Ocean Wind
An Ørsted Initiative

Appendix E – Biological Survey Results

- Seal Haul-Out Survey
- SAV Survey
- Benthic Habitat Assessment - will be provided in the Supplemental COP per the departure schedule

Seal Haul-Out Survey

Aerial Seal Haul-out Surveys
Ocean Wind Offshore Windfarm

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Environmental Imaging Solutions

Aerial Seal Haul-out Surveys

Ocean Wind Offshore Windfarm

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July 16, 2019

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Acknowledgments

Normandeau–APEM would like to thank the following people for information provided during planning, execution, and reporting phases of this research:

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Amendment Record

Revision Number	Date	Change Details	By
1	July 16, 2019	Insert information on flight speed in methods	JRW
2	August 5, 2019	Add image labels, Acknowledgements, Contact Information	JRW

1 Summary

Surveys were commissioned along the New Jersey coastline to find information on seal species presence. Original survey design called for surveys to occur between two hours before and two hours after low tide. An investigative survey flight was conducted in accordance with these conditions but no seals were found. Further research into seal patterns of activity suggested that many seals preferred to approach the coast nearer high tide. The survey crew remobilized and captured aerial digital imagery in suitable conditions along 215 km of coastline. Areas around known seal haul-out locations were intensively surveyed, as was the area around potential cable landing sites. Approximately 29,000 images were captured during the digital aerial survey flight, of which ≈19,000 were captured along the coast but not in the main areas of interest. Approximately 9,500 images covering ≈64 km^2 contained 45 seals and 310 bird flocks. The seals were identified as probable harbor seal (*Phoca vitulina vitulina*). Bird flocks represented gulls, ducks, auks, shorebirds, geese, crows, vultures, and egrets.

The survey areas were intensively covered by overlapping imagery and the numbers of seals found during the surveys reflects seal activity for the optimal combination of tide and weather conditions at this time.

2 Introduction

The APEM–Normandeau Team was contracted by Ørsted to conduct an aerial digital survey to identify seal haul-out locations and census the numbers of seals at each. Areas with bird flocks were also of interest. Aerial visual surveys were conducted prior to the digital survey to help target imagery at haul-out locations and bird flock locations.

The Survey Area (Sandy Hook to Great Bay, New Jersey) covers approximately 215 km of the coastline (Figure 1) from the Sandy Hook haul-out site to the Great Bay harbor seal haul-out site on Fish Island. This included all coastal areas behind barrier islands (e.g., Long Beach Island) as well as the main coastline and beach areas. The area around two potential cable landfall sites was intensively targeted for survey.

This report describes the background, methods and results of the aerial digital survey which was undertaken in March 2019 to help inform future assessment work related to a proposed wind farm development.

