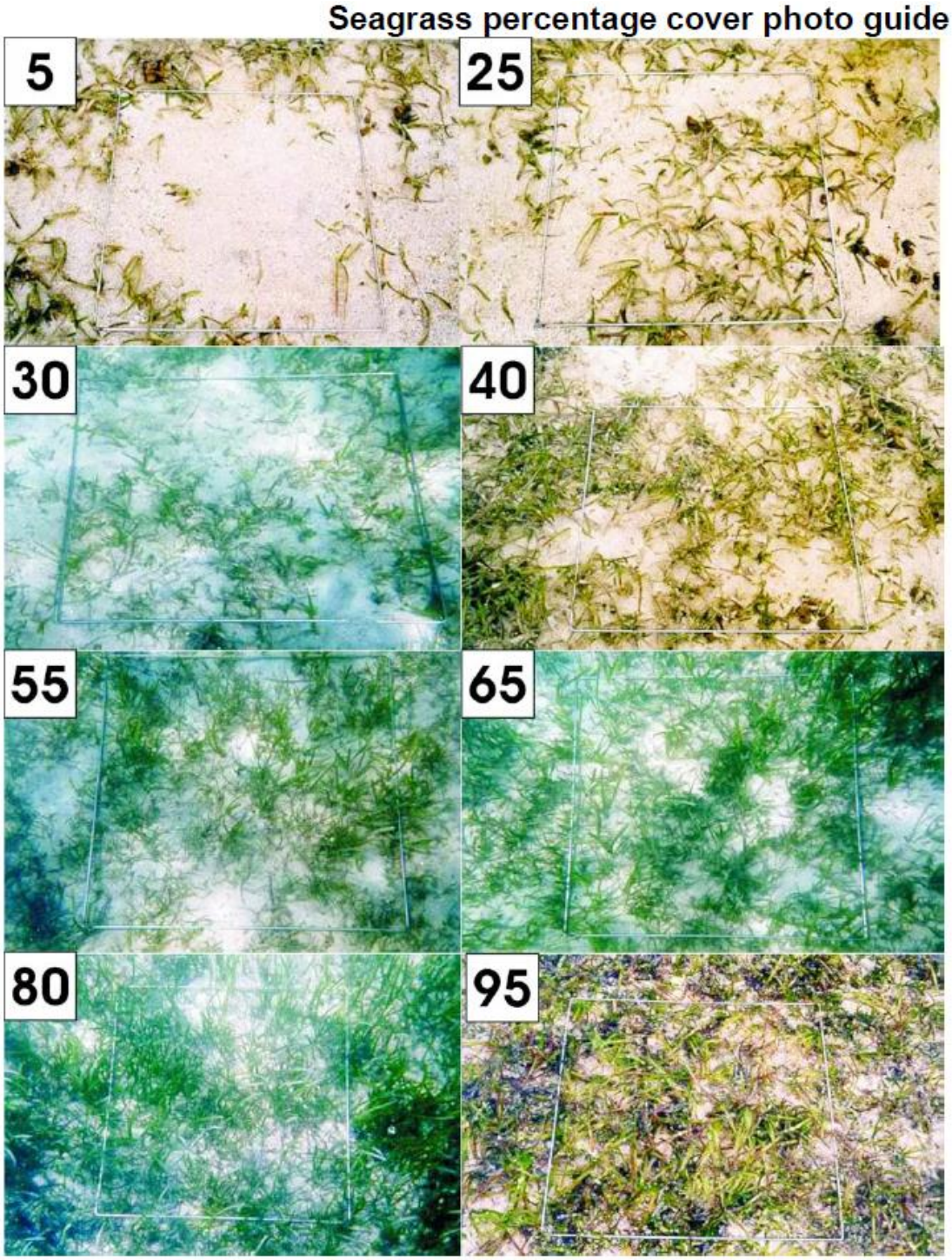
Appendix A



October 2015

Turbidity Monitoring Plan during the Construction of the Cargo Ferry Ramp in Sardinas Bay

Part of the Mitigation Plans for the

Impacts Associated to the Reconstruction of the Culebra Cargo Ferry Terminal in Sardinas Bay

Culebra, Puerto Rico

Prepared For :

AUTORIDAD de los PUERTOS de PUERTO RICO

Prepared By:

ATKINS

Contents

1.0 Introduction 3

2.0 Project Description 5

3.0 Turbidity Monitoring Plan during Construction at Sardinas 10

3.1 State Regulatory Frame 10

3.2 Portable Turbidity Meter 10

4.0 Monitoring Protocol 13

4.1 Monitoring Documentation 13

4.2 Monthly Reports 13

5.0 References 14

Under Revision

1.0 Introduction

The Puerto Rico Ports Authority (PRPA) conducted a structural evaluation at the Culebra Cargo Ferry Terminal on August, 2010, where advanced deterioration was observed in the deck slab and concrete beams, which has probably spread to the entire concrete surface. This appears to be a result of storm events, hurricanes and the wave action. Furthermore, if the repair and reconstruction of the cargo terminal is not conducted promptly, structural failure may occur. The PRPA has since been planning the necessary works, seeking financing and regulatory compliance.

Key stakeholders, Federal and State Agencies have been engaged since the structural deterioration findings from 2010 to thoroughly assess any potential damage to the environment through the implementation of attenuation, mitigation and/ or avoidance actions that may cause the reconstruction of the Culebra Cargo Ferry Terminal Project. Sediment resuspension in the water column is expected to occur during the removal and drilling of the cargo-platform and mooring dolphin piles. The following turbidity control and monitoring plan has been prepared in order to mitigate potential impacts caused by sediment resuspension during construction.

Therefore, this Turbidity Monitoring Plan during the Construction of the Cargo Ferry Ramp in Sardinas Bay has been prepared in accordance with the FEMA 44 CFR Part 10 Regulations, the Department of Homeland Security's Management Directive 5100.1, and the Council on Environmental Quality 40 CFR Part 1500-1508 Regulations thus complying with the NEPA process.

This monitoring plan shows the methodology and equipment required to assess turbidity values due to the construction of the Culebra Cargo Ferry Ramp.

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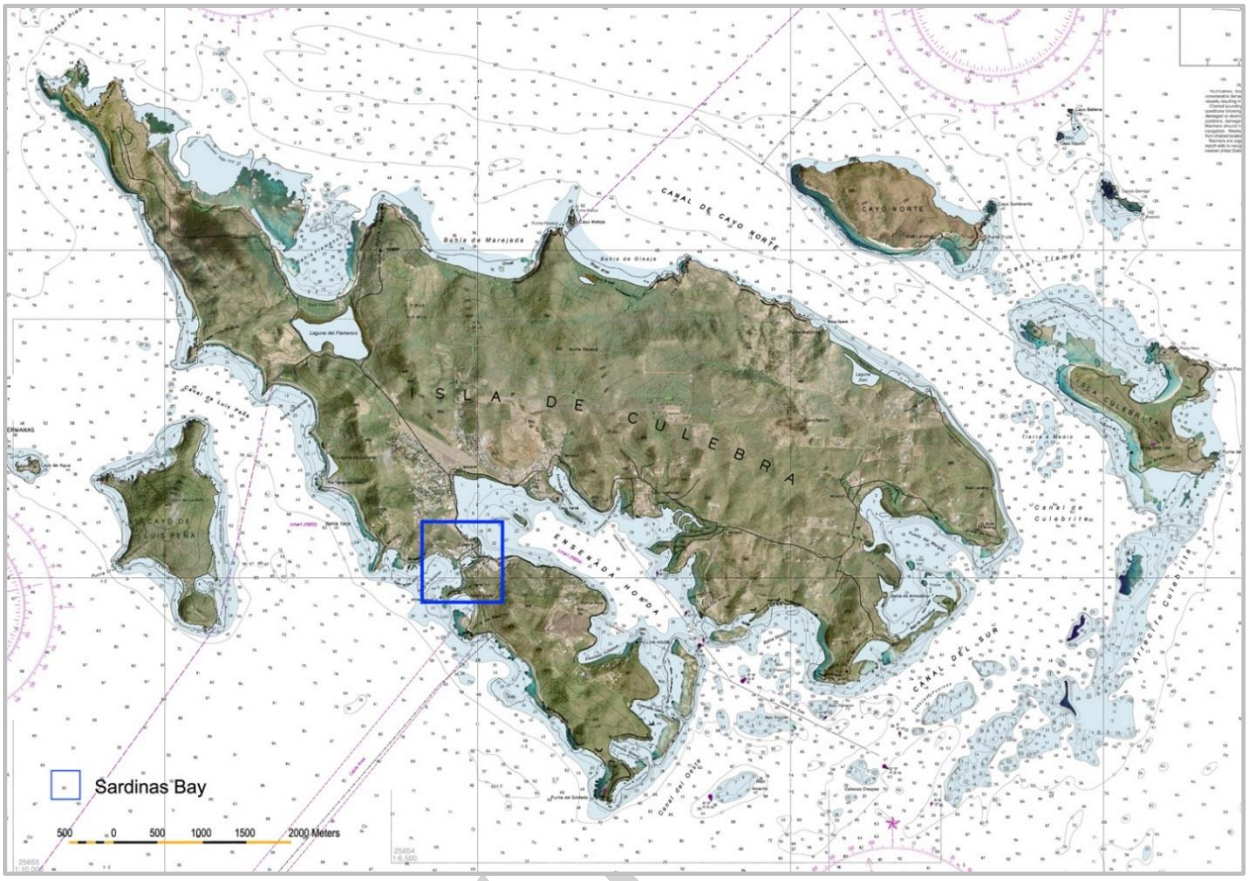

Figure 1: *Location of the Culebra Cargo Ferry Terminal in Sardinas Bay.*

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2.0 Project Description

The construction of the Culebra Ferry Terminal Cargo Ramp in Sardinas Bay consists of the demolition of the existing concrete platform, which measures approximately 4,907 square feet, as well as the removal of the 27 existing H-piles, which measure 15 by 15 inches.

Once the demolition has been completed, 25 piles of 20 inches in diameter will be driven over the existing cargo ramp footprint which will support the new cargo ramp of 5,501 square feet. The new cargo facility will have a passenger boarding bridge that will measure approximately 10 feet wide by 100 feet long for passengers to board and disembark the cargo ferries. This boarding bridge will be attached at one end to a mooring dolphin, which will be supported by 4 pilings of 20 inches in diameter. Three 20-inch diameter pilings will support the boarding bridge

A mooring dolphin measuring 10 by 10 feet will be installed on the passenger ferry dock to improve docking safety. This mooring will be supported by 4 pilings of 20 inches in diameter. An operation catwalk measuring 4 feet in width by 25 feet in length will connect the passenger ferry terminal with the mooring dolphin, which will provide access to the mooring during docking maneuvers. ***Figure 2*** *illustrates the construction features described above.*

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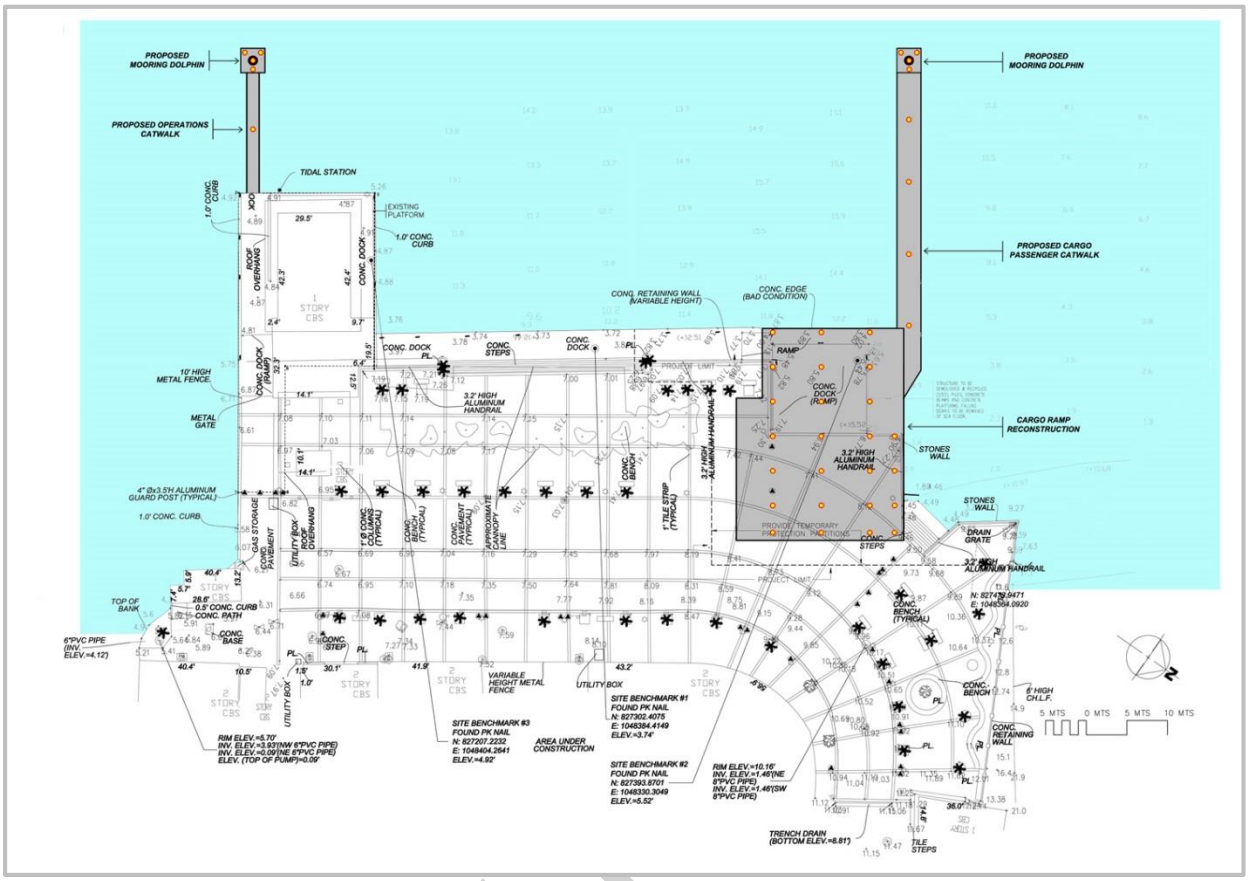

Figure 2: *Construction layout. The location of the pilings is shown by the yellow/red dots.*

Resuspension of sediments during construction will be controlled by installing a turbidity barrier surrounding the construction perimeter. ***Figure 3 Proposed Turbidity Barrier Layout Plan*** is showing the elements of the construction of the Cargo Ferry Terminal in Sardinas and the turibidity barrier layout.

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Figure 3: *Proposed Turbidity Barrier Layout Plan of the Sardinas Bay Cargo Ferry Terminal. Areas shadowed in grey are the proposed location of the mooring dolphins, passenger boarding bridge, operations catwalk, and cargo ramp.*

The construction of the new cargo ramp facilities is estimated to take approximately 6 months. During this period, a spud barge, which will be located in front of the cargo ramp, will be used as a deck for the demolitions equipment, materials and as a general construction/operations platform. A crane will be employed for the removal and relocation of the pilings. Turbidity barriers will be installed by the contractor, which will delimit the turbidity control area of the construction. ***Figures 4*** and ***5 Turbidity Barrier Types & Details***.

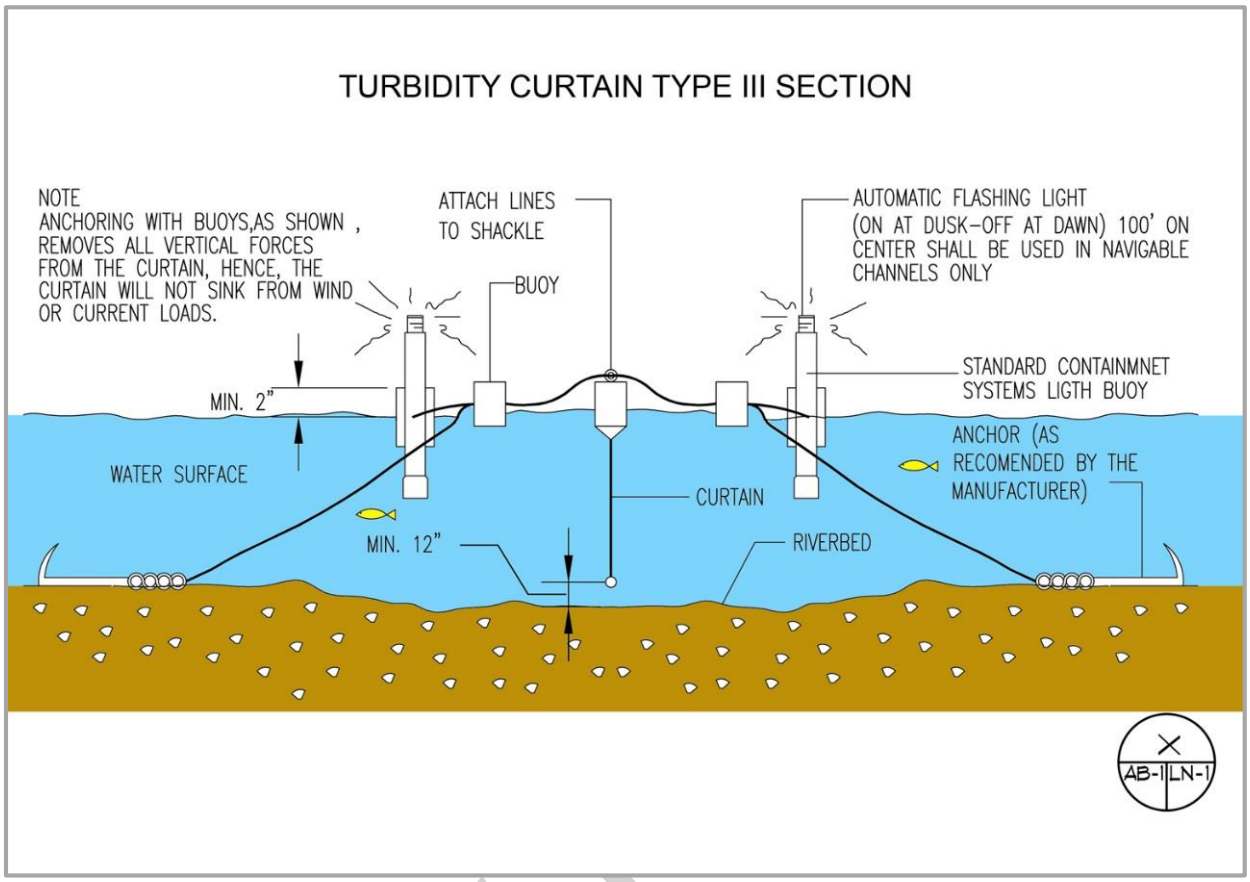

Figure 4: *Turbidity Barrier Type III Section.*

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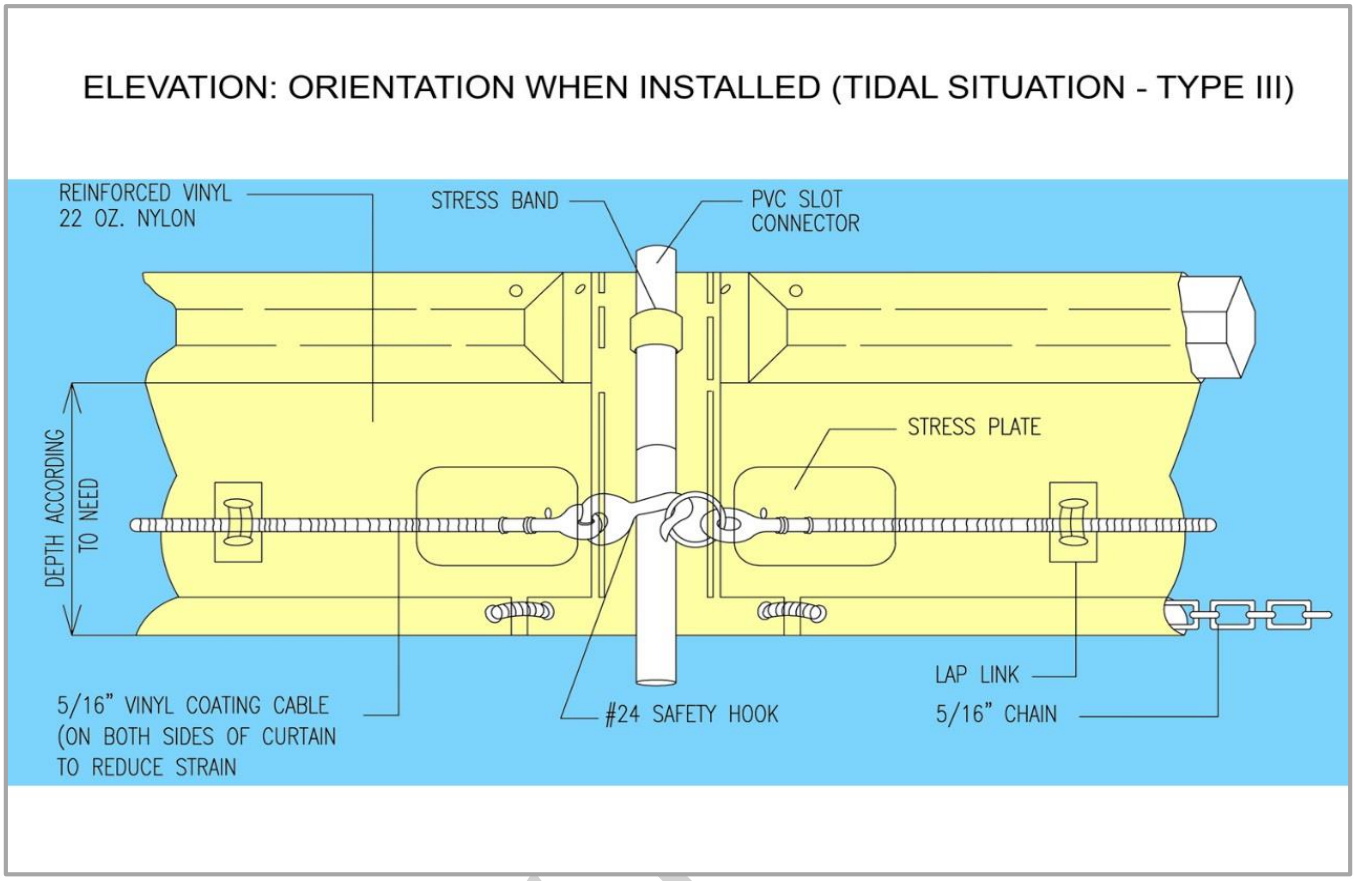

Figure 5: *Turbidity Barrier Detail*

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3.0 Turbidity Monitoring Plan during Construction at Sardinas

3.1 State Regulatory Frame

The Puerto Rico Water Quality Standards (WQS), as amended August 19, 2014, defines the waters of the Municipality of Culebra at Sardinas Bay as Class SB. Class SB includes the coastal and estuarine waters not classified as Class SA or SC under Rules 1302.1 (A) and (C) of the WQS regulation. Class SB classification will apply from the zone subject to the ebb and flow of tides (mean sea level) up to 500 meters (0.31 mile) seaward from said zone. Beyond said limit, the next less restrictive classification will apply to a maximum of 10.35 miles seaward.