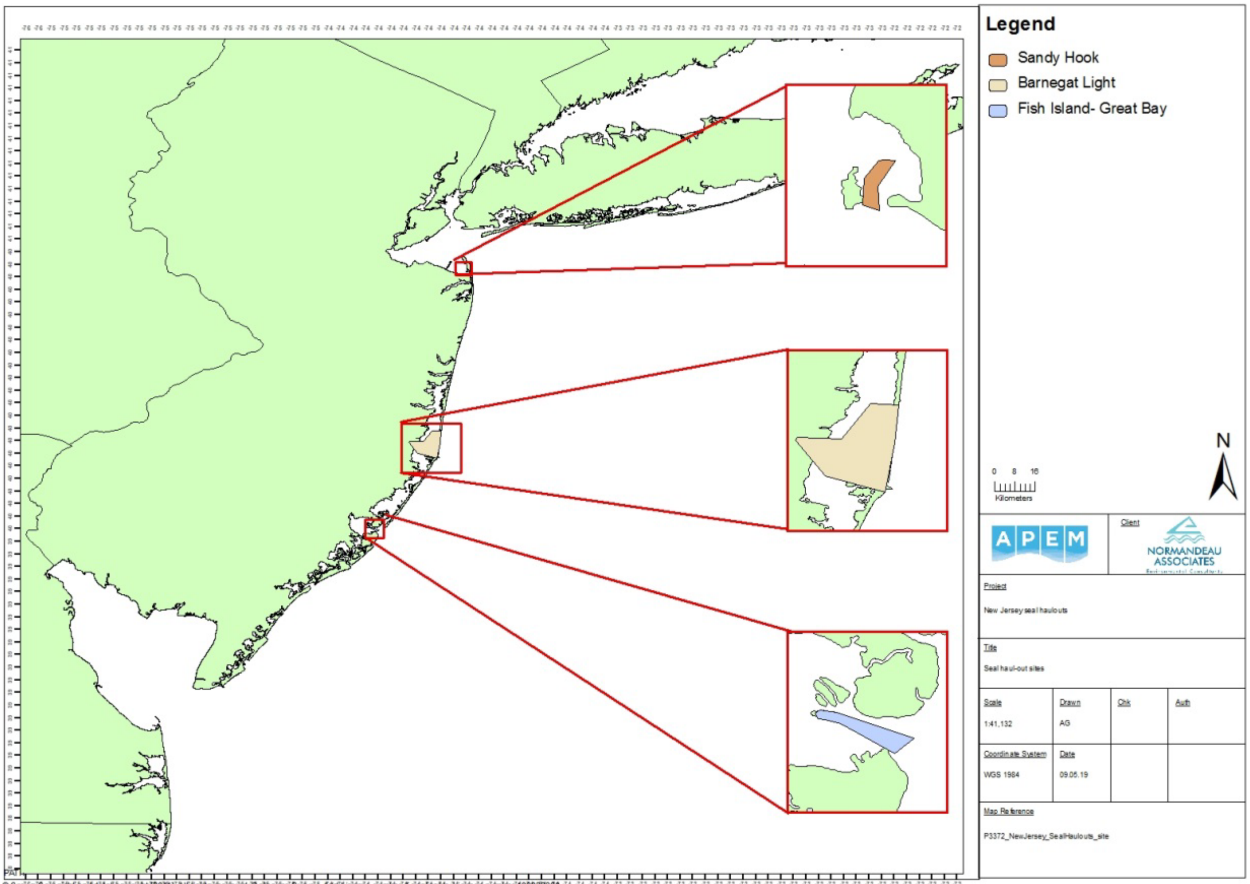

Figure 1. New Jersey coastline showing the extent of the seal haul-out Survey Area.

3 Background

A brief review of available information about seals in New Jersey waters and their habits was undertaken as part of this report and is presented below.

3.1 Seal Species in New Jersey

Four seal species occur in the coastal waters off New Jersey: harbor seals, gray seals, hooded seals, and harp seals. These species migrate from Canada in the fall and early winter southward to the East Coast to forage until May or June when they return to northern waters (Moll et al. 2017). This section contains a brief description of each species and the most current stranding data for New Jersey.

3.1.1 Harbor Seal (Phoca vitulina vitulina)

Harbor seals migrate south from the east Canadian Arctic to New England waters in the fall and early winter with anecdotal sightings as far south as North Carolina (Hayes et al. 2018). In mid-May to June, harbor seals migrate north to Maine and eastern Canada. This species can be found year-round throughout New England and the Gulf of Maine (Gilbert et al. 2005). Recent anecdotal reports indicate that some pupping occurs at high-use haul-outs off Manomet, Massachusetts, and the Isle of Shoals, Maine. No pups were observed from 1996 through 2011

(Toth et al. 2018), but stranding data indicate pups occur in the coastal New Jersey waters (Hayes et al. 2018). Radio-tagging in 2001 established that sub-adult, juvenile, and adult seals may occur in New Jersey (Waring 2006). Toth et al. (2018) indicated a significant increase ($p = 0.03$) in abundance from 1996 through 2011 in Great Bay, New Jersey. Maximum counts increased from 100 individuals in 1996 to 160 individuals during the 2010–2011 season; and in 2016, five years after the study, 220 harbor seals were observed at the haul-out site.

Harbor seals strand each year throughout their migratory range. From 2011 to 2015, 37 harbor seals (five pups and 32 adults/sub-adult/juveniles) stranded along the New Jersey coast (Table 1; Hayes et al. 2018).

Table 1. Harbor seals stranded along NJ coast, 2011–2015*

Year	Adults (pup)
2011	10(0)
2012	7(0)
2013	4(0)
2014	2(1)
2015	9(4)
Total	32(5)

* Hayes et al. 2018

3.1.2 Gray Seal (*Halichoerus grypus atlantica*)

Gray seals range from Labrador to New Jersey and are known to pup in several locations along the Maine coast and Nantucket-vineyard Sound, Massachusetts (Hayes et al. 2018). Radio-tagging surveys indicate that gray seals travel between the US and Canada; however, an unknown percentage of seals reside year-round in the US (Hayes et al. 2018). Between 2011 and 2015, 49 gray seals (35 adult and 14 pups) stranded along the New Jersey coast (Table 2; Hayes et al. 2018).

Table 2. Gray seals stranded along NJ coast, 2011–2015*

Year	Adults (pup)
2011	10(0)
2012	4(0)
2013	7(2)
2014	7(6)
2015	7(6)
Total	35(14)

* Hayes et al. 2018

3.1.3 Hooded Seal (*Cystophora cristata*)

Hooded seals occur throughout much of the North Atlantic and Arctic oceans and are highly migratory. This species occurs in US waters from Maine to Florida but has occurred as far south as Puerto Rico (Waring et al. 2008). Hooded seals generally prefer deep water and are found farther offshore than harp seals. Between 2001 and 2005, 8 adult hooded seals stranded along New Jersey (Table 3; Waring et al. 2018).

Table 3. Hooded seals stranded along NJ coast 2001–2005*

Year	Adults (pup)
2001	5(0)
2002	1(0)
2003	1(0)
2004	1(0)
2005	0(0)
Total	8(0)

* Waring et al. 2018

3.1.4 Harp Seal (Pagophilus groenlandicus)

Harp seals occurs throughout much of the North Atlantic and Arctic oceans and are highly migratory (Hayes et al. 2018). Adults and some of the immature animals migrate southward along the Labrador coast south to the US Atlantic in winter and spring (Hayes et al. 2018). Between 2011 and 2015, 23 harp seals (22 adults and 1 pup) stranded along the New Jersey Coast (Table 4; Hayes et al. 2018).

Table 4. Harp seals stranded along NJ coast, 2011–2015*

Year	Adults (pup)
2011	16(0)
2012	0(0)
2013	2(1)
2014	1(0)
2015	3(0)
Total	22(1)

* Hayes et al. 2018

3.2 Haul-out Conditions

Seals haul-out during the winter to rest and get warm (Moll et al. 2017). Haul-out sites vary but include intertidal and subtidal rock outcrops, sandbars, sandy beaches, and peat banks in salt marshes (Moll et al. 2017). The number of seals that may haul-out on a given day varies substantially based on tide, temperature and wind chill, wind speed and direction, wave intensity, and disturbance (Moll et al. 2017; Schneider and Payne 1983; Toth et al. 2018). Information regarding which conditions are most likely to positively affect seal haul-out numbers along the coast of New Jersey are summarized from several studies below.

Moll et al. (2017) surveyed a harbor seal haul-out on a rock outcrop located near Coddington Point on Naval Station Newport, Rhode Island, from 2010 through 2017. The focus of the study was to better understand harbor seal haul-out usage, abundance, behavior, and environmental conditions. Results from weekly counts during the daytime and at low tide (usually within one hour of peak low tide) indicated that more seals hauled out in the following conditions (Moll et al. 2017):

- Warmer water temperature
- Low wind gust speed
- Wind from the sheltered direction
- Lower water level, and
- Proximity of observation time to solar noon.

Further analysis suggested that strong winds from sheltered aspects might have had less of an effect on the number of seals hauled out than strong winds from exposed aspects. Overall, the results indicated that the seal count decreased as wind speed increased. However, binning wind direction into exposed (e.g., northwest) aspects and protected (southeast) aspects provided a more useful and predictive characterization. The number of seals hauled out in lower wind speeds from the protected aspect (in this case E, SE, S, and SW) was significantly higher ($p<0.05$) than in higher winds (up to >15 knots) from the exposed aspect (NE, N, NW, and W; Moll et al. 2017).

Moll et al. (2017) also indicated variable site fidelity among seals at this haul-out. Some individuals were regularly observed throughout the season, while others were seen only sporadically or one time.

Schneider and Payne (1983) examined how the combined effects of several environmental factors affected the number of seals hauled out during winter in southeastern Massachusetts. Results indicated that tide, air temperature, and wave intensity had the most influence on the total number of seals hauled out ($p<0.0001$; Schneider and Payne 1983). The number of seals decreased with increasing time before and after low tide with increasing air temperature and increasing wave intensity. The negative relationship with air temperature reflects the pattern of seasonal abundance, which reached a peak during the coldest months (Schneider and Payne 1983). Examination of the next level of variates indicated that total counts were significantly correlated with wind direction, wind speed, disturbance, and sky cover but were of less importance than season, tide, and wave intensity (Schneider and Payne 1983). Overall, Schneider and Payne (1983) concluded that while several factors affected the number of seals appearing near shore at Manomet, Massachusetts, only tide and disturbance had any significant effect on the percentage hauling out. In addition, nearly all of the animals visible from shore hauled out at the same time, which is apparently common at ledge site haul-outs. Thus, ledge counts may be preferred for monitoring distribution and abundance of harbor seals. The authors also indicated that harbor seals do not haul-out in synchrony with each other or with the tide on uninhabited beaches.