Class SB waters are defined as *"waters intended for use in primary and secondary contact recreation, and for propagation and preservation of desirable species, including threatened or endangered species"*.

For the purpose of this monitoring plan only the turbidity standard will be monitored in compliance with the State regulation, which will not exceed 10 nephelometric turbidity units (NTU), except by natural causes.

3.2 Portable Turbidity Meter

3.2.1 EPA Method 180.1

EPA method 180.1, "Determination of Turbidity by Nephelometry", is based upon a comparison of the intensity of light scattered by the sample under defined conditions with the intensity of light scattered by a standard reference suspension. The higher the intensity of scattered light, the higher the turbidity. Readings, in NTUs, are made in a nephelometer designed according to specifications laid out in the method. A primary standard suspension is used to calibrate the instrument. A secondary standard suspension is used as a daily calibration check and is monitored periodically for deterioration using one of the primary standards.

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3.2.2 Portable Turbidimeter

Grab Sample Portable Unit

Portable turbidimeters are similar to the bench top units, except that they are designed for portable use and are battery operated. Portable turbidimeters are available in a variety of designs, including the single beam and ratio designs. The accuracy of portable instruments is comparable to the bench top units, but the resolution of low turbidity reading may only be 0.01 NTU as compared to the 0.001 NTU resolution of bench top units (Hach Corporation, 1995).

***Above**: 21000 HQ Turbidimeter*

Portable turbidimeters are designed for use in the field with grab samples. These instruments are designed to be rugged and capable of withstanding the effects of moving the instrument as well as variable field conditions. However, since these instruments are inherently susceptible to damage or disturbance from dropping, abuse, or environmental conditions such as dust, these units are not appropriate for the process monitoring and reporting tasks normally accomplished by on-line turbidimeters. Portable instruments are useful for measuring turbidity at remote locations such as at sampling points and for special process studies, such as backwash recycle characterization or distribution system analysis that may be accomplished more readily and accurately in the field rather than conducting analysis after transporting a sample to a laboratory.

Single Parameter Sonde

Single parameter optical monitoring sonde is recommended for this monitoring plan thus most of these instruments are display and data logger compatible, and readings are recorded by submerging the instrument down to the desire depth.

***Above**: Turbidity Spectrometer to be installed in the sonde*

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Display Unit

The display unit will retrieve and store data from the turbidity spectroscope at pre-determined intervals specified in the data logger display unit programming and ensure the data is available to the telemetry unit. When selecting a display unit, it is important to choose one that is compatible with the instrument and telemetry equipment in use. However, handheld display units are usually sold in conjunction with the multi parameter instruments. Handheld display units are useful in the field setting and connect to the instrument via a field cable. The field units allow the user to view the turbidity data in situ or via connection in the station shelter.

***Above**: YSI Multiparameter Display Unit and Data logger*

3.3.3 Calibration and Standardization

Turbidimeter calibration: The operating instructions from the manufacturer should be followed closely. Measure standards on the turbidimeter covering the range of interest. If the instrument is already calibrated in standard turbidity units, this procedure will check the accuracy of the

***Above**: Examples of YSI and Hydrolab single and multiparameter sondes*

calibration scales. At least one standard should be run in each instrument range to be used. Some instruments allow adjustments of sensitivity so that scale values will correspond to

turbidities. If a pre-calibrated scale is not supplied, calibration curves should be prepared for each range of the instrument.

3.3.4 Recommended Instrument

The follwing instruments are recommended for the intended turbidity monitoring described in this plan. The 2100Q Portable Turbidimeter, compliant with USEPA Method 180.1 design criteria, or YSI or Hydrolab single parameter optical monitoring sonde.

4.0 Monitoring Protocol

The contractor will monitor turbidity units within and outside the turbidity barrier at least twice per day during construction activities that may cause the resuspension of sediments in Sardinas Bay (***Figure 2***). First turbidity reading will be taken in the morning, prior construction activities are started, and in the afternoon before construction activities are ceased.

Should the value outside the turbidity barrier exceed the standard for ambient marine waters of 10 NTU, construction activities will be suspended, unless the excessive turbidity is caused by natural events, as specified in Puerto Rico WQS regulation.

4.1 Monitoring Documentation

The contractor will be responsible for preparing the monitoring protocol documentation which will include the Calibration Protocol, Calibration Log Sheet, and Field Monitoring Data Sheet. The calibration protocol must establish monitoring frequency at the exact locations, calibration frequency and thresholds for corrective actions in case that the instrument strays during field works.

4.2 Monthly Reports

Monthly monitoring reports will be prepared and submitted during the first 10 days of the month. Reports will include a brief description of the observed general weather conditions, a table containing turbidity readings, and original monitoring and instrument calibration data sheet.

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5.0 References

EPA (1999) EPA Guidance Manual for Compliance with the Interim Enhanced Surface Water Treatment Rule: Turbidity Provisions, EPA 815-R-99-010.

FEMA (2011) 44 CFR §10 – Environmental Considerations

NEPA (2005) 40 CFR 1500.1, Title40, Volume 24, Parts 790 to End, Regulations for Implementing the Procedural Provisions of The National Environmental Policy Act.

NOAA (1998) Fonseca, MF, WJ Kenworthy, and GW Thayer. Guidelines for the conservation and restoration of seagrasses in the United States and adjacent waters. NOAA Coastal Ocean Program Decision Analyses Series No. 12. NOAA, Washington, DC

PREQB (2014) Puerto Rico Water Quality Standards, Act 7837, 2010, amended August 19, 2015, www.jca.pr.gov , searched September 10, 2015.

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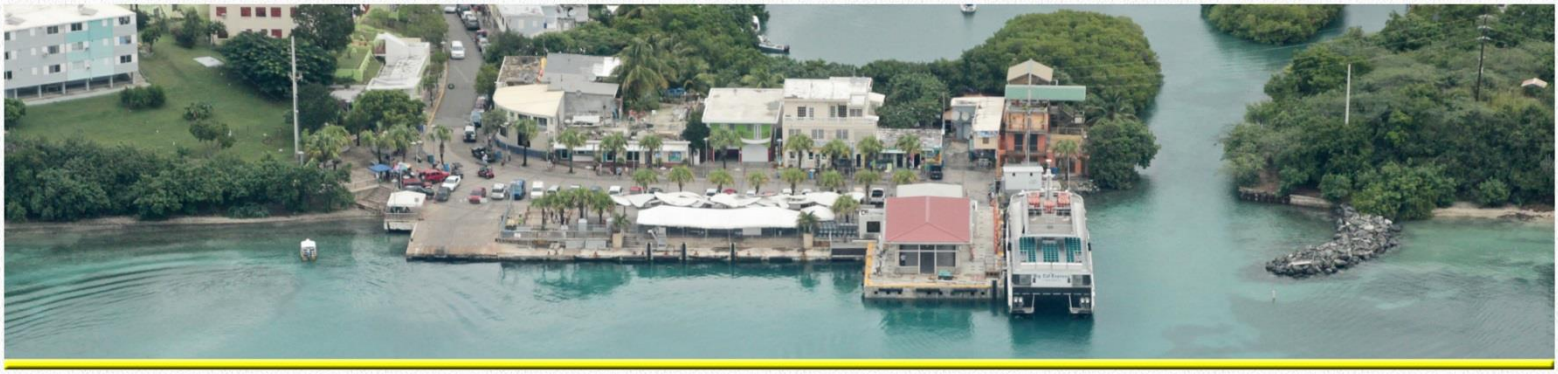


October 2015

Underwater Noise Monitoring Plan for use during Pile-Driving Operations using Hydraulic Hammers

Part of the Mitigation Plans for the

Impacts Associated to the Reconstruction of the Culebra Cargo Ferry Terminal in Sardinas Bay

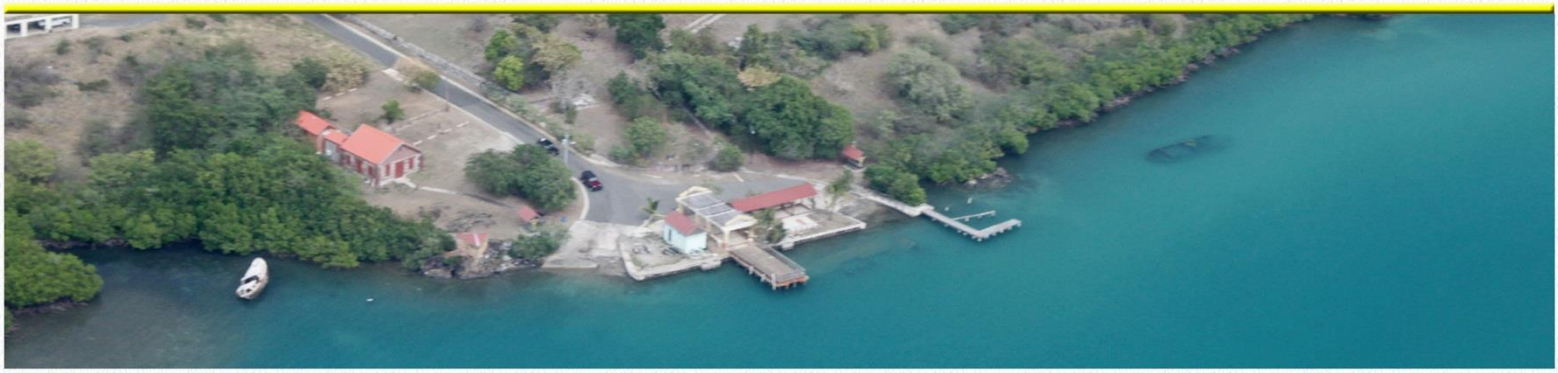
Culebra, Puerto Rico

Prepared For :

AUTORIDAD de los PUERTOS de PUERTO RICO

Prepared By:

ATKINS



Contents

1.0 Introduction 3

2.0 Site Description and Number of Piles to be Monitored 5

2.1 Sardinas Bay 5

2.1.1 Number of Piles to be Monitored at Sardinas Bay 5

2.2 San Ildefonso. 7

2.2.1 Number of Piles to be Monitored at San Ildefonso 7

3.0 Hydroacoustic Monitoring 9

3.1 Purpose 9

3.1.1 Recommended Equipment 9

3.2 Hearing Frequency in Species of Interest 10

3.2.1 Sea turtles 10

3.2.2 Manatees 11

4.0 Noise Monitoring Methodology 11

4.1 Calibration 12

4.2 Sound Attenuation Monitoring 13

5.0 Monitoring Report 14

6.0 References 16

Appendix A 17

Appendix B 18

Appendix C 20

Under Revision

1.0 Introduction

The Puerto Rico Ports Authority (PRPA, State proponent) conducted a structural evaluation at the Culebra Cargo Ferry Terminal on August, 2010, where advanced deterioration was observed in the deck slab and concrete beams, which has probably spread to the entire concrete surface. Said deterioration appears to be a result of storm events, hurricanes and wave action.

As the only heavy commercial cargo transportation port in Culebra, the cargo ferry provides an essential service to the island-municipality residents. An alternatives analysis resulted in the proposed construction of an Auxiliary Cargo Terminal, while the existing cargo terminal is reconstructed. After evaluating potential sites for an Auxiliary Terminal, the San Ildefonso site in Ensenada Honda (***Figure 1***) was chosen for the limited environmental impacts involved, since no dredging is required, the landside is ample, has been previously developed, and has the required power and water service. Nevertheless, there are unavoidable impacts associated with the construction and operation of the proposed action.

The National Oceanographic and Atmospheric Administration/National Marine Fisheries Service (NOAA/NMFS) designates the island of Culebra as Critical Habitat for the green turtle (*Chelonia mydas*) and as a Habitat Focus Area. Under provisions of Section 7(a)(2) of the Endangered Species Act, a Federal agency that carries out permits, licenses, funds, or otherwise authorizes activities that may affect a listed species must consult with the US Fish and Wildlife Service to ensure that its actions are not likely to jeopardize the continued existence of any listed species. This same process also applies to the National Marine Fisheries Service and the species under their its jurisdiction.

Federal and State Agencies, and key stakeholders have been engaged since 2010 to thoroughly assess any potentially adverse impacts to the environment that may be caused by the reconstruction of the Culebra Cargo Terminal, and to recommend attenuation, mitigation and/or avoidance actions. Noise caused by pile driving may have detrimental effects upon fish and wildlife at certain levels. Pile driving at San Ildefonso will be conducted using a drilling method that minimizes underwater noise and vibration; however, pile driving in Sardinas Bay is still proposed using a hydraulic hammer, thus, significant noise is expected, which could pose a threat to species protected under the Endangered Species Act.

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Therefore, this Underwater Noise Monitoring Plan has been prepared in accordance with the requirements under the Regulations of the Federal Emergency Management Agency (FEMA) at 44 CFR Part 10, the Department of Homeland Security's Management Directive 5100.1, and the Council on Environmental Quality Regulations at 40 CFR Part 1500-1508 to implement the National Environmental Policy Act requirements for FEMA. It is based upon the California Department of Transportation (2012) Technical Guidance for Assessment and Mitigation of the Hydroacoustic Effects of Pile Driving on Fish (2013). This monitoring plan shows the methodology and equipment required to assess underwater noise values near pile driving using hydraulic hammers.

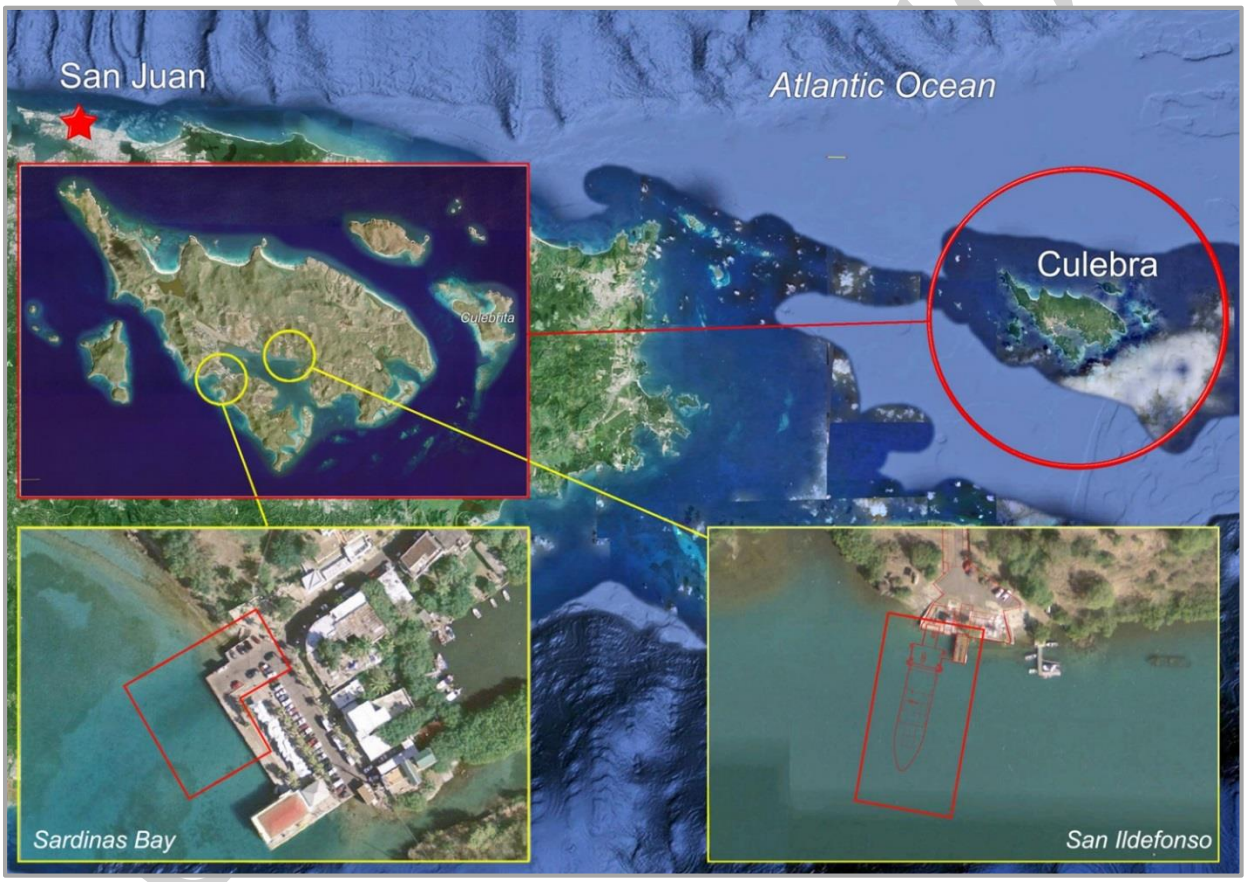

Figure 1: *Location of the Sardinas Bay and San Ildefonso Ferry Terminals.*

2.0 Site Description and Number of Piles to be Monitored

2.1 Sardinas Bay

The construction of the Culebra Ferry Terminal Cargo Ramp in Sardinas Bay consists of the demolition of the existing concrete platform, as well as the removal of the 27 existing H-piles, which measure 15 by 15 inches.

Once the demolition has been completed, 25 piles of 20 inches in diameter will be driven over the existing cargo ramp footprint, which will support the new cargo ramp measuring roughly 5,501 square feet. The new cargo facility will have a passenger boarding bridge that will measure approximately 10 feet wide by 100 feet long for passengers to board and disembark the cargo ferries. This boarding bridge will be attached at one end to a mooring dolphin, which will be supported by 4 pilling of 20 inches in diameter. Three pilings of 20 inches in diameter will support the boarding bridge

A mooring dolphin measuring 10 by 10 feet will be installed on the passenger ferry dock to improve docking safety. This mooring will be supported by 4 pilings of 20 inches in diameter. An operation catwalk measuring 4 feet in width by 25 feet in length will connect the passenger ferry terminal with the mooring dolphin, providing access to PRMTA during docking maneuvers. A total of 36 new piles will be driven as part of the Culebra Ferry Terminal reconstruction.

Figure 2 shows the above described construction features and indicates the location of the piles that will be driven for the construction of the cargo platform, the boarding passenger bridge and the two mooring dolphins. There will be a total of 36 piles driven as part of the Culebra Ferry Terminal Reconstruction in Sardinas Bay.

2.1.1 Number of Piles to be Monitored at Sardinas Bay

The number of piles to be monitored depend on a variety of factors such as bathymetry, the total number of piles to be driven, substrate type, depth of water, distance from shore, type of piles (if more than one type is driven), and any other considerations, as appropriate.

All of the piles to be driven in Sardinas Bay are 20 inches diameter concrete filled piles. Nonetheless, the substrate type and depth varies from one construction feature to another. These three main characteristics were key in determining how many and which of the piles struck will be monitored. One pile within each construction feature will be monitored.

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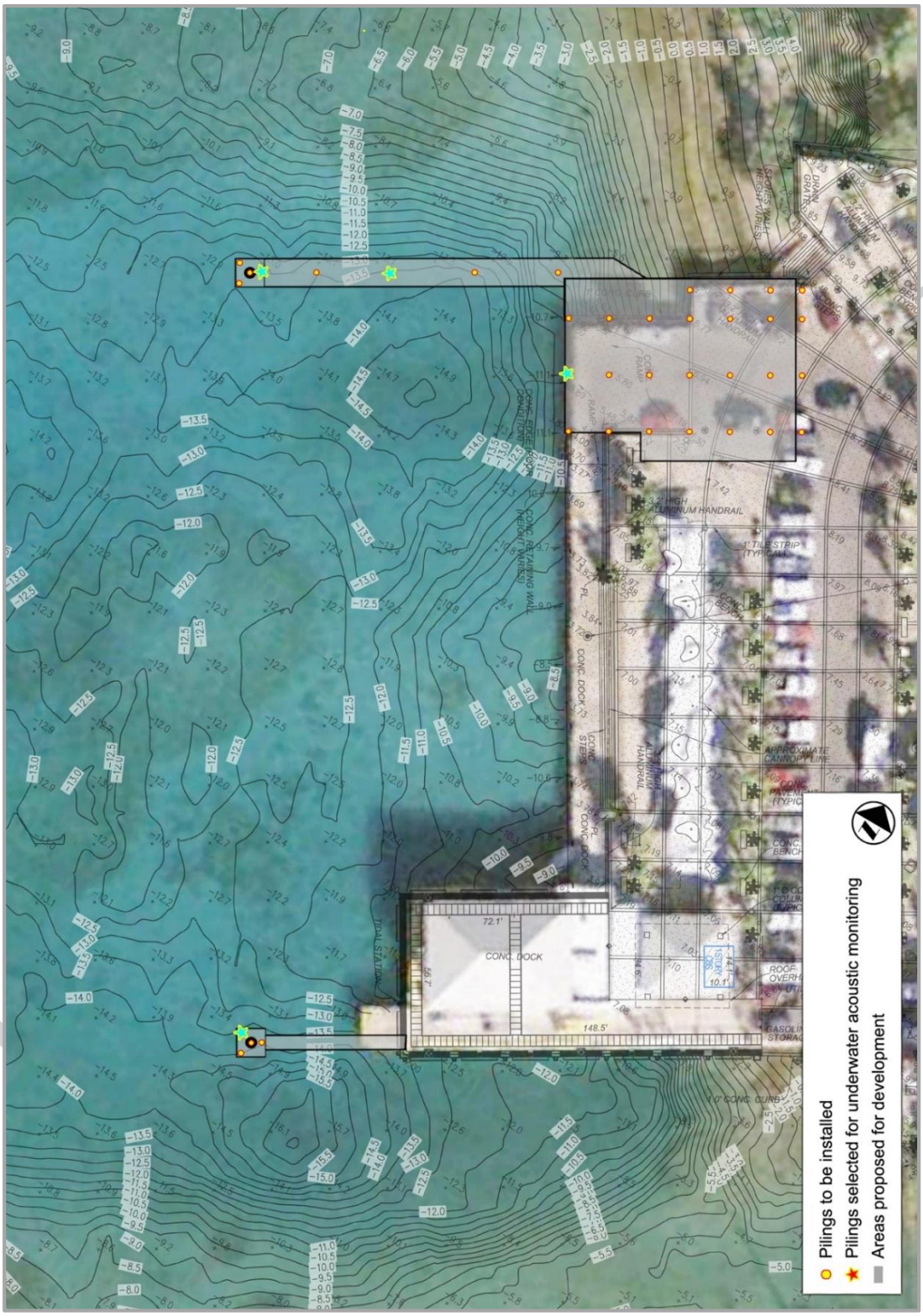

***Figure 2**: Construction Layout showing the location of the piles to be monitored.*

Therefore, hydroacoustic monitoring will be conducted for one pile that will be struck with an impact hammer at each construction feature, (for a total of four piles). The piles that were chosen for monitoring are driven in water depths that are representative of depths typically found in the location where they will be driven.

2.2 San Ildefonso.

The proposed Culebra Auxiliary Cargo Ferry Terminal includes the installation of a pre-fabricated floating aluminum platform (pontoon platform) that will match freeboard ferryboat highs and ease loading and unloading activities. This floating pontoon platform will be anchored to the bottom using six round concrete piles with a 30 inch diameter, which will be driven approximately 20 to 30 feet below msl. To protect the floating pontoon platform from the cargo ferry during docking maneuvers, a pile cap and fender measuring approximately 56 feet in length by 6 feet in width (336 square feet, or 31.2 square meters) will be built, supported by eleven round concrete piles with a 30 inch diameter. The stern of the cargo ferry will be tied to the steel bollards in the pile cap. This pile cap beam will be located at an approximate distance of 64 feet from the existing seawall at an approximate depth of -17 feet msl. To protect the existing historical seawall, a pile cap beam measuring feet 29 long by 3 feet wide supported by six concrete piles with a diameter of 18 inches will be constructed at a distance of approximately 5 feet from the existing seawall.

The existing recreational dock will be demolished and replaced with a new dock built out of a prefabricated aluminum platform and supported by 8 steel encased concrete piles 18 inches in diameter. A total of 31 piles will be driven in San Ildefonso, 17 of 30 inches and 14 of 18 inches.

2.2.1 Number of Piles to be Monitored at San Ildefonso

Two piles of 30 inches and two of 18 inches will be monitored in San Ildefonso. Hydroacoustic monitoring will be conducted for one pile that will be struck with an impact hammer at each construction feature, (for a total of four piles). Piles chosen to be monitored are driven in water depths that are representative of typical water depths at the project location where piles will be driven. ***Figure 3*** shows the location of the piles that will be monitored in San Ildefonso.

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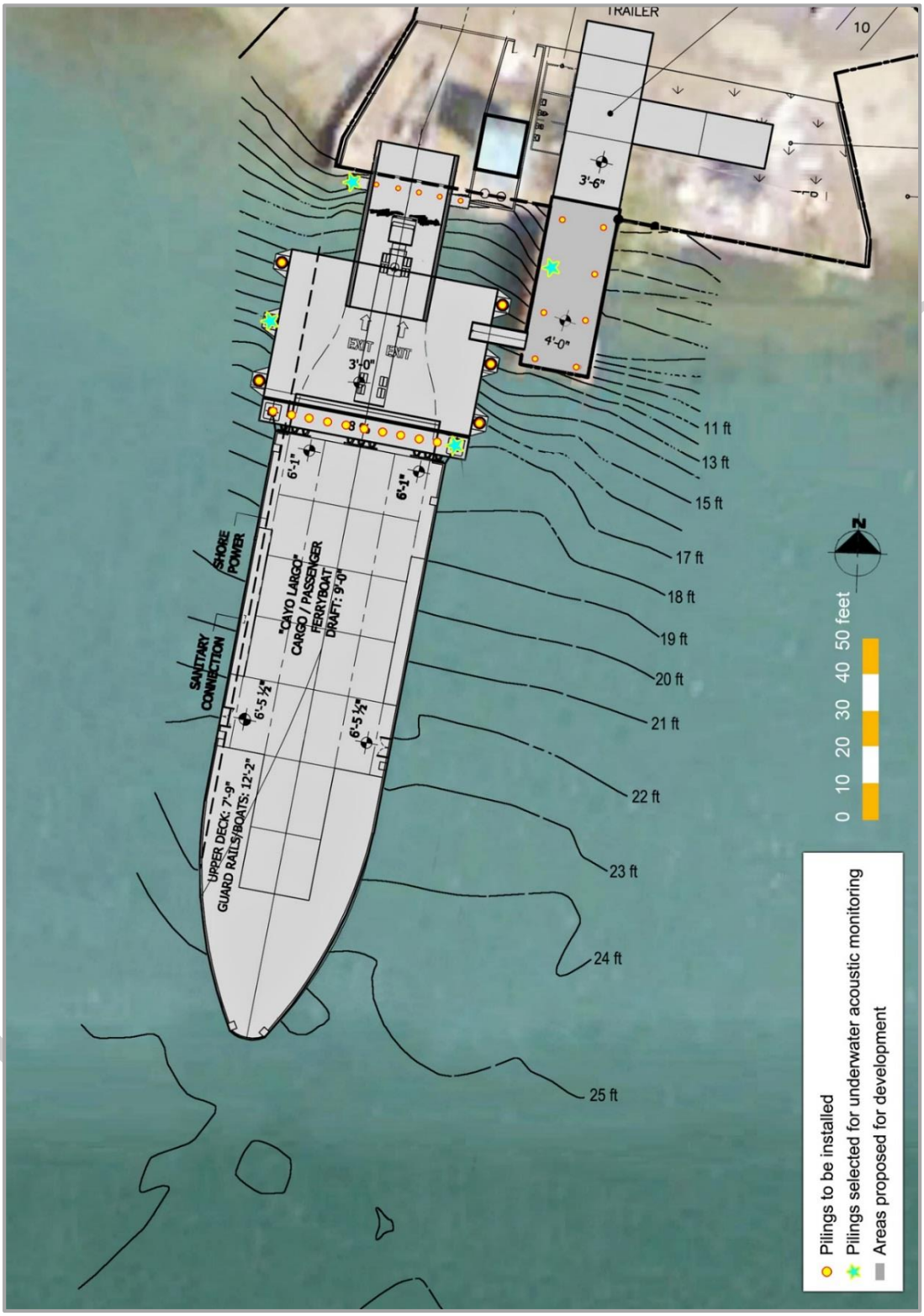

***Figure 3**: Construction Layout showing the location of the piles to be monitored.*

3.0 Hydroacoustic Monitoring

3.1 Purpose

Noise vibrations emitted during pile driving operations has an adverse effect on certain marine species. This Hydroacoustic Monitoring Plan has been prepared to comply with recommendations from the National Marine Fishery Services (NMFS) of establishing a hydroacoustic monitoring methodology, sampling frequency, and recommend hydroacoustic equipment and installation sites, if applicable.

3.1.1 Recommended Equipment

A list of the proposed sound level monitoring equipment for the contractor shall be included, along with specifications and a description of the purpose. The measurement range in terms of amplitude (in dB referenced to one micropascal (re: 1 uPa)), sensitivity and frequency shall be stated. A minimum frequency range of 20 Hz to 20 kHz and a minimum sampling rate of 48,000 Hz will be used when monitoring. Sampling rates higher than 48 kHz are preferred. ***Table 1*** describes the minimum requirements of the equipment to be used. In addition to the equipment selection, quality control/quality assurance procedures should be described (e.g., how will system responses be verified and how will data be managed).

Table 1 *Equipment for underwater sound monitoring (hydrophone, signal amplifier, calibrator). All have current National Institute of Standards and Technology (NIST) traceable calibration.*

Item	Specifications	Minimum Quantity	Usage
Hydrophone	*Receiving Sensitivity- -211dB re 1V/µPa*	*1*	*Capture underwater sound pressures near the source and convert to voltages that can be recorded/analyzed by other equipment.*
Hydrophone	*Receiving Sensitivity – -200dB re 1/µPa*	*1*	*Capture underwater sound pressures for background levels and convert to voltages that can be recorded/analyzed by other equipment.*
Signal Conditioning Amplifier	*Amplifier Gain- 0.1 mV/pC to 10 V/pC Transducer Sensitivity Range- 10-12 to 103 C/MU*	*1*	*Adjust signals from hydrophone to levels compatible with recording equipment.*

Under Revision

Calibrator (pistonphone-type)	*Accuracy- IEC 942 (1988) Class 1*	*1*	*Calibration check of hydrophone in the field.*
Digital Signal Analyzer	*Sampling Rate- 48kHz or greater*	*1*	*Analyzes and transfers digital data to laptop hard drive.*
Microphone (free field type)	*Range- 30 – 120 dBA Sensitivity- -29 dB ± 3 dB (0 dB = 1 V/Pa) Wind Screen*	*1*	*Monitoring airborne sounds from pile driving activities (if not raining).*
If water velocity ~> 1m/s, Flow shield	*Open cell foam cover or functional equivalent*	*1/hydrophone*	*Eliminate flow noise contamination.*
Laptop computer or Digital Audio Recorder	*Compatible with digital signal analyzer*	*1*	*Record digital data on hard drive or digital tape.*
Real Time and Post-analysis software	*-*	*1*	*Monitor real-time signal and post-analysis of sound signals.*

To facilitate further analysis of data full bandwidth, the time-series underwater signal shall be recorded as a text file (.txt) or wave file (.wav) or similar format. Recorded data shall not use data compression algorithms or technologies (e.g. MP3, compressed .wav, etc.).

3.2 Hearing Frequency in Species of Interest

3.2.1 Sea turtles

Audiograms were conducted for the green *(Chelonia mydas)*, kemp's ridley (*Lepidochelys kempi*), and loggerhead (*Caretta caretta*) turtles. Audiograms are determined from Auditory Brainstem Responses (ABRs). Sea turtles do not hear well above 1,000 Hz or below 100Hz, they generally hear best between 200 and 700 Hz depending on the species and age of the turtle (*Ketten and Bartol, 2005*).

Sea turtles appear to hear best between 200 and 750 Hz and do not respond well to sounds above 1,000 Hz. To determine the hearing capabilities in an adult green sea turtle (*Chelonia mydas*), researchers obtained a behavioral audiogram for an older female green sea turtle named

Under Revision

Myrtle, housed in the Giant Tank exhibit of the New England Aquarium. Based on her responses, it was concluded that adult green sea turtles hear best between 200Hz-500Hz.[1]

3.2.2 Manatees

Manatees have a functional hearing range from 400 to 46,000 hertz. Their peak sensitivity actually lies between 16,000 and 18,000 hertz, and not 1,000 to 5,000 hertz as previously thought. Below 16,000 hertz, sensitivity decreases approximately 10 decibels per octave, and below 2,000 hertz it drops precipitously (20 decibels per octave) until functional hearing ends at 400 hertz. Unfortunately, the dominant sounds produced by most boats and ships are below 1,000 hertz; these lower frequencies fall outside or overlap the lower fringe of the hearing range of manatees. The audiogram suggests that even in quiet conditions, manatees would have difficulty detecting these sounds at acoustic levels of less than 90 or 100 decibels. All underwater sound levels mentioned are given against a standard underwater reference acoustic pressure of 1 micropascal.[2]

4.0 Noise Monitoring Methodology

This study is proposed to be conducted with at least two hydrophones. The contractor will mark with a GPS the monitoring points from each of the piles struck. One of the hydrophones will be transported with a small vessel from one monitoring point to another to calculate transmission loss over distance, placing the instrument at an approximate water depth of 4 m (13 ft). The second hydrophone will be located near the pile struck at least 3H from the pile, where H is the water depth at the pile and at 0.7 to 0.85H depth from the surface. ***Figures 2*** and ***3*** show the location of the piles to be monitored at each site.

Based on daily weather conditions, the contractor will determine the distance and depth in meters from each pile monitored. If water velocity is 1 meter/second or greater, 1-3 meters off the bottom may be recommended for near field hydrophones and greater than 5 meters off the bottom may be recommended for near field hydrophones and greater than 5 meters from the surface may be recommended for any far field hydrophones. A weighted tape measure will be used to determine the depth of the water. The hydrophone(s) will be attached to a nylon cord, a steel chain, or other

[1] tp://www.dosits.org/animals/soundreception/howtoseaturtleshearsound; retrieved on July 7, 2013.
[2] http://www.americanscientist.org/issues/id.758,y.0,no.,content.true,page.2,css.print/issue.aspx; Manatees, Bioacoustics and Boats-Hearing tests, environmental measurements and acoustics phenomena may together explain why boats and animals collide, Edmund Gerstein, American Scientist, retrieved on October 8, 2015.

Under Revision

proven anti-strum features if the current is swift enough to cause strumming of the line. The nylon cord or chain will be attached to an anchor that will keep the line the appropriate distance from each pile. The nylon cord or chain will be attached to a float or tied to a static line at the surface. The distances will be measured by a tape measure, where possible, or a range-finder. The acoustic path (line of sight) between the pile and the hydrophone(s) should be unobstructed in all cases.

When collecting sound measurements in an area with currents (i.e., in rivers or tidally influenced areas), appropriate measures will be taken, when necessary, to ensure that the flow-induced noise at the hydrophone will not interfere with the recording and analysis of the relevant sounds (NMFS, 2012a). As a general rule, current speeds of 1.5 meters/second or greater are expected to generate significant flow-induced noise, which may interfere with the detection and analysis of low-level sounds such as the sounds from a distant pile driver or background sounds. If such measures are necessary, include a description of those measures.

For example: If it becomes necessary to reduce the flow-induced noise at the hydrophone, a flow shield will be described and installed around the hydrophone to provide a barrier between the irregular, turbulent flow and the hydrophone. If no flow shield is used in these situations, the current velocity will be measured and a correlation between the levels of the relevant sounds (background or pile driving) and current speed will be made to determine whether the data is valid and can be included in the analysis.

4.1 Calibration

The hydrophone calibration(s) will be checked at the beginning of each day of monitoring activity. The method of calibration and calibration equipment used will be described. NIST traceable calibration forms shall be provided for all relevant monitoring equipment. Prior to the initiation of pile driving, the hydrophone will be placed at the appropriate distance and depth as described above.

The contractor will inform the acoustics specialist when pile driving is about to start to ensure that the monitoring equipment is operational. Underwater sound levels will be continuously monitored during the entire duration of each pile being driven with a minimum one-third octave band frequency resolution. The wideband instantaneous absolute peak pressure and Sound Exposure Level (SEL) values of each strike, and daily cumulative SEL should be monitored in real time

Under Revision

during construction to ensure that the project does not exceed its authorized take level. Peak and rms pressures will be reported in dB (re:1 µPa). SEL will be reported in dB (re: 1 µPa2·sec). Wideband time series recording is strongly recommended during all impact pile driving.

Prior to, and during, the pile driving activity, environmental data will be gathered, such as water depth and tidal level, wave height, and other factors that could contribute to influencing the underwater sound levels (e.g. aircraft, boats, etc.). Start and stop time of each pile driving event and the time at which the bubble curtain or functional equivalent is turned on and off will be logged.

The Agency will provide the following information, in writing, to the contractor conducting the hydroacoustic monitoring for inclusion in the final monitoring report: a description of the substrate composition, approximate depth of significant substrate layers, hammer model and size, pile cap or cushion type, hammer energy settings and any changes to those settings during the piles being monitored, depth pile driven, blows per foot for the piles monitored, and total number of strikes to drive each pile that is monitored.

4.2 Sound Attenuation Monitoring

All monitored piles may be tested with the sound attenuation system on and off (or presence and absence) to test its effectiveness. To account for varying resistance as the pile is driven; the sound attenuation device will be turned off and on for determined periods during the beginning, the middle third, and near the end of the drive. After turning off the attenuation system, pile driving should not resume for at least 2 minutes to allow time for air bubbles to completely disperse. For piles that require less than 5 minutes to drive, pile driving should occur for only two periods with the bubbles off, one near the beginning and once near the end of the drive.

Under Revision

5.0 Monitoring Report

If sound attenuation devices are used during the monitoring, include the following text and analysis:

An analysis of the change in the waveform and sound levels with and without the name type of noise attenuation device for impact driving operating will be conducted.

Preliminary results for the daily monitoring activities, if required, will be submitted/reported to the primary point of contact to be determined by PRPA at each of the Services within 24 hours after monitoring concludes for the day. In addition, a final draft report including data collected and summarized from all monitoring locations will be submitted to the Services within 90 days of the completion of hydroacoustic monitoring. The results will be summarized in graphical form and include summary statistics and time histories of impact sound values for each pile. A final report will be prepared and submitted to the Services within 30 days following receipt of comments on the draft report from the Services. The report shall include:

1. Size and type of piles.
2. A detailed description of the *name type of noise attenuation device*, including design specifications *(if applicable)*.
3. The impact hammer energy rating used to drive the piles, make and model of the hammer.
4. A description of the sound monitoring equipment.
5. The distance between hydrophone*(s) or microphone(s)* and pile.
6. The depth of the hydrophone*(s)* and depth of water at hydrophone locations.
7. The distance from the pile to the water's edge.
8. The depth of water in which the pile was driven.
9. The depth into the substrate that the pile was driven.
10. The physical characteristics of the bottom substrate into which the piles were driven.
11. The total number of strikes to drive each pile and for all piles driven during a 24-hour period.
12. The underwater wideband background sound pressure level reported as the 50% CDF *(if applicable)*.
13. The results of the hydroacoustic monitoring, as described under Signal Processing. An example table is provided in Appendix C for reporting the results of the monitoring.
14. The distance at which peak, cSEL, and rms values exceed the respective threshold values.

Under Revision

15. A description of any observable fish, marine mammal, or bird behavior in the immediate area will and, if possible, correlation to underwater sound levels occurring at that time.

Under Revision

6.0 References

50 CFR § 226. 207-208 (1998) Wildlife and Fisheries Designated Critical Habitat for green turtle and hawksbill turtle.

ATKINS (2014) San Ildefonso Benthic Report.

CALTRANS (2012) Compendium of Pile Driving Sound Data. California Department of Transportation. February, 2012.