Toth et al. (2018) observed harbor seal haul-out areas at salt marsh sites in Little Egg Inlet in Great Bay, New Jersey, from 1996 through 2011 (Figure 2). Data were collected opportunistically from 1996 through 2009 and in 2010–2011, surveys were made more regularly (conducted 5 days per week) from the Rutgers University Marine Field station cupola. Data recorded included date/time, number, and location of hauled-out seals and number of seals in close proximity in the water, tide stage, wind speed and direction, notable weather conditions, and presence of young pups. Observations were made for harbor seals only, but the authors indicated that although gray, harp, and hooded seals can also be found in coastal New Jersey at the same time they were not included in the counts for this study.

Monthly maximum number of seals varied from 75 individuals in January to 160 individuals in March, and the months with the highest number of hauled-out seals were February through April (Toth et al. 2018). In addition to the study site, harbor seals were anecdotally sighted in adjacent marsh islands in Great Bay (2 km from the mouth of Great Bay inlet, 1 km from the study site) and at various sites up the Mullica River into brackish water (20 km from the mouth of Great Bay inlet, 16 km from the study site).

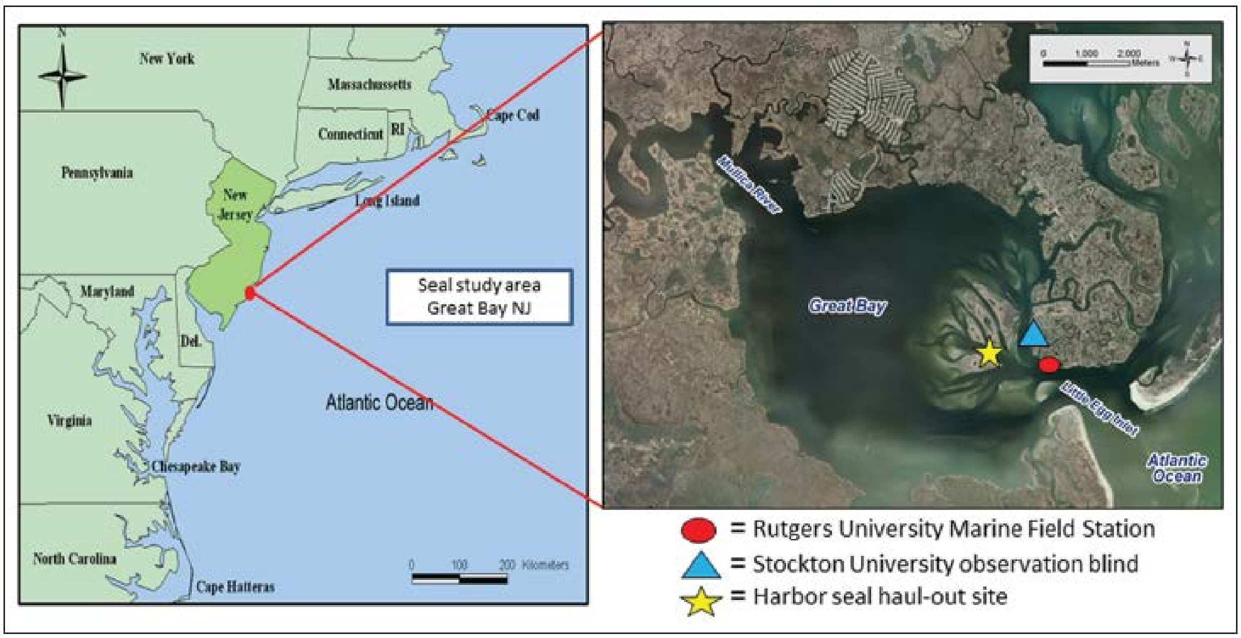

Figure 2. Harbor seal haul-out study area for the 1996–2011 survey (Source: Toth et al. 2018)

Although seals may be hauled out in suitable habitats along the New Jersey coast, there are three known annual haul-out locations in New Jersey: Sandy Hook, Barnegat Light, and Great Bay (Figure 3).