Edmund Gerstein (2002) Manatees, Bioacoustics and Boats-Hearing tests, environmental measurements and acoustics phenomena may together explain why boats and animals collide.http://www.americanscientist.org/issues/id.758,y.0,no.,content.true,page.2,css.print/issue.aspx. American Scientist Article March-April 2002 Issue. Retrieved on October 8, 2015.

FHWG (2013) Concurrence and General Instructions on Use of the Underwater Noise Monitoring Plan Template. Fisheries Hydroacoustic Working Group, consisting of the NOAA Fisheries West Coast Region, the US Fish & Wildlife Service Regions 1 and 8, and the California Department of Fish and Wildlife. August 28, 2013.

NEPA (2005) 40 CFR 1500.1, Title40, Volume 24, Parts 790 to End, Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act.

Under Revision

Appendix A

Calculation of Cumulative SEL

An estimation of individual SEL values can be calculated for each pile strike by calculating the following integral, where T is T90, the period containing 90% of the cumulative energy of the pulse (eq. 1).

$$\textbf{SEL} = 10 \log \left(\int_0^T \frac{P^2(t)}{P_0^2} \, dt \right) dB \quad \textbf{(eq. 1)}$$

Calculating a cumulative SEL from individual SEL values cannot be accomplished simply by adding each SEL decibel level arithmetically. Because these values are logarithms they must first be converted to antilogs and then accumulated. Note, first, that if the single strike SEL is very close to a constant value (within 1 dB), then cumulative SEL = single strike SEL + 10 times log base 10 of the number of strikes N, i.e, 10Log10(N). However if the single strike SEL varies over the sequence of strikes, then a linear sum of the energies for all the different strikes needs to be computed. This is done as follows: divide each SEL decibel level by 10 and then take the antilog. This will convert the decibels to linear units (or uPa2●s). Next compute the sum of the linear units and convert this sum back into dB by taking 10Log10 of the value. This will be the cumulative SEL for all of the pile strikes.

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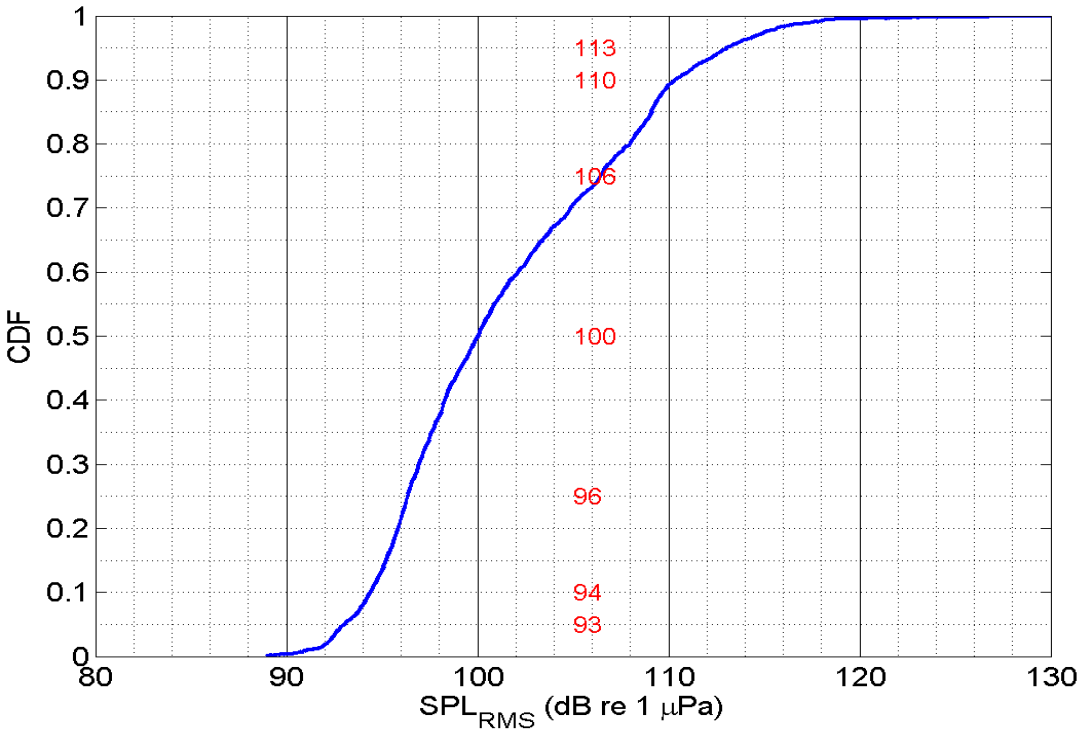
Appendix B

Calculation of a Cumulative Distribution Function and Plot for Background Sound Level Analysis

Data from three full 24-hour underwater measurement cycles (minimum) are used to calculate a 30-second Root Mean Square (RMS) value for each 30-second period for the entire dataset. The RMS should be calculated for both the full frequency range recorded as well as a separate dataset which has been passed through a high pass filter thus eliminating those frequencies below 1000 Hz. These datasets are then grouped into 24-hour periods. To determine if the data is approximately log-normal in distribution, each 24-hour period is plotted as a Probability Density Function (PDF). Each 24-hour period can be plotted on the same PDF plot. The plots should be approximately log normal in distribution and thus can be used in the further analysis. Each day of data should have an approximately Gaussian sigmoid shape, the differences between them and the ideal might be hard to spot, but the sigmoid from day to day will show noticeable variation. Data which does not approximate a log normal distribution should be excluded from further analysis.

The Cumulative Distribution Function (CDF) plot is obtained by plotting the normalized cumulative sum vs. the bin location. You can also get the PDF from plotting the normalized bin count vs. the bin location. The normalized bin count is obtained by dividing the count column by (number of data points multiplied by the space between 2 consecutive bins). This provides the integral of the PDF equal to 1. For instructions on creating a histogram in Microsoft Excel, see: http://www.vertex42.com/ExcelArticles/mc/Histogram.html

Under Revision


CDF
SPL$_{RMS}$ (dB re 1 μPa)
113
110
106
100
96
94
93
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
80
90
100
110
120
130

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Appendix C

Example table for information required for reporting the results of hydroacoustic monitoring of pile driving.

Date and Time	Pile ID	Hammer Impact or Vibratory	# Strikes or Vibratory Seconds	Distance to Pile from Hydrophone (m)	Water Depth (m)		Peak (dB)			$SEL_{90\%}$ (dB)				$RMS_{90\%}$ (dB)			Notes
					At Pile	At H-phone	Max	Min	Mean	Max	Min	Mean	$cSEL_{90\%}$	Max	Min	Mean	

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October 2015

Ensenada Honda Navigational Channel Entrance ESA Corals & Fish Monitoring Plan

Part of the Mitigation Plans for the

Impacts Associated to the Reconstruction of the Culebra Cargo Ferry Terminal in Sardinas Bay

Culebra, Puerto Rico

Prepared For :

AUTORIDAD de los PUERTOS de PUERTO RICO

Prepared By:

ATKINS

Contents

1.0 Introduction 2
2.0 Project Description 4
3.0 Background Information 5
3.1 Listed Coral Species 5
3.2 Nassau Grouper 6
4.0 Monitoring Plan 7
5.0 Study Locations and Methodology 8
5.1 First Monitoring Phase 8
5.2 Second Monitoring Phase 9
5.3 Equipment 10
5.4 Personnel 11
6.0 References 12

Under Revision

1.0 Introduction

The National Environmental Policy Act (NEPA) directs federal agencies to thoroughly assess the environmental consequences of "major federal actions significantly affecting the environment." Before the Federal Emergency Management Agency (FEMA) can fund or implement an action that may affect the environment, agency decision-makers must study the potential impacts that the proposed action and alternatives will have on the human and natural environment, and make that information available to the public.

The Puerto Rico Ports Authority (PRPA) conducted a structural evaluation at the Culebra Ferry Terminal on August, 2010, where advanced deterioration was observed in the deck slab and concrete beams, which has probably spread to the entire concrete surface. This appears to be a result of storm events, hurricanes and the wave action. Furthermore, if the repair and reconstruction of the cargo terminal is not conducted promptly, structural failure may occur. The PRPA has since been planning the necessary works, seeking financing and regulatory compliance.

Being the only heavy commercial cargo transportation port in Culebra, the cargo ferry provides an essential service to the residents of the island. The areal constraints prevent the cargo and passenger ferries from docking simultaneously, as the size of the required demolition/construction barge would prevent the Puerto Rico Maritime Transport Authority (MTAPR) passenger ferries from docking, altering the scheduled service.

After evaluating potential sites for an Auxiliary Terminal, the San Ildefonso site in Ensenada Honda (***Figure 1***) was chosen for the limited environmental impacts involved, since no dredging is required, the landside is ample, has been previously developed, and has the required power and water service. There are unavoidable impacts associated with the construction and operation of the proposed action.

Since 2010, Federal and State Agencies, and key stakeholders, have been engaged to thoroughly assess any potential adverse impact to the environment that may be caused by the reconstruction of the Culebra Cargo Terminal, and to recommend attenuation, mitigation and/ or avoidance actions. The following Endangered Species Act (ESA) Listed Corals and Fish Monitoring Plan has been prepared in compliance with the NEPA process. This monitoring plan will evaluate the

Under Revision

impacts of intensive ferry activities upon the reef located at the entrance of Ensenada Honda during the construction period.

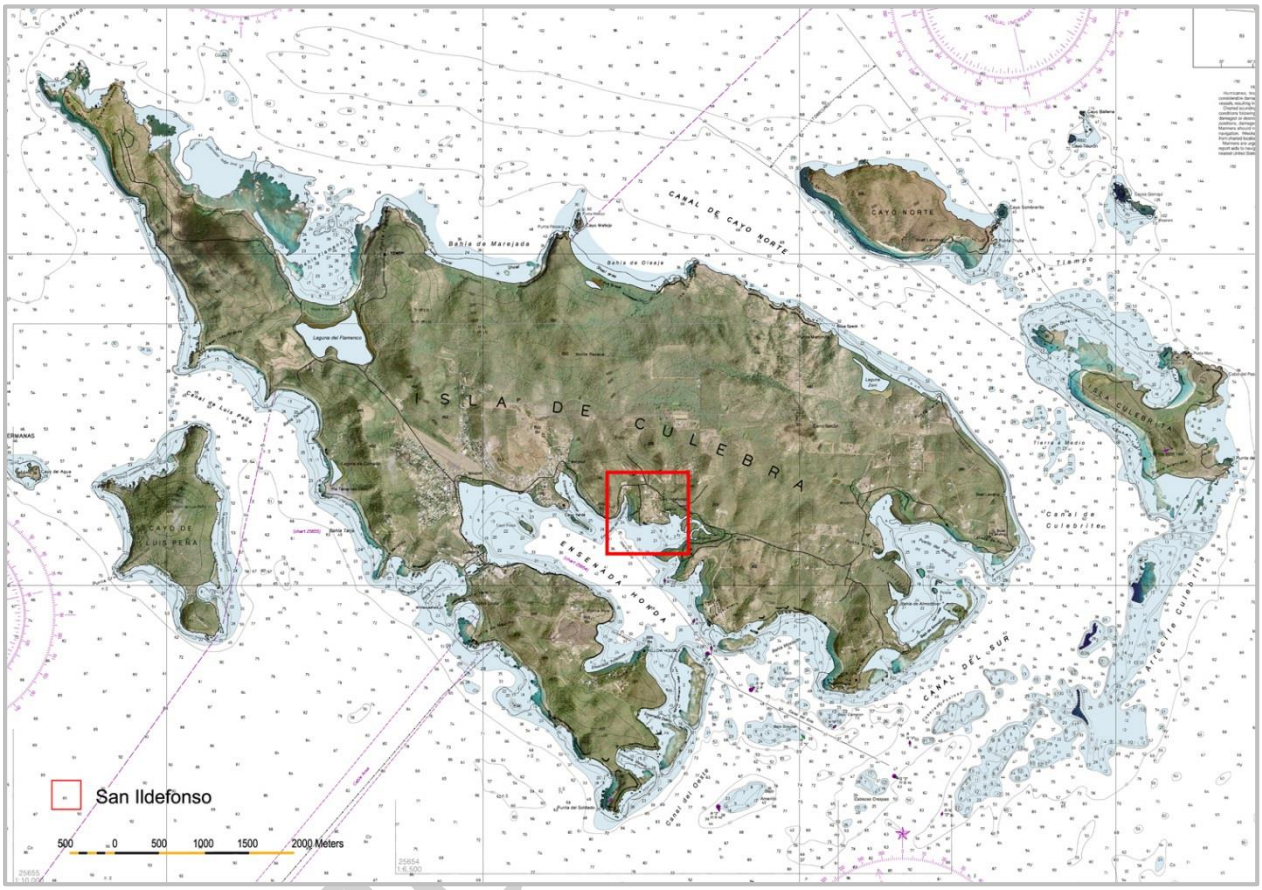

Figure 1: *Location of the Auxiliary Cargo Ferry Terminal in San Ildefonso.*

2.0 Project Description

The Culebra Cargo Ferry will be docking at the San Ildefonso Auxiliary Terminal Facility during the construction of the Culebra Cargo Ramp at Sardinas Bay. To reach the Auxiliary Terminal in San Ildefonso by sea, the cargo ferry would travel south around Punta del Soldado and turn 40° NE in the "Canal del Oeste" between the lighted buoy (R "2", FI R 4s in the Nautical Chart) that marks "Bajo Amarillo", keeping this heading for approximately 1 nautical mile, where the "Canal

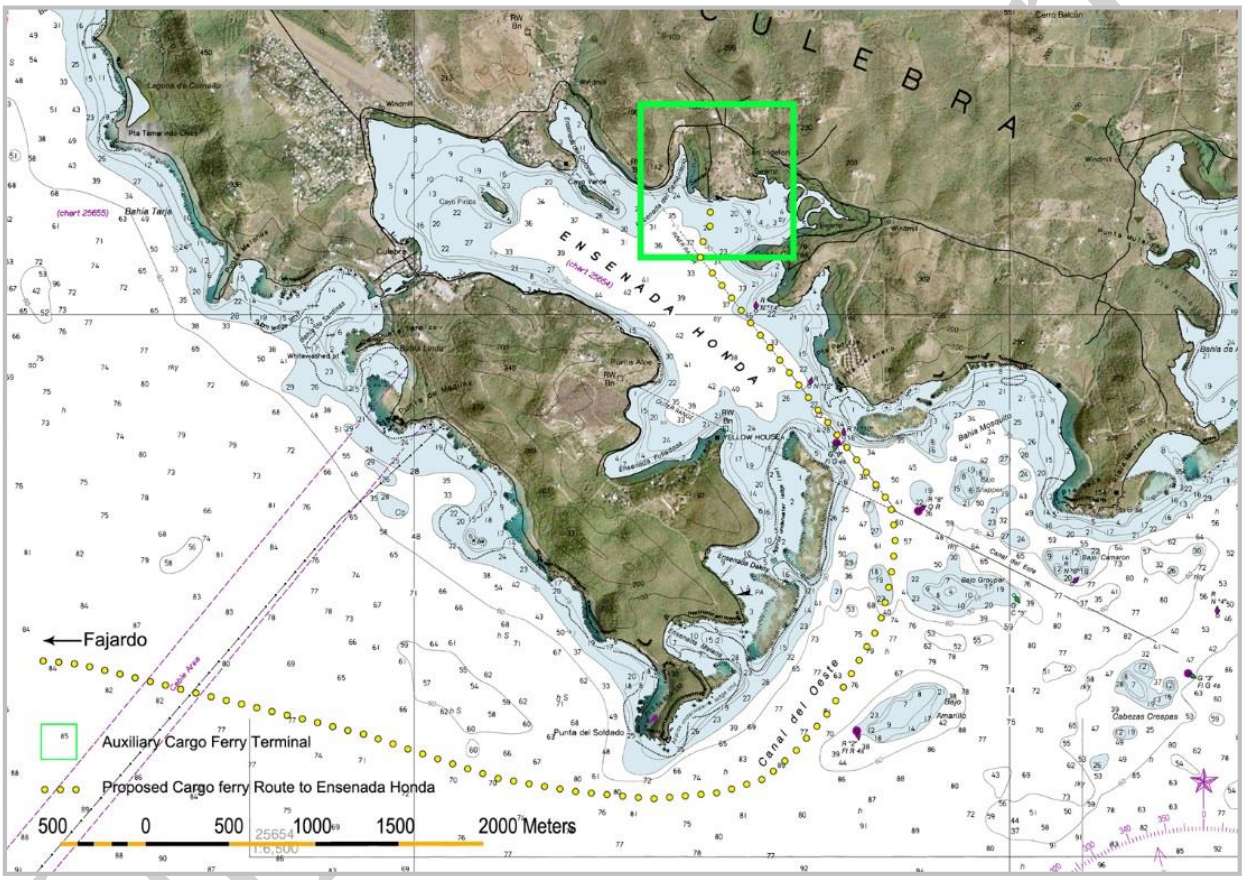

***Figure 2**: Proposed Cargo Ferry Route to San Ildefonso Auxiliary Facility at Ensenada Honda*

del Este" is located. Once reaching Canal del Este, the cargo ferry must turn 325° NW to the entrance of Ensenada Honda, clearly marked by two buoys (G "9", FI G 4s and RN "10"). Once inside Ensenada Honda, the cargo ferry must travel an additional nautical mile before arriving at San Ildefonso on the northern shoreline (see ***Figure 2***).

Approximately 280 scheduled cargo ferry trips will take place during this period, increasing navigational activities upon the reef located at the entrance to Ensenada Honda.

3.0 Background Information

3.1 Listed Coral Species

On September 10, 2014, the National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service (NMFS), Office of Protected Resources (OPR) listed seven species of corals under the ESA (= listed species). Two of those species, the elkhorn coral (*Acropora palmata*) and staghorn coral (*Acropora cervicornis*), were previously listed as threatened and retained that listing. Below are the five coral species that have been recently listed as threatened.

- *Dendrogyra cylindrus* - Pillar coral
- *Mycetophyllia ferox* - Rough cactus coral
- *Orbicella annularis* - Lobed star coral
- *Orbicella faveolata* - Mountainous star coral
- *Orbicella franksi* - Boulder star coral

Above, left: *Acropora palmata.* ***Above, right****: Dendrogyra cylindrus*

All of these coral species are found throughout the Caribbean. The *Acropora* spp. and the *Orbicella* spp. complex have historically dominated coral reefs throughout the Caribbean forming dense assemblages of large, hundreds-of-years old colonies interspersed with a few small colonies (Bruckner 2012). Since the decline of *Acropora* spp during the 1980s, the total reduction of coral cover in the Caribbean has been associated with the decline of the star coral (*Orbicella spp*.) (NOAA 2015).

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The other coral species – pillar coral (*Dendrogyra cylindrus*) and rough cactus coral (*Mycetophyllia ferox*) – are rare. Pillar coral is uncommon and appears in scattered isolate colonies, though the species is rarely found in aggregations (NOAA 2015). Rough cactus coral is one of the least common species observed in monitoring studies (NOAA 2015).

3.2 Nassau Grouper

The Nassau grouper (*Epinephelus striatus*) is currently listed by NMFS as a species of concern, although it is currently in the process of potentially becoming a listed species. The 12-month finding and listing determination was announced in the Federal Register in September 2014 and the commenting period ended in December 2014.

The Nassau grouper is primarily a shallow-water insular fish found throughout the Caribbean. This species is considered a reef fish; however, it transitions through a series of habitats during its development from a planktonic larva to an adult on the reef. Recently settled juveniles are found in macroalgae, coral clumps, and seagrass beds. As the juveniles grow, they move to progressively deeper areas and offshore reefs. Adult Nassau grouper tend to be relatively sedentary and are generally associated with high relief coral reefs or rocky substrate in clear water to depths of 130 meters (Federal Register 2014).

Above: *Adult Nassau grouper*

The study area represents a transitional habitat for the species. The seagrass and coral habitat within Ensenada Honda provides initial settlement habitat for the early stage juveniles. Nearshore coral habitats represent an area for later stage juveniles and young adult as they transition to progressively deeper offshore coral areas.

Under Revision

4.0 Monitoring Plan

The primary purpose of the plan is to develop methods that are sensitive in evaluating any potential impacts to coral reefs at the entrance of Ensenada Honda near the navigational channel, including federally listed coral species or Nassau grouper habitat from the intensive cargo ferry activity that may result from the use of the Auxiliary Cargo Ferry Terminal in San Ildefonso. The use of the site will require the ferry to enter Ensenada Honda through the narrow channel between Cayo Quebrado (Green Navigation Marker 9) and Punta Carenero (Red Navigation Marker 10) via Canal del Oeste (west channel) or Canal del Este (east channel) (see ***Figure 3***).

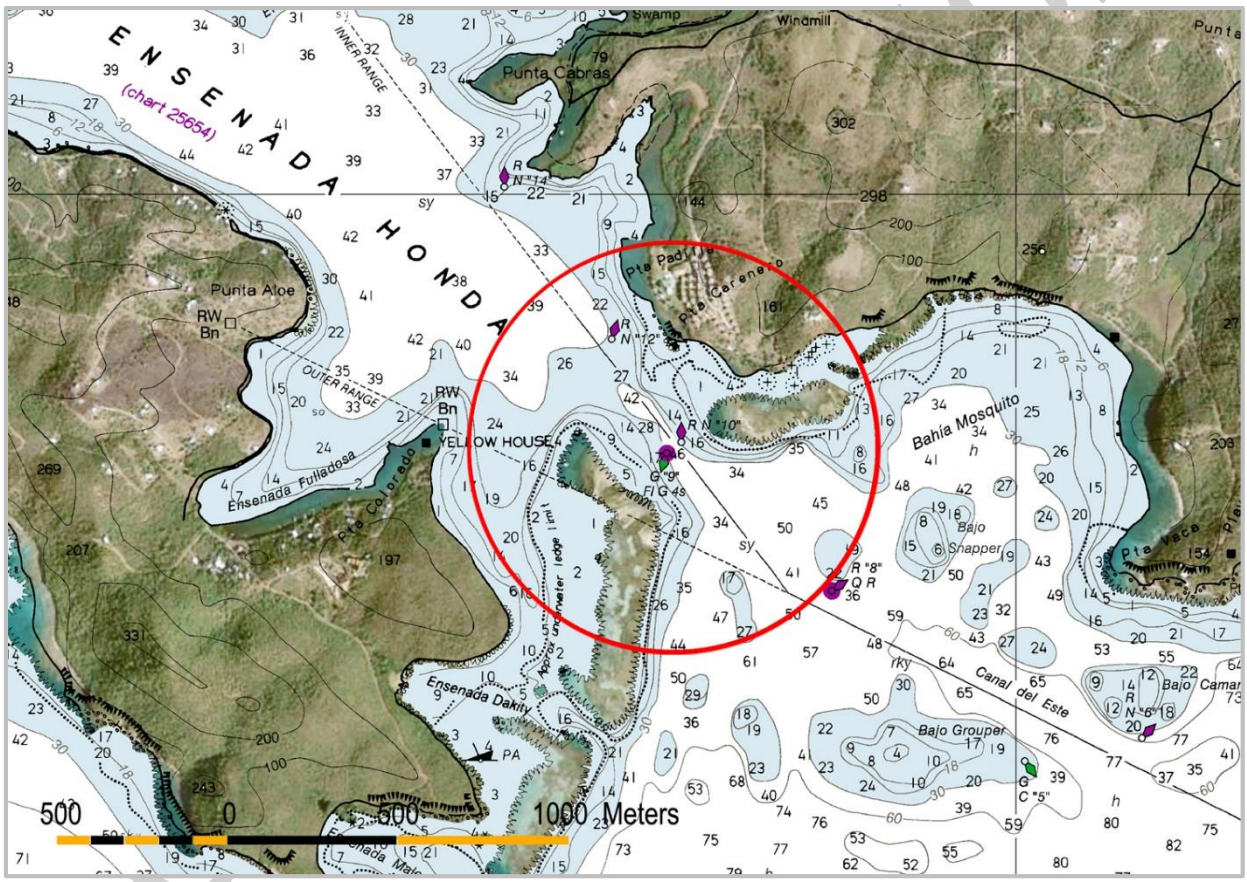

Figure 3: *Location of the Ensenada Honda Entrance Channel and nearby reefs.*

5.0 Study Locations and Methodology

The study locations will ultimately be defined by the operations of the cargo ferry. The critical study location is the narrow channel described above and the selected entry channel (Canal del Oeste or Canal del Este) to reach Ensenada Honda. The proposed study methods are two-phased. This two phased approach follows the recommended survey protocols for *Acropora* spp. in support of Section 7 ESA consultation. The survey protocols for the recently listed coral species are currently being developed, but should be similar to the *Acropora* spp. protocols (NOAA 2007) since the recently listed species have similar problems regarding surveys (i.e. a patchy and potentially clumped distribution and a stratified distribution potentially along a depth gradient or substrate type within the study area).

5.1 First Monitoring Phase

The first phase requires a broad-scale characterization of the hard bottom habitat around the channels including the narrow channel between Cano Quebrado (Green Navigation Marker 9) and Punta Carenero (Red Navigation Marker 10) and the entry channels (Canal del Oeste and Canal del Este). The purpose of this broad-scale characterization is to focus on the general reef geomorphology (structure) and major habitat types to identify the locations of or the potential for the listed coral species. In addition, this phase is also an opportunity to locate and characterize any existing reef damage establishing a baseline for future damage assessment surveys and potentially establishing sensitive locations that will need to be avoided in the ferry route.

First Phase Methodology:

1. The survey will be performed using a series of transects along depth contours from 0 to 6 meter water depth along the channel sides (i.e. representative of potential impact area). The number and length of transects will be determined by the conditions (visibility and safety conditions with multiple divers in the water).

2. The start and stop points of each transect will be recorded using a Global Positioning System (GPS) unit (preferably a unit with sub-meter accuracy such as a Trimble). GPS positions will also be collected at points along the transect where concentrations of listed coral species, potential Nassau Grouper habitat, or significant damage are located.

Under Revision

3. As necessary, these areas - in particular, large colonies of listed coral species, concentrations of smaller colonies of listed coral species, locations of or potential habitat for Nassau grouper, and/or large existing damage areas - will be further delineated after the initial transect survey (see second phase described below). For the listed coral species, survey personnel will also record the size of the aggregation or colony and percentage of living tissue.

4. The result of this broad-scale survey is a survey site map with the locations of concentrations of listed coral species, potential Nassau Grouper habitat, and significant damage areas (if present).

5.2 Second Monitoring Phase

The second phase is a more detailed assessment of the hard bottom/coral habitat along the channel edges in areas identified during Phase I as having concentrations of the targeted species and/or habitat.

Second Phase Methodology:

1. Video transects will be established to specifically characterize the bottom habitat within these areas.

2. The number of transects will follow the *Acropora* spp. protocols within these identified areas.

3. These transects will be established at select locations perpendicular to the channels edges in depths from 0 to 6 meters.

4. The beginning and end of the transect will be recorded using GPS. A fiberglass surveyor's tape will be extended along the bottom, marking the linear extent of the transect.

5. The transect will be videotaped at a specific, constant distance from the bottom. The entire video transect will be reviewed for presence of the targeted species; however, selected non-overlapping frames of the video will be analyzed in a software program to

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determine the percent coverage of benthic components (e.g., hard coral, algae, hard bottom) within the hard bottom/coral area.

6. The Phase I results will be used to select the potential bottom elevation (water depth) differences in the habitat, i.e. if the phase one results indicate that the targeted species or habitat does not exist within certain depths, those depths will be eliminated from the phase two analysis.

5.3 Equipment

It is suggested that the work be accomplished using a survey boat and operator and a dive team of 3 to 4 dive personnel. Suggested equipment includes:

- *A survey boat of approximately 6 meters;*
- *Dive equipment and tanks;*
- *Drop buoys and dive buoys;*
- *GPS unit (preferably with sub-meter accuracy such as a Trimble unit);*
- *100 meter fiberglass surveyor's tape;*
- *Data sheets on underwater paper;*
- *Underwater video camera; and*
- *Underwater still camera.*

Under Revision

5.4 Personnel

The scientific dive team must be competent in coral identification, particularly in the identification of the listed coral species. The type of habitat found within the study area may contain small colonies of the listed coral species. At very early stages in colony formation, differentiation of *Orbicella* spp. may be difficult. In addition, the dive team must be able to identify fish species and, in particular, Nassau grouper. For the Nassau grouper, the study area represents transitional habitat (as explained above) so personnel must be able to identify juvenile Nassau grouper.

The boat operator must be competent in working with dive operations in order to properly assist the scientific dive team.

Under Revision

6.0 References

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National Oceanic and Atmospheric Administration, National Marine Fisheries, Office of Protected Resources. 2015. Recovery Outline. Pillar coral, rough cactus coral, lobed star coral, mountainous star coral, and boulder star coral. 5 p.

National Oceanic and Atmospheric Administration, National Marine Fisheries, Office of Protected Resources. 2007. Recommended survey protocol for *Acropora* spp. in support of Section 7 Consultation. 1p.

Under Revision

October 2015

Cargo Ferry Protocol for Approach and Departure Maneuvers at the Auxiliary Terminal in San Ildefonso

Part of the Mitigation Plans for the

Impacts Associated to the Reconstruction of the Culebra Cargo Ferry Terminal in Sardinas Bay

Culebra, Puerto Rico

Prepared For :

AUTORIDAD de los PUERTOS de PUERTO RICO

Prepared By:

ATKINS

Contents

1.0 Introduction 2

2.0 Protocol..... 4

Under Revision

1.0 Introduction

The Puerto Rico Ports Authority (PRPA, State proponent) conducted a structural evaluation at the Culebra Cargo Ferry Terminal on August, 2010, where advanced deterioration was observed in the deck slab and concrete beams, which has probably spread to the entire concrete surface. Said deterioration appears to be a result of storm events, hurricanes and wave action.

As the only heavy commercial cargo transportation port in Culebra, the cargo ferry provides an essential service to the island-municipality residents. An alternatives analysis resulted in the proposed construction of an Auxiliary Cargo Terminal, while the existing cargo terminal is reconstructed. After evaluating potential sites for an Auxiliary Terminal, the San Ildefonso site in Ensenada Honda (***Figure 1***) was chosen for the limited environmental impacts involved, since no dredging is required, the landside is ample, has been previously developed, and has the required power and water service.

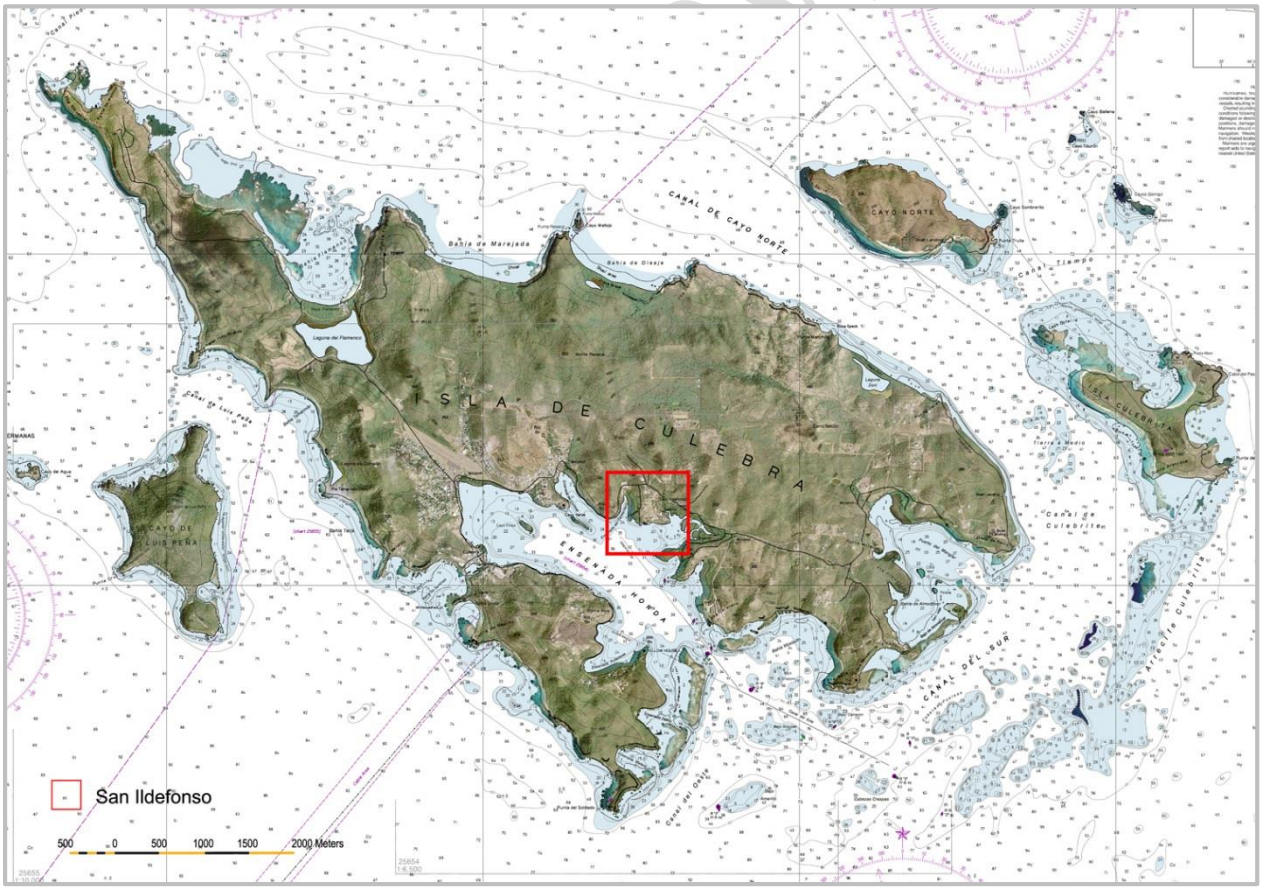

Figure 1: *Location of the Auxiliary Cargo Ferry Terminal in San Ildefonso.*

There are unavoidable impacts associated with the construction and operation of the proposed action.

Since 2010, Federal and State Agencies, and key stakeholders, have been engaged to thoroughly assess any potential adverse impact to the environment that may be caused by the reconstruction of the Culebra Cargo Terminal, and to recommend attenuation, mitigation and/ or avoidance actions. The Puerto Rico Department of Natural and Environmental Resources (DNER) recommended a protocol for ferry vessel skippers use when approaching/departing the Auxiliary Cargo Ferry Terminal in San Ildefonso. The goal would be to minimize the disturbance and suspension of bottom sediments that create turbid conditions within the marine basin.

Under Revision

2.0 Protocol

The Puerto Rico Maritime Transportation Authority (MTA) has proposed construction of the terminal as an alternate means for ferry vessels to deliver fuel, food, goods, and passengers to the island of Culebra. The proposed terminal would be located on the north-eastern shores of Ensenada Honda at San Ildefonso (***Figure 1***) as an upgrade to an existing facility. The proposed terminal would improve the existing ramps and piers to accommodate ferry vessels.

Presently, the MTA anticipates that the *Cayo Norte*, the *Cayo Largo*, the *Isleño* and the *Santa María* will be visiting the terminal. These vessels LOA range from 155 to 165-feet with beams from 37.5 to 45-feet. Charted depths of the terminal approach range from 30 to 40 feet. At the proposed berth, depths range from 15 to 25 feet. The ferry boats are RORO/PAX vessels, meaning that they carry cargo that is rolled on/rolled off as well as passengers that walk on/off the vessels. Presently, passenger ferry transfers at the Auxiliary Terminal are not planned. Cargo is stern loaded with gangways from the RORO onto the cargo ramp.

Berthing maneuvers require the approaching vessel to rotate 180 degrees and then back stern on. Vessels would depart in a direct forward movement from the cargo ramp. Upon entering the Ensenada Honda channel, the skipper would engage engines at “slow”, no more than 8 to 10 knots. After coming about, stern-to and at final approach to the ramp, the skipper would engage to “dead slow”. The minimum speeds must consider how the ship responds to the rudder under extreme wind conditions and adjusted accordingly to assure safe berthing maneuvers. Upon departure, the skipper should utilize only the minimum thrust needed to make way, maintaining “dead slow” speed until clear of the shallow marine basin.

All ferry vessel skippers should attend sensitivity training with annual refreshers to obtain a comprehensive picture of the channel, where the coral, sea grass beds and other natural resources are prevalent and how to operate the ship in a manner that minimizes impacts to them.

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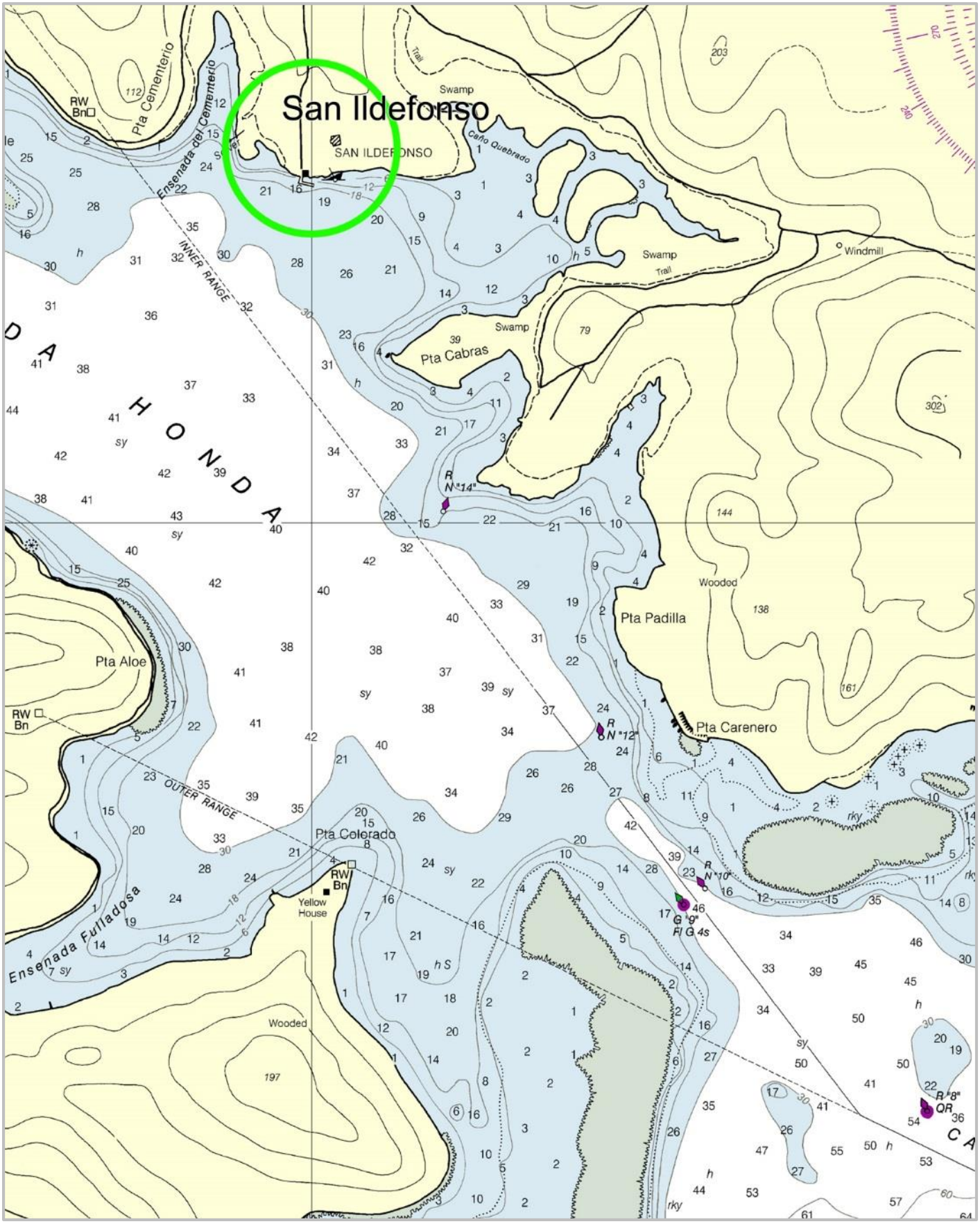

***Figure 1**: Ensenada Honda and San Ildefonso*

October 2015

Assessment of Requirements for Additional Navigational aids for Ensenada Honda

Part of the Mitigation Plans for the

Impacts Associated to the Reconstruction of the Culebra Cargo Ferry Terminal in Sardinas Bay

Culebra, Puerto Rico

Prepared For :

AUTORIDAD de los PUERTOS de PUERTO RICO

Prepared By:

ATKINS

Contents

1.0 Introduction 2
2.0 Aids to Navigation 4
3.0 Interviews 5
3.1 US Coast Guard 5
3.2 Puerto Rico Maritime Transportation Authority (MTA) 5
4.0 Ensenada Honda ATONs 6
4.1 Existing Markers 6
4.2 Vessel Traffic Conflicts 6
4.3 Additional Markers 6
4.4 Inner Range Channel Alternative #1 7
4.5 Inner Range Channel Alternative #2 7
5.0 Auxiliary Terminal ATONs 9
5.1 Terminal Channel Alternative #1 9
5.2 Terminal Channel Alternative #2 10
6.0 Regulatory Speed Zone 13
6.1 Boating Safety Zone Alternative #1 13
6.2 Boating Safety Zone Alternative #2 13
6.3 Regulatory Markers 18
6.4 Regulatory Zone Enforcement 18
7.0 Conclusion 19
8.0 References 20

Under Revision

1.0 Introduction

The Puerto Rico Ports Authority (PRPA, State proponent) conducted a structural evaluation at the Culebra Cargo Ferry Terminal on August, 2010, where advanced deterioration was observed in the deck slab and concrete beams, which has probably spread to the entire concrete surface. Said deterioration appears to be a result of storm events, hurricanes and wave action.

As the only heavy commercial cargo transportation port in Culebra, the cargo ferry provides an essential service to the island-municipality residents. An alternatives analysis resulted in the proposed construction of an Auxiliary Cargo Terminal, while the existing cargo terminal is reconstructed. After evaluating potential sites for an Auxiliary Terminal, the San Ildefonso site in Ensenada Honda (***Figure 1***) was chosen for the limited environmental impacts involved, since no dredging is required, the landside is ample, has been previously developed, and has the required power and water service.