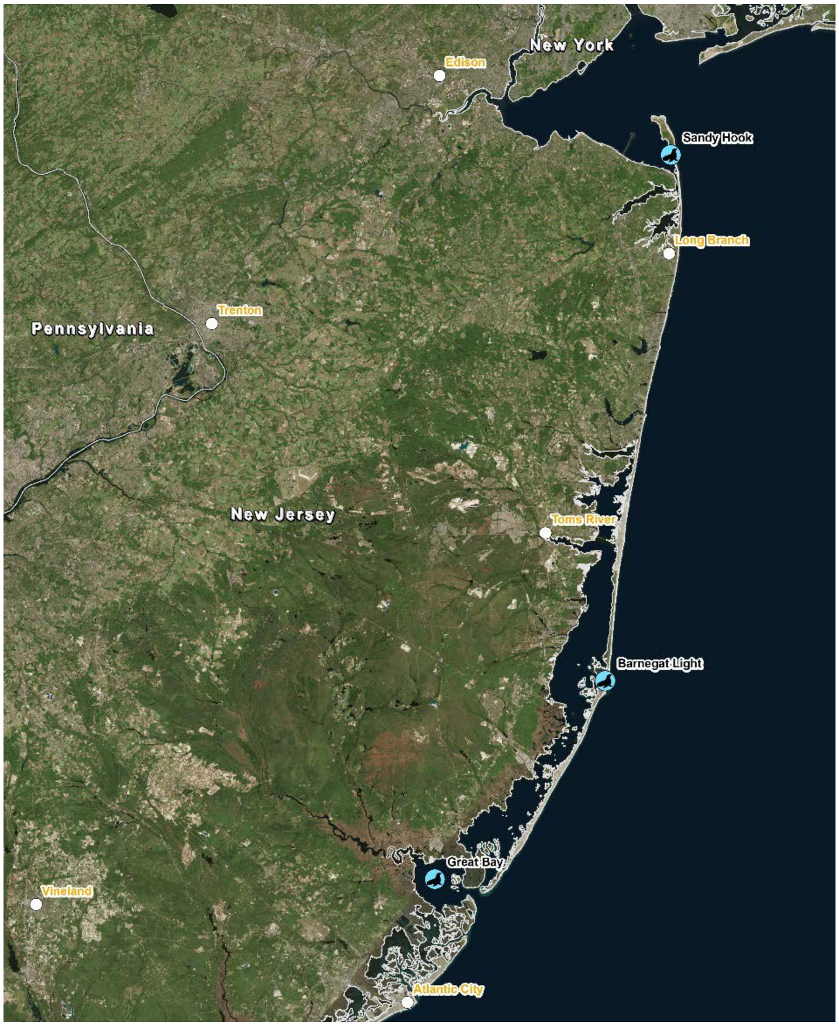

Figure 3. Three known annual seal haul-out locations in New Jersey (Source: Conservation Wildlife Foundation New Jersey 2019).

3.3 Great Bay

Great Bay consists of tidal rivers, inland bays, and multiple wetland types, typically with low salt-march vegetation (*Spartina alterniflora*; Slocum 2009). Great Bay is an ideal haul-out site because of its relative isolation and separation from the mainland and urban disturbances. In addition, seals can forage for fish in both the ocean and estuary (Toth et al. 2018). Great Bay is the largest seal haul-out site in New Jersey and is used by more than 120 individuals with up to 150 observed at one time (NJ WAP 2017). This site is the focus of Stockton University's New Jersey Seal Study course, studied since 1994, and the study mentioned above (Toth et al. 2018). Toth et al. (2018) also indicated that although multiple anecdotal haul-out areas were observed, large numbers of harbor seals showed consistent site fidelity to the study area over the 15-year study (Figure 4).

Figure 4. Great Bay's seal haul-out site in New Jersey.

3.4 Sandy Hook

Sandy Hook is New Jersey's second largest seal haul-out site. Seals can most often be observed on the bayside beaches but may also be occasionally observed on the ocean beaches, the rocky shoreline near Officer's Row, or on floating patches of ice in Sandy Hook Bay (Figure 5). Up to 95 seals have been observed here at one time (NJ WAP 2017). Skeleton Hill Island, which is really not much bigger than a sandbar, in particular is a favorite winter haul-out spot. A video of Skeleton Hill Island on 23 March 2018 shows 150 seals, a record for that area (Patch Staff 2018).

Figure 5. **Sandy Hook's seal haul-out sites in New Jersey.**

3.5 Barnegat Light

Barnegat Light is New Jersey's third largest seal haul-out site (Figure 6). Seals can be observed swimming in and out of Barnegat Light and hauled-out on sandy beaches, sand bars, and docks (NJ WAP 2017). The numbers of seals at this site are lower than at the other two haul-out sites, but fairly regular during the winter.

Figure 6. Barnegat Light's seal haul-out sites in New Jersey.

4 Methods

An aerial visual reconnaissance mission was flown to pinpoint the location of seal colonies along the New Jersey coast before an ultra-high definition aerial digital survey was conducted. This mission was flown using a 1974 Cessna U206F at approximately 1000 ft. The aircraft flew at around 100 kts and circled areas of interest to allow sufficient time for accomplishing comprehensive visual searches. An observer equipped with a Canon EOS-1Ds Mark III captured images from the aircraft throughout the task. The survey was flown north to south along the coastline, entering inlets and estuaries containing sand bars; potential haul-out sites were flown over in a clockwise orbit. This allowed the observer the best view to conduct the survey. Areas where previous research had indicated were historical haul-out sites were surveyed more intensely with several orbits being flown. The observer used the android mobile application Locus Map to track the flight and to mark the location where a target was spotted. The survey was flown during the middle of the day to maximize the amount of sunlight available to capture the best quality images and make spotting the seals easier. The survey was flown during a window where the lowest tides matched up with solar noon so that the sandbanks were exposed.