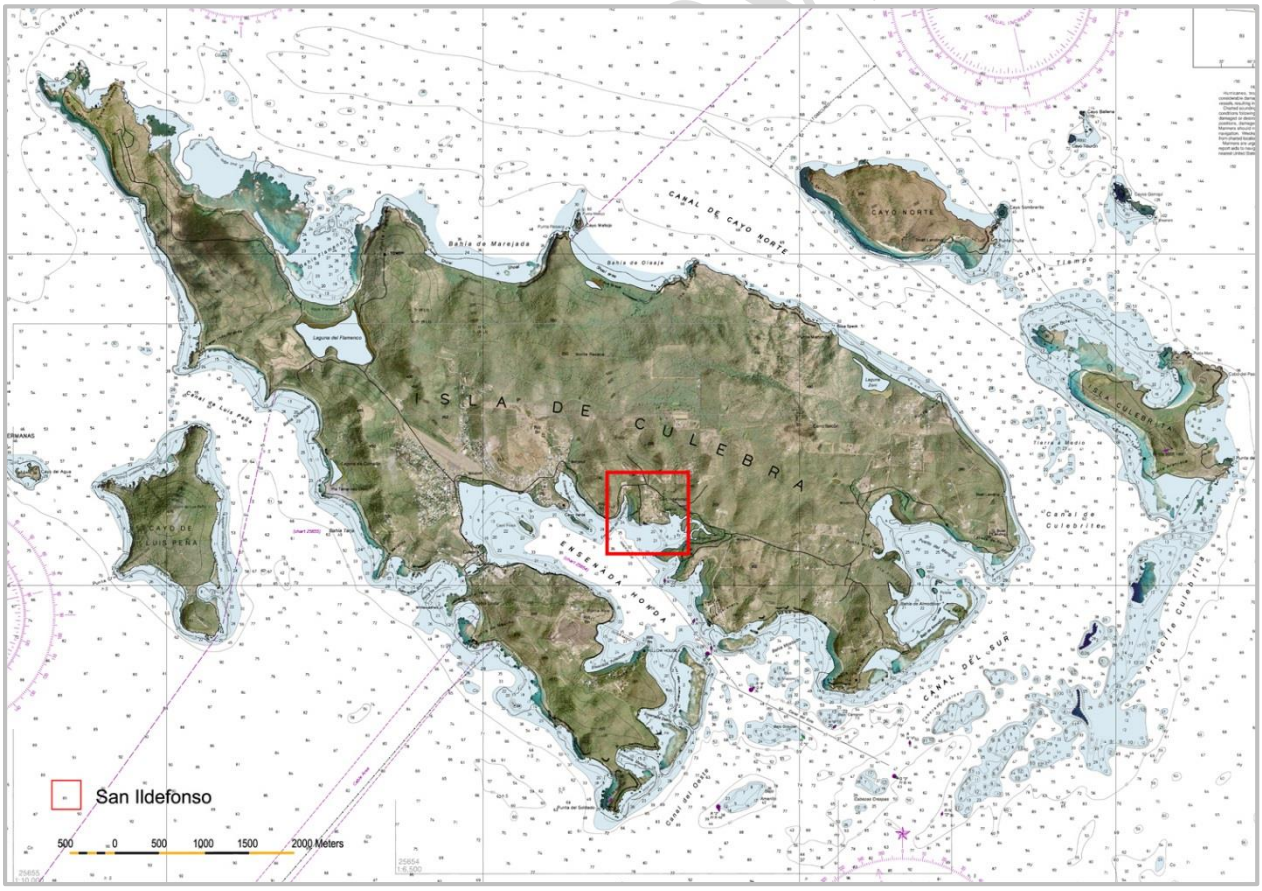

Figure 1: *Location of the Auxiliary Cargo Ferry Terminal in San Ildefonso.*

There are unavoidable impacts associated with the construction and operation of the proposed action.

Since 2010, Federal and State Agencies, and key stakeholders, have been engaged to thoroughly assess any potential adverse impact to the environment that may be caused by the reconstruction of the Culebra Cargo Terminal, and to recommend attenuation, mitigation and/ or avoidance actions. The Puerto Rico Department of Natural and Environmental Resources (DNER) recommended an assessment of the existing navigational channel to confirm if additional aids to navigation are necessary for the cargo ferry to safely navigate within Ensenada Honda without causing any impacts to natural resources in the area.

This study includes a review of the waterway and upland facility location, the analysis of the channel markings and vessel traffic operations, and proposed alternatives designed to provide optimal safe navigation for multiple users of the waterway and facilities.

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2.0 Aids to Navigation

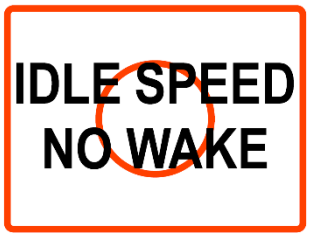
Buoys and signs are the "traffic signals" that guide vessel operators safely along navigable waterways. They also identify dangerous or controlled areas and give directions and information. There are two types of navigation aids - lateral and non-lateral markers. Lateral markers are used to mark the boundaries of safe water areas; for example, to direct travel within a channel. The markers use a combination of colors and numbers, which may be applied to buoys or permanently placed signs.

Non-lateral markers are navigational aids that give information other than the boundaries of safe water areas. The most common are regulatory markers that are white and use orange symbols with black lettering.

The navigable waters of the United States, including Puerto Rico, are marked to assist navigation using the U.S. Aids to Navigation System, a system consistent with the International Association of Lighthouse Authorities (IALA) Maritime Buoyage System.[1] The IALA Maritime Buoyage System is followed by most of the world's maritime nations and improve maritime safety by encouraging conformity in buoyage systems worldwide.

Above: *Lateral: Channel Marker dayboards*

For purposes of marking the waterway(s) leading into the Ensenada Honda auxiliary terminal, a combination of lateral (channel markers) and non-lateral aids (regulatory markers) will be investigated. Lighted aids are also considered, particularly at the confluence of the main inner range channel and channel entrance to the auxiliary terminal.



Above: *Lateral: Regulatory Marker*

[1] Code of Federal Regulations, Title 33, Chapter 1, Subchapter C, Part 62.21 General (a) (United States Aids to Navigation System: e-CFR - Navigation Aides

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3.0 Interviews

Telephone interviews were conducted the U.S. Coast Guard and the MTA, respectively, on September 21 and 22, 2015. Meeting notes from those calls are included in ***Appendix A***.

3.1 US Coast Guard

A discussion was held between Atkins and the U.S. Coast Guard, Sector San Juan, on September 21, 2015 to explore considerations associated with improved navigational markers in Ensenada Honda. Per the U.S. Coast Guard, the proposed additional navigation aids can be installed as federal *aids to navigation* (ATONs) or *private aids to navigation* (PATONs). Authorization and installation of PATONs will be faster to implement than a request for federal ATONs, which requires U.S. Coast Guard District 7 financial support. Based on the meeting discussion, the U.S. Coast Guard felt that three buoys were all that was necessary for safe navigation (***Figure 2, Inner Range Channel***). The light at the San Ildefonso Auxiliary Terminal was also supported in the navigational process.

3.2 Puerto Rico Maritime Transportation Authority (MTA)

A discussion was held between Atkins and Captain José A. Bonnano, the Deputy Director of the MTA on September 22, 2015 to explore considerations associated with improved navigational markers in Ensenada Honda. As an alternative to additional federal aids to navigation, it was recommended that the office of the Mayor of Culebra be contacted to sponsor proposed PATONs. Ferry approaches are already made at slow speed with the exception of adverse weather conditions for safety reasons. Speed restrictions target other vessels near the proposed San Ildefonso Auxiliary Terminal launching from the adjacent public boat ramp. Captain Bonanno fully supports a navigational aid plan that exceeds the U. S. Coast Guard requirements to control vessel traffic and clearly define the channel (shown in ***Figure 2, Inner Range Channel***). Focusing vessels into the channel will protect natural resources in Ensenada Honda. Lighted buoys are not necessary, but would be a nice feature for additional safety.

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4.0 Ensenada Honda ATONs

4.1 Existing Markers

Currently, there are Federal ATONs leading into Ensenada Honda, including red and green markers at the entrance, two additional red markers along the eastern shoreline, and range markers directing safe passage in a northwest direction toward the proposed auxiliary terminal (see ***Figure 1***). The inner range channel passes through navigable water at depths ranging from approximately 15 to 40 feet (according to the NOAA Raster Nautical Chart).

4.2 Vessel Traffic Conflicts

Within Ensenada Honda, there are potential conflicts between ferry vessel operations and the following:

- *small craft launch and retrieval operations at the public boat ramp and in the channel leading to the ramp and auxiliary terminal*
- *increased vessel traffic on weekends and holidays*
- *larger vessels anchoring in the navigable channel (typically associated with cruise ship shore excursions anchoring and allowing passengers to swim)*
- *anchored/moored boats in the channel and areas adjacent to the auxiliary terminal*

4.3 Additional Markers

Augmenting existing aids to navigation with additional markers are being considered for the purpose of delineating a channel for safe navigation. The following alternatives are considered:

- *Marking the inner range channel with more green channel markers and marking a new channel that diverts toward the auxiliary terminal*
- *Marking only the new channel leading to the auxiliary terminal*

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4.3.1 Inner Range Channel Alternative #1

Marking the inner range channel with more green channel markers and marking a new channel leading to the auxiliary terminal.

Additional green ATONs may better delineate the channel, but should only be used if there were heavy vessel congestion or continual anchoring of vessels within the navigable channel. Based on discussions with the USCG, vessels associated with cruise ship shore excursions occasionally anchor in the bay. However, due to the width of the waterway, which provides ample safe water and area for maneuverability, additional green channel markers may not be required along the inner range channel.

Additionally, the USCG was not in favor of adding additional green aids to navigation along the inner range channel due to the adequate depth of the waterway and limited vessel traffic. Alternatively, Captain José A. Bonanno, MTA Deputy Director, recommended augmenting the red markers with additional green markers, as illustrated in ***Figure 2***, to keep cruise tour vessels and other boats from anchoring in the main navigation channel (see meeting minutes in ***Appendix A***).

4.3.2 Inner Range Channel Alternative #2

Marking only the new channel leading to the leading to the auxiliary terminal.

As returning vessels approach Ensenada del Cementerio, west of Punta Cabras, northbound (returning) vessels will change course (from a northwest to north direction), toward the ramp and auxiliary terminal facility. A marked channel to direct safe passage to/from the auxiliary terminal and boat ramps is needed (***Figure 4, Auxiliary Terminal PATONs Alternative #2***).

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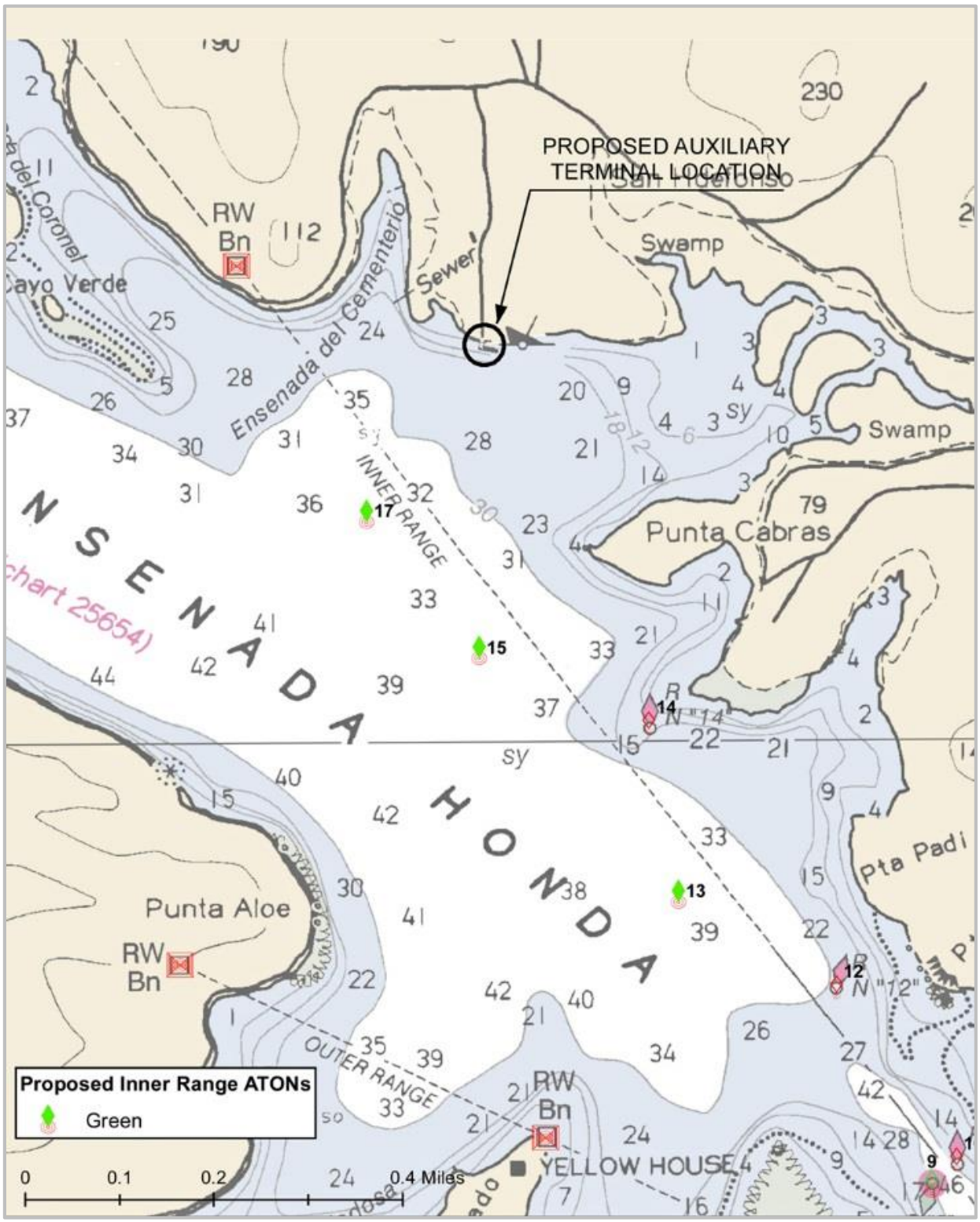

Figure 2: *Inner Range Channel Additional ATONs*

5.0 Auxiliary Terminal ATONs

There are currently no existing channel markers leading to/from the existing boat ramp and proposed auxiliary terminal facility.

Installing new PATONs in this area to augment existing markers in the main inner range channel will aid in the safe passageway to/from the terminal facility. Markers leading to/from the terminal also delineate a navigable channel, thus prohibiting vessels from anchoring in the channel corridor. There are currently anchored boats in close proximity to the launch and docking facility. A marked channel deters vessels from anchoring in the navigable channel, which could potentially obstruct ferry passage.

According to the nautical chart, the depth of the water in this area is approximately 30–40 feet, therefore, in lieu of steel pilings, buoys are required to mark the channel boundary. The channel must provide adequate space for the ferry to safely turn and dock, without impacting submerged aquatic resources, ultimately placing the stern of the vessel at the bulkhead of the terminal facility for loading and offloading of cargo. The ferry vessels MTA anticipates that will visit the auxiliary terminal are the Cayo Norte, the Cayo Largo, the Isleño and the Santa Maria. The LOA (length overall) of these vessels range from 155 to 165 feet with the beams from 37.5 to 45-feet. For the purpose of determining an adequate turning basin, a factor of 2.5 times the length of the ferry was used and rounded to a 400-foot radius circle.

5.1 Terminal Channel Alternative #1

The first marking option is to install two new red channel markers, numbered 16 and 18, to be contiguous with the existing federal ATONs along the inner range channel (currently ending at red marker 14), as shown in ***Figure 3***. The red markings serve to keep vessels in safe water when turning north toward the auxiliary terminal, and marking the channel boundary on the east side to prevent the anchoring of vessels in the channel. Based on recommendations by ATM, channel marker 16 would be a lighted aid.

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5.2 Terminal Channel Alternative #2

Since this new channel diverts from the main inner range channel, four new channel markers are proposed to:

- *gate the channel entrance (restarting the numbering of the new PATONs with Green 1 and Red 2); and*
- *designate a channel closer to the auxiliary terminal (marked as PATONs 3 and 4).*

The new markers will be PATONs, maintained by the DNER or the Municipality of Culebra. The non-contiguous sequence in numbering differentiates this channel from the main inner range channel. Markers at the entrance of the channel will be numbered 1 and 2, and the two PATONs closer to the terminal will be 3 and 4. The two buoys at the entrance of the channel may be lighted buoys. Red channel marker 4 may be in shallow enough water to allow the marker to be a piling and signs structure.

Figure 4 illustrates the proposed locations for these additional red and green lateral markers.

Above, left: *Shallow water channel marker buoys.* ***Above, right:*** *Green can and red nun lighted channel marker buoys.*[2]

[2] Images from Urethane Technologies, Inc.

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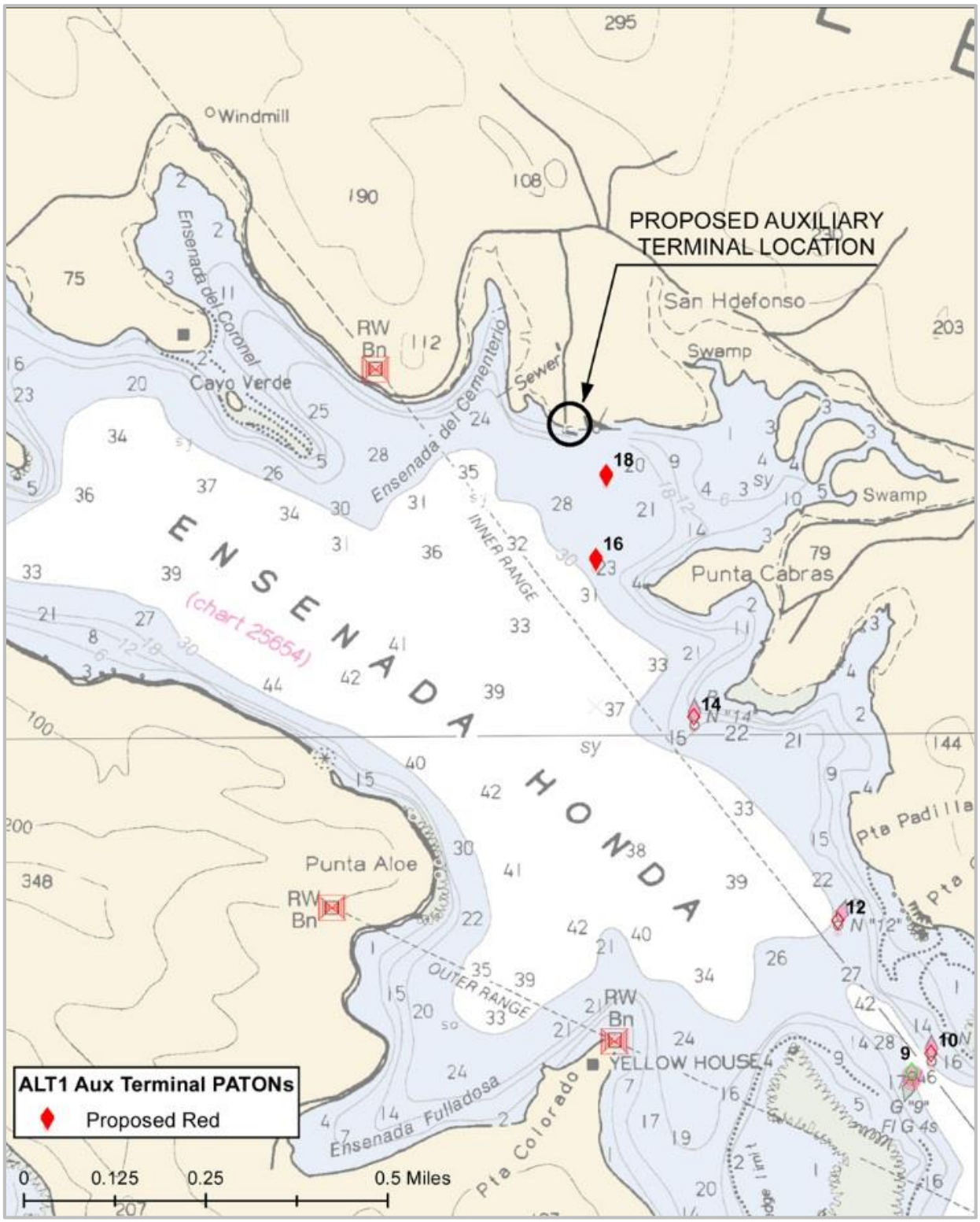