Since no seals were noted during the observer flight, a discussion was held on whether to proceed the next day with the digital flight. The initial spotter flight was on 9 March, but no seals were hauled out. We looked into weather and wind to see if this might have a bearing and worked closely with Dr. Jackie Sullivan Toth. We also received regular updates from Rutgers University Marine Field Station on the seal population at the Great Bay site (Table 5). We first checked haul-out patterns from 5 March through 8 March to see if there was tide, weather, or any pattern prior to the March 9 flight. The patterns of activity suggested that nearer high tide was more likely for seals to gather and then haul-out at the Great Bay site; although, no data were available from Sandy Hook or Barnegat Light.

Table 5. Seal Data from Rutgers University Marine Field Station

Date (March 2019)	Time (am)	Number of Seals	Water Temperature (°C)	Wind Speed, Direction, and Temperature (°C)
5	11:50	20	4.8	~15, WNW, −3.3°
6	09:30	4	5	17, WNW, −7.2°
7	11:20	101	4.9	7, SSW, −8.3°
9	10:30	24	4.3	6, W, −5°

Following consultation it was determined that air temperatures were on the low side for the seals to show haul-out behavior; therefore, the digital aerial flight was postponed until the next available window.

Flight plans were created to capture digital imagery within the historical seal haul-out locations and the proposed cable landfall location. The digital survey flight was flown using the Shearwater III camera system, at a flight altitude of 1,600 ft and flight speed of 120 kts over ground selected to ensure good quality imagery was captured. Counts are not undertaken whilst the flight is in progress, but are gathered from the captured imagery at a later time. Digital stills aerial surveys provide a permanent record from which to gain accurate counts of targets detected within the imagery. There is no decrease in detection from the transect line and therefore the flight speed does not decrease the ability to provide accurate counts.

Images captured within these locations were extracted and visually inspected to determine if there were any seals present. Seals detected were tagged to provide a georeferenced location for individuals. Images with flocks of birds were also identified.

The high-resolution aerial digital survey was completed on 17 March 2019. Suitable weather windows were identified for 16 to 18 March. An update on 14 March had 145 seals hauled out at high tide; although the wind speed was 16 knots. Wind speed and tide had been the reason survey on 14 and 15 March were not considered. This information provided thus far resulted in a survey design change to incorporate some areas nearer low tide and to reach Great Bay nearer high tide.

On 16 March, although we were ready to fly, Dr. Toth reported only 2 seals hauled out the entire day and none were clearly visible in the water so the flight was abandoned. Wind speed looked a little high and was keeping the water from the marsh edge possibly making it difficult for the seals to haul out.

The forecast for 17 March was determined to be suitable—little to no wind in the afternoon for the high tide and a suitable low tide window to fly the other sites and allowing survey of Barnegat and the cable landings (Site 2) on a rising tide. Based on the pattern over the previous few days of seals coming in with the high tide, 17 March was the last day that would allow the survey to be carried out in late afternoon just before high tide (5:47 pm, Sandy Hook [Site 1]; 6:31 pm, Great Bay [Site 3]) with a 10 degree sun angle (6:00 pm). We planned to be on task at 2:00 pm to complete sites 1, 2, and 3. Time permitting, we planned on re-surveying Sandy Hook, although we were aware that the sun angle might overrun slightly depending on transit times between the areas.

Dr. Toth provided a rising tide update on 17 March suggesting that, although no seals were hauled out, "tons" were in the surrounding water possibly waiting for the tide to rise to haul-out. We mobilized and flew the survey. We flew Sandy Hook, Barnegat Inlet, and Great Bay. Because the survey went quicker than planned, we got to Great Bay earlier than we would have liked. We flew it a second time to ensure we had imagery from closer to high tide. The plan was to re-fly Sandy Hook on the way back to the airport; however, this ended up cutting it close to fuel time cut-off and was abandoned. An update in the afternoon indicated there weren't many seals hauled out but there were plenty in the surrounding water. A quick quality control review of the imagery found seals in the water around Great Bay.

4.1 Weather Conditions

4.1.1 Visual Survey

The visual survey flight was undertaken on 9 March 2019. Temperatures of 4.4°C–6.1°C were recorded with a wind speed of 1–3 knots from an east-north-easterly direction and little to no cloud cover. A dew point of between −3°C to −4.5°C was recorded.

4.1.2 Aerial Digital Survey

The aerial digital survey was undertaken on 17 March 2019. A temperature of −1.1°C was recorded with a wind speed of 10 knots. Cloud cover was recorded at 0% with visibility of over 10 km. Sea state was recorded as 1.

4.2 Target Extraction and Quality Control

4.2.1 Image Analysis

Approximately 29,000 images were captured during the digital aerial survey flight. Of those, the images that had their central node fall within the boundary polygons of the areas shown in Figure 1 were extracted from the dataset and processed to allow target detection. This provided approximately 9,000 images to be analyzed. Images were screened to identify those that contained seals. In addition images that contained flocks of birds were also identified.

Images that contained seals were geo-processed and seals were "tagged" to provide location information for each individual. Survey data were analyzed to produce maps showing seal distributions in each area. For each map, seal observations were composed of individual points geo-referenced to actual spatial locations at the time of sighting.

Images that contained flocks of birds were "tagged" and location was recorded. Images were briefly reviewed to record approximate numbers of individuals and a description of species groups, and the locations of the flocks were mapped. Some example images are shown in Appendix A.

4.2.2 Identification Quality Control

Targets flagged as potential seals were quality checked by the QC manager to ensure they were suitable for inclusion. All but two snags were determined to be seals and remained in the data set. Some example images are shown in Appendix A.

5 Results

5.1 Visual Survey

No seals were noted during the observer flight.

5.2 Aerial Digital Survey

To ensure total coverage of each area, data collection methods were pre-planned to include overlap between images. Duplicate areas were discounted during analysis, and if any targets were detected in these areas only one copy was retained within the dataset. The total area covered was calculated by mapping the outer extents of the images and calculating the area within GIS. The areas surveyed covered the seal haul out sites and the potential cable landing sites, and covered a combined total area of 63.674 km^2 (Table 6). Imagery analyzed including the overlap covered a combined area of 87.838 km^2, which indicates the intensity of survey effort provided by a total of 9,477 images. Depending on the area, between 92% and 97% of imagery contained no seals or bird flocks (Table 6).

Table 6. Blank Images Detected in Each Survey Area

Area	Size of haul out area (km^2)	Area of images analyzed (km^2)	# Images	Blank Images	
				# Blank	% Blank
SITE_1_SANDY_HOOK	0.110	4.142	432	401	92.82
SITE_2_BARNEGAT_LIGHT	61.183	83.771	8190	7944	97
SITE_3_GREAT_BAY	2.381	9.925	855	787	92.05

5.2.1 Seal Distribution and Identification by Survey Area

The distributions of detected seals are shown in Figure 7 to Figure 9. Each point shows an individual seal location in each of the survey areas. Of the three main seal colony locations, Barnegat Light also included the area around the potential cable landfall route (Figure 7, Figure 8, Figure 9). In total 45 seals were detected within the images: six in the Sandy Hook area, five in the Barnegat Light area, and 34 in the Fish Island–Great Bay area (Table 7). The majority of the seals detected were in the water, with very few hauled out, making some identifications difficult. Only 7 of the 45 seals were identified to species, of which all were identified as probable harbor seals (Table 8).