Figure 3: *Auxiliary Terminal Channel PATONs Alternative #1*

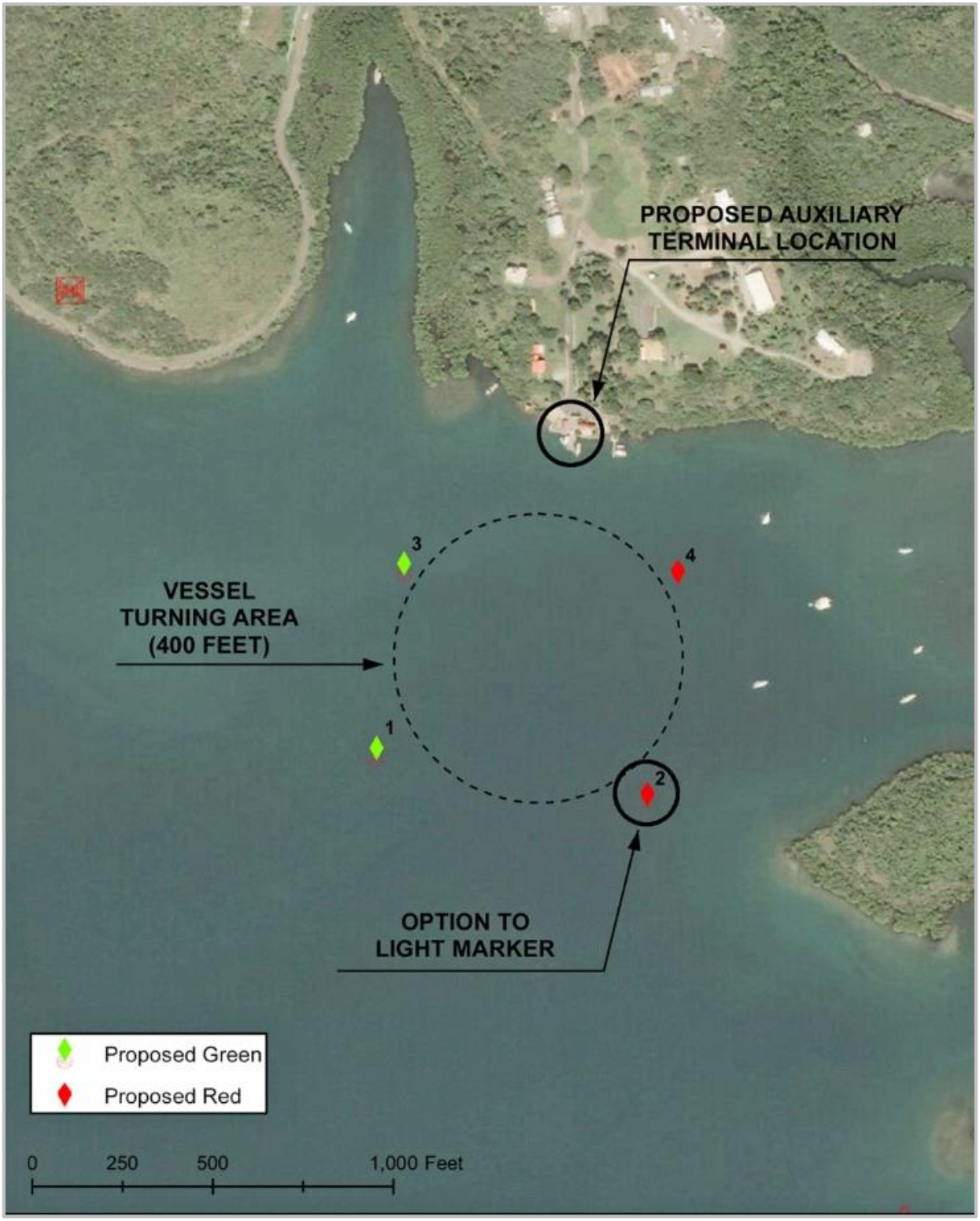

Figure 4: *Auxiliary Terminal Channel PATONs Alternative #2*

6.0 Regulatory Speed Zone

The proposed ferry terminal is adjacent to a frequently used public boat ramp. To reduce conflicts in navigation between recreational, commercial, and ferry vessel traffic, a boating restricted speed zone may be required in the area around the auxiliary terminal facility (***Figure 5***). The regulatory zone (for boating safety) will also limit vessel wakes, which can be a threat to human safety and maritime property.

The DNER is authorized under *Act 430 of December 21, 2000* to adopt and enforce regulations that restrict vessel speeds. This law, known as the *Aquatic Navigation and Security Act of Puerto Rico*, provides for the ability of the department to mark speed restrictions with regulatory buoys. The department is under the Office of the Commissioner of Navigation Rule Number 6979, adopted May 31, 2005, and established fines for the Department's enforcement under Article 35 for persons operating a vessel more than 5 MPH and causing a wake that affects other vessels within a marina or port. In order to enact such a boating safety zone, the ATM will be required to coordinate with the DNER, the U.S. Coast Guard and U.S. Army Corps of Engineers (USACE) to develop a Notice of Proposed Rule Making for the regulatory zone markers. It is anticipated that the regulatory zone will be enforced by the Puerto Rico Forces United for Rapid Action (FURA).

6.1 Boating Safety Zone Alternative #1

There are two alternatives proposed for marking the boating regulatory zone with non-lateral markers. The first alternative (***Figure 6)***, places regulatory markers along the boundary of a 1,000-foot buffer of the boat ramp and terminal facility. Alternative #1 limits the speed of vessels in close proximity to the boat ramp and auxiliary terminal facility and utilizes a total of four (4) markers to post the regulatory zone.

6.2 Boating Safety Zone Alternative #2

The second alternative (***Figure 7)***, allows for a straight boundary line between Cayo Verde to Punta Cabras. This alternative creates a boating speed restricted area in a larger expanse of water, but this option only utilizes four (4) markers and creates a more understandable zone boundary than Alternative #1. This option may also serve to protect protected species like

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submerged aquatic resources and manatees. It is uncertain if this type of boating speed restriction is allowable under Puerto Rico regulations.

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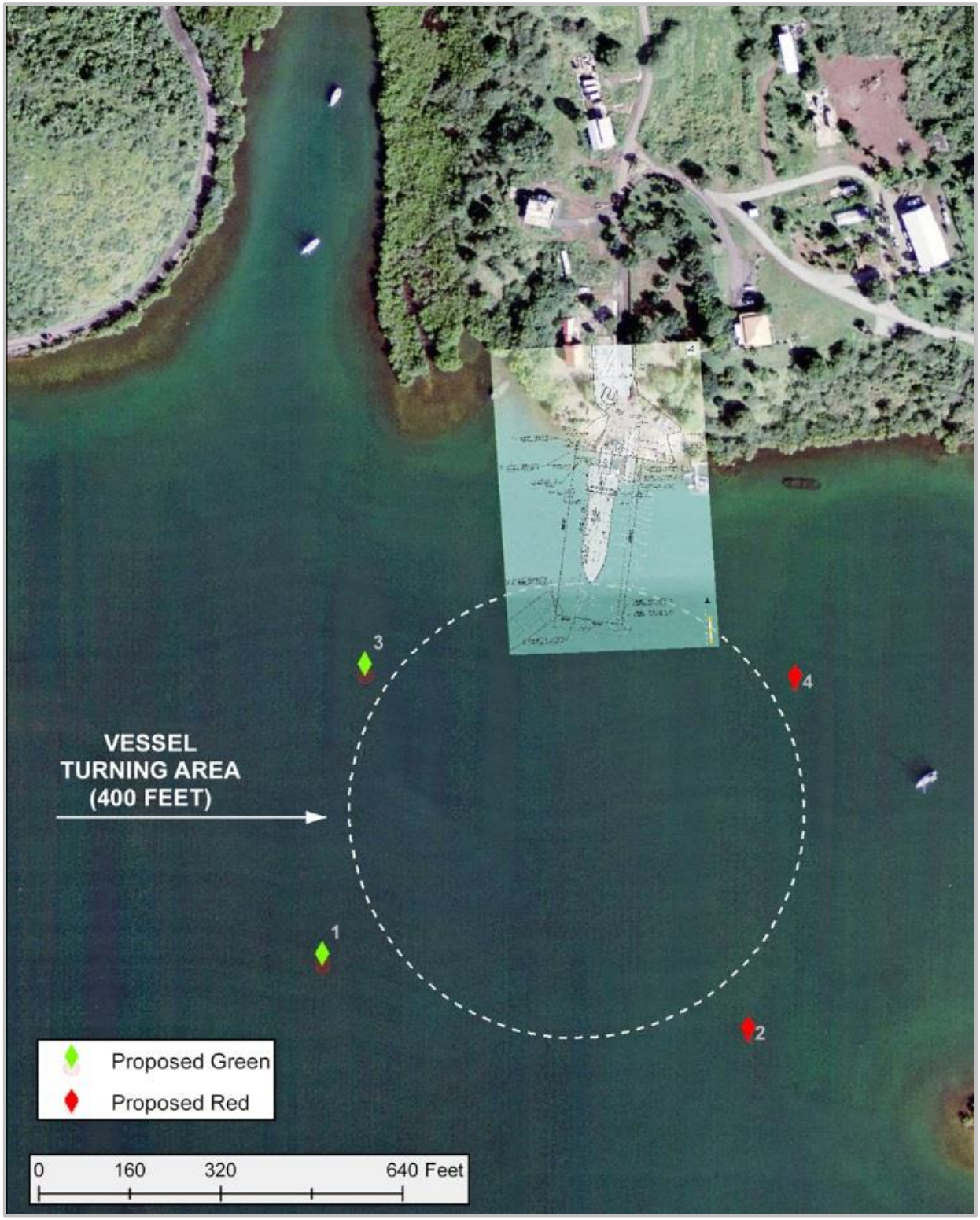


Figure 5: *Proposed Auxiliary Terminal with Alternative #2 PATONs*

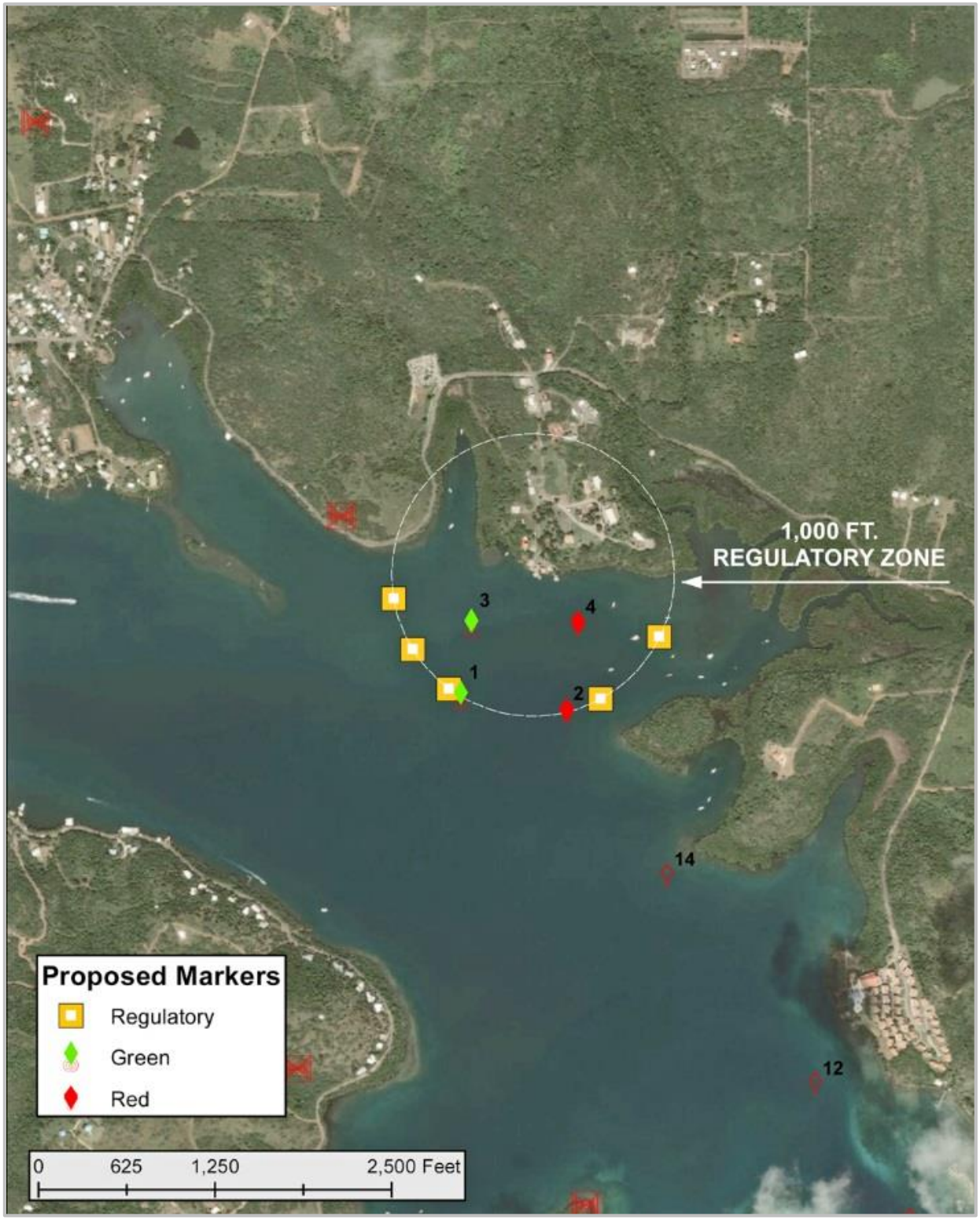


Figure 6: *Alternative #1-1000 foot Regulatory Zone and PATONs.*

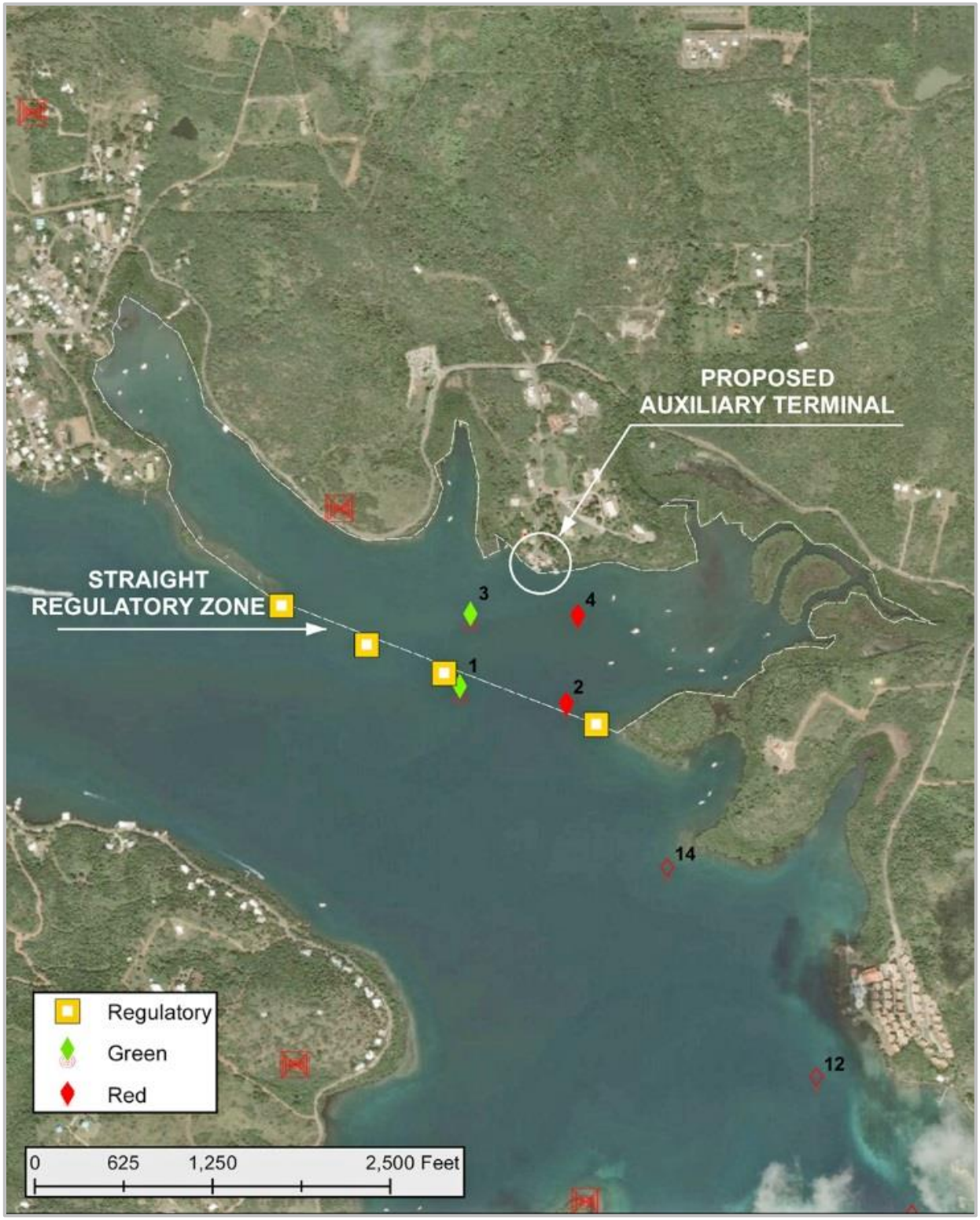
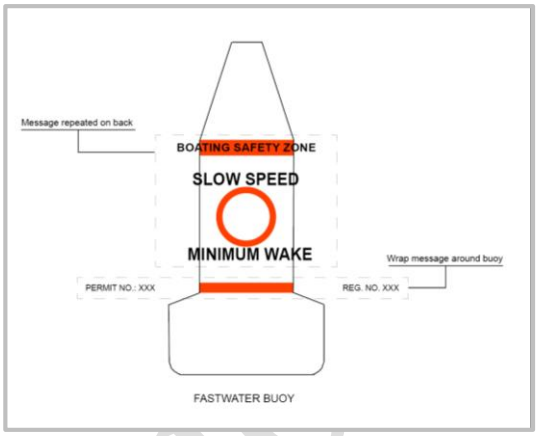


Figure 7: *Alternative #2-Straight Regulatory Zone and PATONs.*

6.3 Regulatory Markers

The recommended regulatory markers in waters greater than 12 feet deep will be 24-inch diameter marker buoys. The locations for regulatory markers in Alternative #1 are all in deep water and will therefore require buoys. Alternative #2 allows for two of the markers (west and east end markers) to be pilings with signs. The piling/signs marker provides better visibility to vessel operators and requires less maintenance than the buoy markers.



Above: *Regulatory Zone buoy.*

Above: *Examples of regulatory buoy and two-pile marker.*

6.4 Regulatory Zone Enforcement

It is anticipated that the PRPA will request the DNER or Municipality of Culebra to install and maintain the new PATONs. It is recommended that a maintenance plan be developed to insure compliance with IALA standards and to maintain safe navigation.

7.0 Conclusion

During the reconstruction period of the Culebra Ferry Ramp in Sardinas Bay, it will be critical to ensure the safe transport of passengers and cargo to Culebra. The increase in ferry transport operations within Ensenada Honda requires improvements in the navigational aids to protect the safety of the public and maritime property. Additional considerations in selecting the most suitable alternatives in navigational aids include the ability to protect protected marine resources, water depths for selecting appropriate aid types, and input of vessel operators who will utilize the facilities.

Under Revision

8.0 References

33 CFR 62.21 (year) Code of Federal Regulations, Title 33, Chapter 1, Subchapter C, Part 62.21 General (a) (United States Aids to Navigation System: e-CFR - Navigation Aides

Aquatic Navigation and Security Act of Puerto Rico Act 430 of December 21, 2000

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8.0 Appendix A

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Meeting notes

Project:	Culebra Ferry Terminal Improvements		
Subject:	Navigation Aids Discussion with the U.S. Coast Guard		
Date and time:	September 21, 2015 9 a.m.	**Meeting no:**	1
Meeting place:	Teleconference	**Minutes by:**	M. Yarbrough
Present:	Pachi Perez Steve Pophal Janet Luce Marie Yarbrough Kailie Benson	**Representing:**	Atkins Caribe Atkins Ports & Coastal Atkins Ports & Coastal Atkins Ports & Coastal U.S. Coast Guard, San Juan

A discussion was held between Atkins and the U.S. Coast Guard, Sector San Juan, on September 21, 2015 to explore considerations associated with improved navigational markers in Ensenada Honda.

Project Background:

- The Puerto Rico Ports Authority has proposed the San Ildefonso Auxiliary Terminal as an alternate means for vessels to delivery fuel, food, goods, and passengers to the island of Culebra. Ensenada Honda is a well-protected harbor sheltered from heavy winds and waves.
- The U.S. Coast Guard maintains the existing federal navigation aids in Ensenada Honda including ten navigation buoys, an outer range channel marker, and an inner range channel marker.

Navigational Aid Ownership Considerations:

- The proposed additional navigation aids can be installed as federal aids to navigation (ATONs) or private aids to navigation (PATONs).
- U.S. Coast Guard Sector San Juan will not have a vessel capable of installing federal ATON buoys until December; however, this equipment limitation will not impact ownership considerations since the aids will not be needed until next year.
- A U.S. Army Corps of Engineers (USACE) federal permit is required for the installation of any additional aids to navigation. Authorization will be the responsibility of the owner. If it is decided that additional federal ATONs are necessary, the U.S. Coast Guard will obtain federal authorizations through the USACE; otherwise, the private aid owner will be responsible for seeking federal permits for installation.
- Authorization and installation of PATONs will be faster to implement than a request for federal ATONs, which requires U.S. Coast Guard District 7 financial support.

Boating Restrictions:

- Precedent has been established for wake restriction authorization through the Department of Natural and Environmental Resources of Puerto Rico (DNER) with enforcement through the Puerto Rico Forces United for Rapid Action (FURA).
- Separate discussions are being held with DNER for vessel restrictions based on manatee habitat.
- A notice of proposed rulemaking would be necessary to provide notice for any proposed boating safety zones.
- A temporary construction speed restriction will be promulgated by the U.S. Coast Guard.

Date issued: September 28, 2015

NOTE TO RECIPIENTS:
These meeting notes record Atkins understanding of the meeting and intended actions arising therefrom.
Your agreement that the notes form a true record of the discussion will be assumed unless adverse comments are received in writing within five days of receipt.

U.S. Coast Guard Meeting Minutes

Plan Design Enable

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Proposed Alternatives:

- Three alternatives for improved channel marking were presented for discussion:
  - Alternate 1: This alternate proposes two red buoys and one green buoy to delineate a 375-ft diameter turning basin.
  - Alternate 2: This alternate augments Alternate 1 with two additional green buoys gating the existing red buoys along the federal channel.
  - Alternate 3: In addition to the navigational buoys, this alternate proposes installation of vessel speed regulatory buoys and a light at the San Ildefonso Auxiliary Terminal.
- Based on the meeting discussion, the U.S. Coast Guard felt that the three buoys proposed in Alternative 1 were all that was necessary for safe navigation.
- The light at the San Ildefonso Auxiliary Terminal was also supported in the navigational process.

Meeting notes

ATKINS

Project:	Culebra Ferry Terminal Improvements		
Subject:	Navigation Aids Discussion with the Puerto Rico Ports Authority		
Date and time:	September 22, 2015 2 p.m.	**Meeting no:**	1
Meeting place:	Teleconference	**Minutes by:**	M. Yarbrough
Present:	Pachi Perez Steve Pophal Janet Luce Marie Yarbrough José Bonanno	**Representing:**	Atkins Caribe Atkins Ports & Coastal Atkins Ports & Coastal Atkins Ports & Coastal U.S. Coast Guard, San Juan

A discussion was held between Atkins and the Deputy Director of the Puerto Rico Ports Authority on September 22, 2015 to explore considerations associated with improved navigational markers in Ensenada Honda.

Project Background:

- The Puerto Rico Ports Authority has proposed the San Ildefonso Auxiliary Terminal as an alternate means for vessels to delivery fuel, food, goods, and passengers to the island of Culebra. Ensenada Honda is a well-protected harbor sheltered from heavy winds and waves.
- The U.S. Coast Guard maintains the existing federal navigation aids in Ensenada Honda including ten navigation buoys, an outer range channel marker, and an inner range channel marker.

Navigational Aid Ownership Considerations:

- The proposed additional navigation aids can be installed as federal aids to navigation (ATONs) by the U.S. Coast Guard or private aids to navigation (PATONs).
- The Mayor of Culbebra would be the appropriate owner of any proposed PATONs.
- Regular buoy maintenance will be necessary.

Boating Restrictions:

- Minimum wake zones would be fully supported.
- Ferry approaches are made at slow speed (approximately 8 knots to maintain steerage) with the exception of adverse weather conditions for safety reasons. The proposed zone would target other vessels near the proposed Ildefonso Auxiliary Terminal launching from the adjacent public boat ramp.
- Commercial cruise ships have tendered in Ensenada Honda.

Proposed Alternatives:

- Three alternatives for improved channel marking were presented for discussion:
  - Alternate 1: This alternate proposes two red buoys and one green buoy to delineate a 375-ft diameter turning basin.
  - Alternate 2: This alternate augments Alternate 1 with two additional green buoys gating the existing red buoys along the federal channel.
  - Alternate 3: In addition to the navigational buoys, this alternate proposes installation of vessel speed regulatory buoys and a light at the San Ildefonso Auxiliary Terminal.
- Captain Bonanno fully supports a navigation aid plan that exceeds the U. S. Coast Guard requirements to control vessel traffic and clearly define the channel (Alternate 3).
- Focusing vessels into the channel will protect natural resources in Ensenada Honda.
- Light buoys are not necessary, but would be a nice feature for additional safety.

Date issued: September 28, 2015

NOTE TO RECIPIENTS:
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Port Authority Meeting Minutes

Plan Design Enable

FEBRUARY 2015

MITIGATION PLAN

FOR THE

POTENTIAL IMPACTS TO SEAGRASS, CORAL, HARD BOTTOM HABITAT AND ESA-LISTED SPECIES OF THE CONSTRUCTION AND OPERATION OF THE AUXILIARY CARGO FERRY TERMINAL IMPROVEMENTS

CULEBRA, PUERTO RICO

PREPARED FOR :

AUTORIDAD de los PUERTOS de PUERTO RICO

PREPARED BY:

ATKINS

Contents

Introduction 3
Impacts 4
Mooring Buoys as Mitigation 4
References 7

Introduction

The Puerto Rico Ports Authority (PRPA) conducted a structural evaluation at the Culebra Ferry Terminal on August, 2010, where advanced deterioration was observed in the deck slab and concrete beams, which has probably spread to the entire concrete surface. This appears to be a result of storm events, hurricanes and the wave action. Furthermore, if the repair and reconstruction of the cargo terminal is not conducted promptly, structural failure may occur. The PRPA has since been planning the necessary works, seeking financing and regulatory compliance.

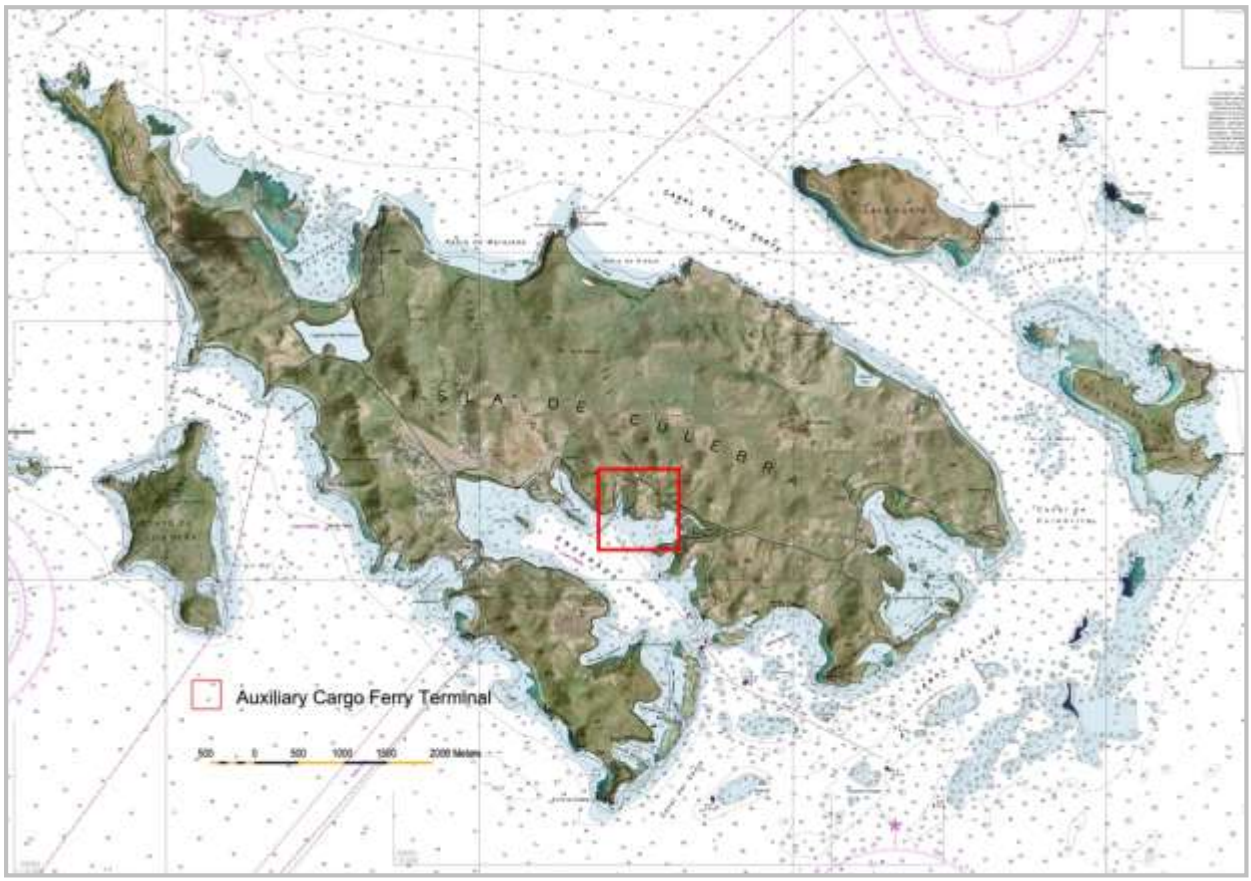

Figure 1: Location of the Auxiliary Cargo Ferry Terminal in San Ildefonso.

During the reconstruction of the cargo terminal, it is not feasible to continue cargo operations at the Culebra Ferry Terminal due to space limitations. Being the only heavy commercial cargo transportation port in Culebra, the cargo ferry provides an essential service to the residents of the island. The areal constraints prevent the cargo and passenger ferries from docking simultaneously, as the size of the required demolition/construction barge would prevent the Puerto Rico Maritime Transport Authority

(MTAPR) passenger ferries from docking, altering the scheduled service. To allow for such operation, the demolition barge and the turbidity barrier would have to be removed before the passenger ferries are scheduled to arrive and reattached once the ferries leave, making it a costly and extremely time-consuming operation. In addition, the MTAPR keeps some ferries at the existing Culebra Ferry Terminal during the day awaiting their return trip, further limiting the operations within in Sardinas Bay.

After evaluating potential sites for an Auxiliary Terminal, the San Ildefonso site in Ensenada Honda (**Figure 1**) was chosen for the limited environmental impacts involved, since no dredging is required, the landside is ample and has been previously developed, and has the required power and water service. **Figure 2** is a site plan and benthic communities within the project footprint in San Ildefonso.

Impacts

There are unavoidable impacts associated with the construction and operation of the proposed action; this mitigation plan addresses the following:

- Sediment resuspension from operation of the ferry at the Auxiliary Cargo Ramp Facility, and its potential impact on adjacent seagrass beds, the nearest of which covers approximately **0.87 acres** of dense *Thalassia testudinum*.
- Approximately **108.2 ft^2** (**0.002 acres**) of soft bottom seafloor, some of it sparsely populated with *Halophila decipiens* seagrass, will be permanently covered by pilings.
- Approximately **3,426 ft^2** (**0.08 acres**) of soft bottom seafloor, some of it sparsely populated with *Halophila decipiens* seagrass, will be impacted by the shading effect of the new structures.
- Potential accidental groundings from up to three ferries per day entering/leaving Ensenada Honda during the six months of operation of the Auxiliary Cargo Ramp Facility.

See **Figure 2** for details of the seafloor impact areas.

Mooring Buoys as Mitigation

The use of mooring buoys have become a proven conservation measure for the protection of existing seagrass beds, coral reefs and other sensitive areas from the damage caused by boat anchors. The DNER has installed approximately 290 mooring buoys in sensitive benthic habitats in order to control damage caused by anchoring vessels (DRNA, 2013).

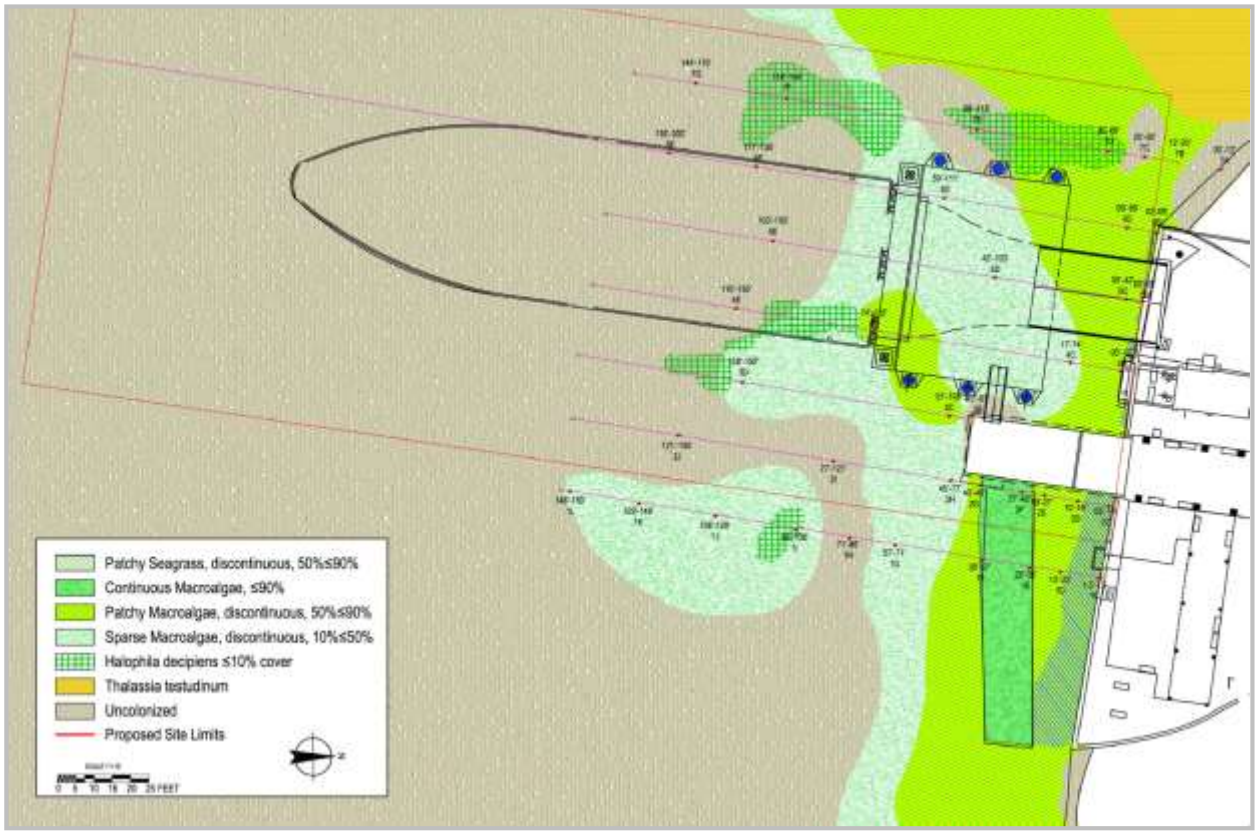

Figure 2 Site plan and benthic communities within the project footprint in San Ildefonso.

The most common personal watercraft anchors are made of a steel alloy, which may weigh between fifteen and twenty-five pounds. When needed, the watercraft operator deploys the anchor simply by throwing it over the side of the watercraft in a suitable location. Once the anchor reaches the seafloor, it drags along until it becomes set, harming seagrass beds and/or corals in the process.

The anchor chain, usually attached between the anchor and the anchor line, or sometimes replacing the anchor line altogether, also harms benthic habitats as it drags through the bottom with normal vessel drifting. The mooring buoys replace the need for vessels to anchor and the associated impacts to benthic habitats.

All mooring buoy systems consist of three elements: a permanent fixture on the sea bottom, a floating buoy on the water surface, and either a chain, rope, or polypropylene line to attach the two. Sea floor characteristics usually dictate which type of system is most suitable. **Figure 3** shows the recommended anchor for mooring buoys as presented by NOAA in the Mooring Buoy Planning Guide, and commonly

used in Puerto Rico for recreational vessels. The impact upon the benthic habitat from installing mooring buoys is insignificant compared to anchors and anchor chain impacts.

The operation of the ferry service at the Auxiliary Terminal at San Ildefonso will cause sediment resuspension, which may directly affect seagrasses adjacent to the project. Seagrasses are habitat to endangered sea turtles, manatees and essential fisheries. To compensate for said impacts, the Puerto

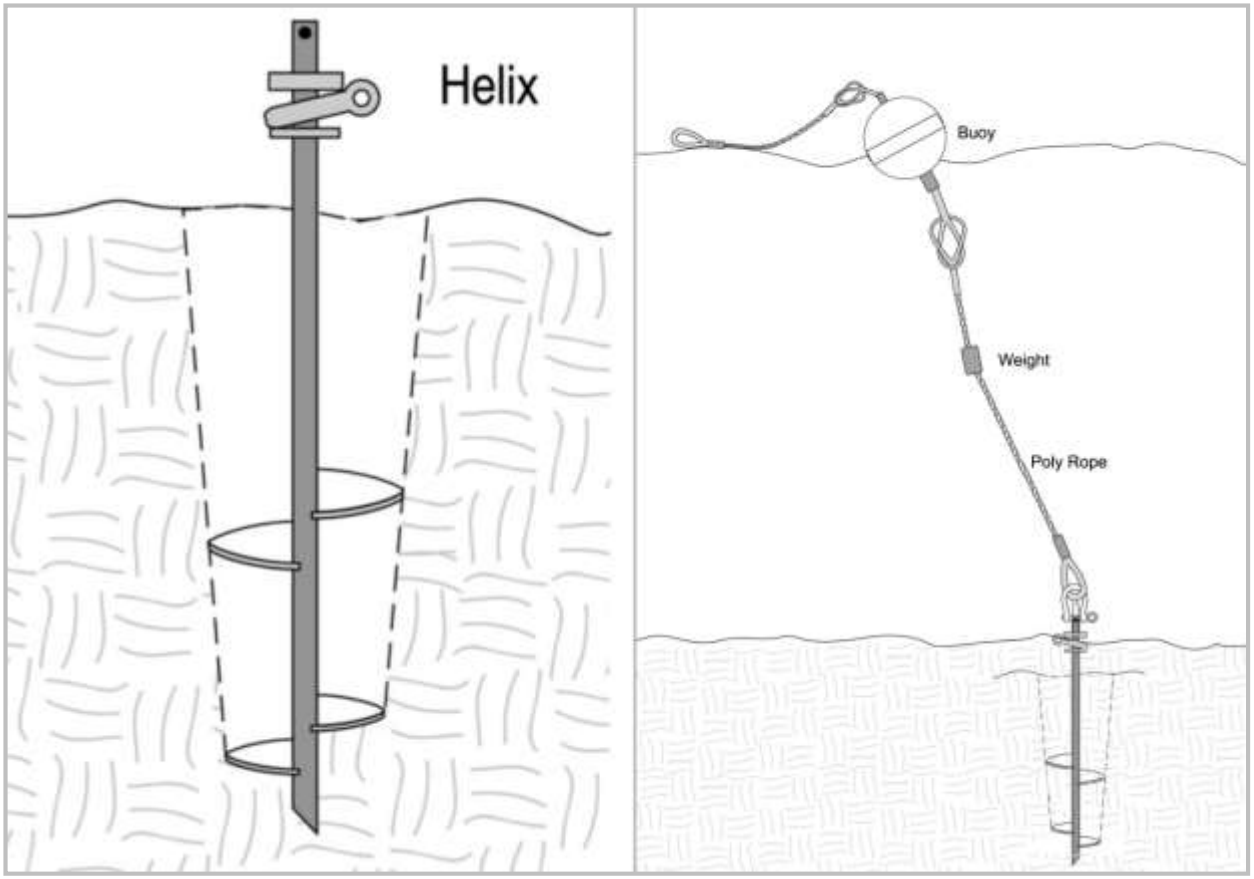

Figure 3. Recommended buoy anchorage (NOAA).

Rico Department of Natural and Environmental Resources (DNER) and the PRPA propose the installation and maintenance of four mooring buoys in Culebrita (specific location to be determined). The effectiveness of installing mooring buoys as a conservation measure on habitats where seagrass beds may be impacted by anchoring has been consistently observed throughout Puerto Rico. Their use for anchorage prevents typical mooring impacts (anchor scars, chain scour, sediment resuspension and anchor drag) to similarly important benthic habitats.

One mooring buoy has the potential to protect anchoring damages up to an approximate radius of **164 ft** (50 m) (Bauzá, 2014), for an approximate area of **84,497 ft^2** (7,850 m^2). This would represent **1.93 acres** of protection for each buoy installed. The installation of four mooring buoys will help protect approximately **7.72 acres** of seagrass beds. Compared with the foreseeable habitat impacts, this provides an 8:1 mitigation ratio.

References

Bauzá (2014) Personal Communication, July 14, 2014 meeting with Jorge F. Bauzá, Ph.D. at the San Juan Bay Estuary Program Office.

DRNA (2013) Nautical Community Mooring Buoy Utilization in Puerto Rico. Bouchard, T., D. Levien, V. Puksta & M. Shooter for Departamento de Recursos Naturales y Ambientales. May 1, 2013.

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PADI (1996-2005) Mooring Planning Guide. Version 1.2. PADI International, Inc.