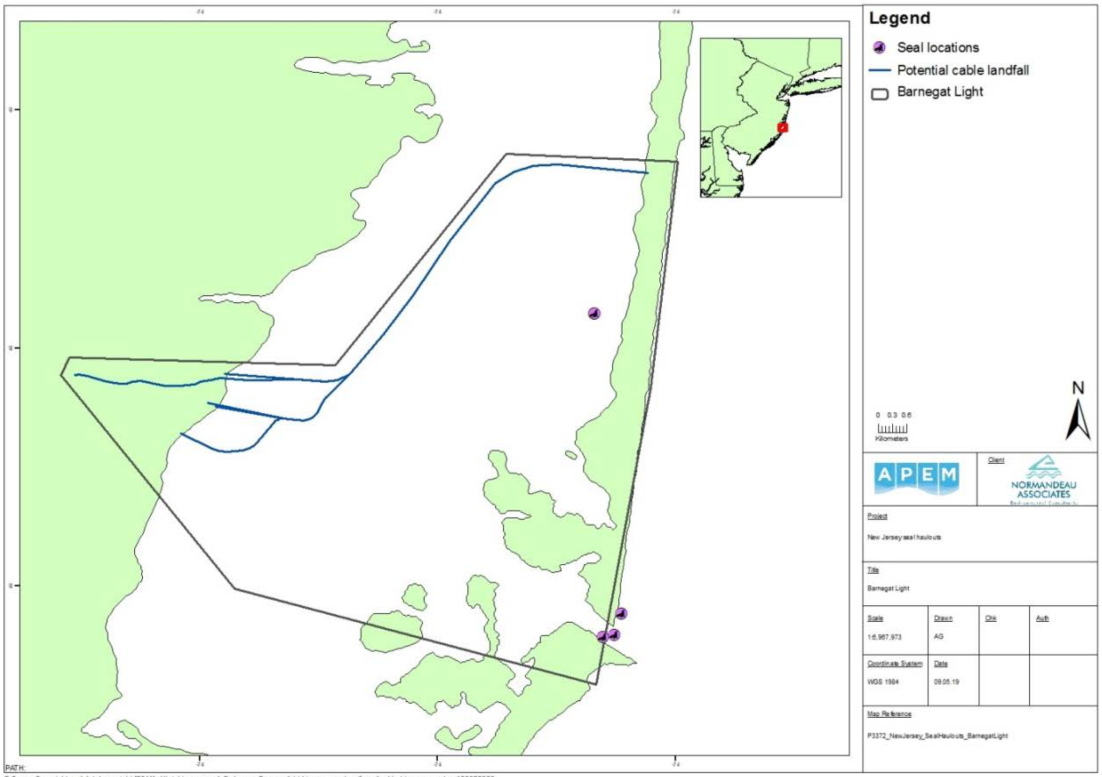

Figure 7. Barnegat Light seal locations.

Figure 8. Sandy Hook seal locations.

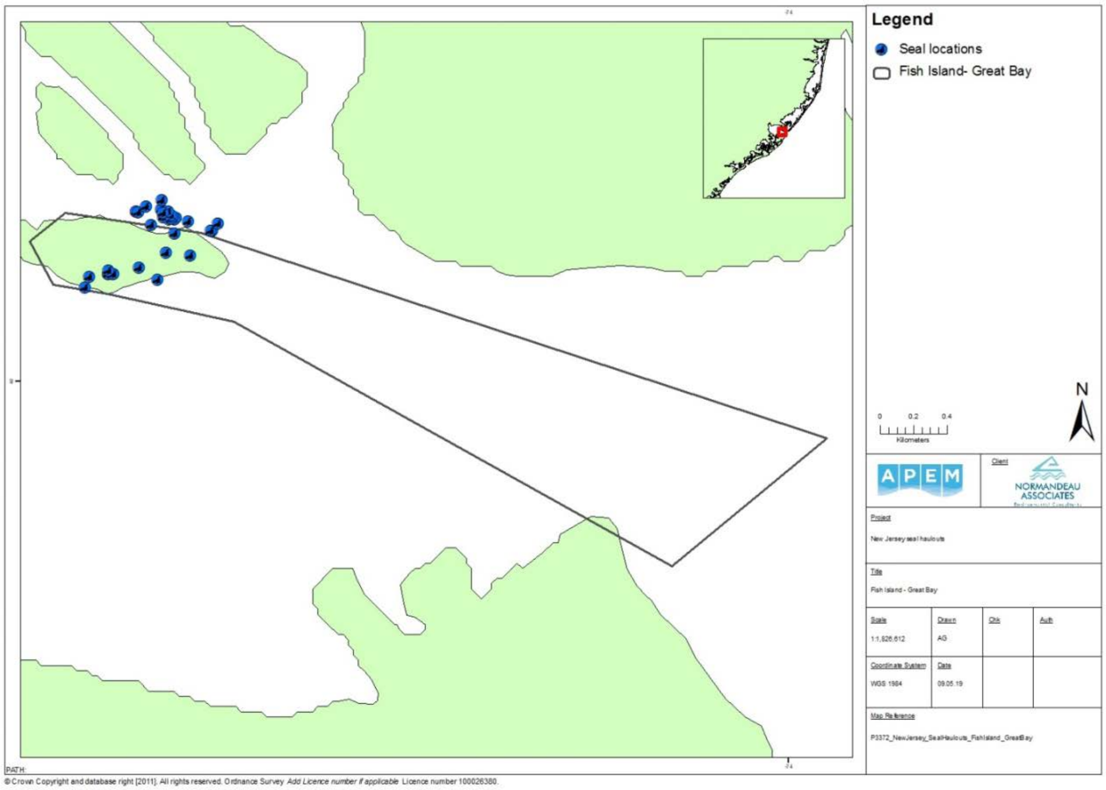

Figure 9. **Fish Island–Great Bay seal locations.**

Table 7. Number of Targets Detected and Sent for Identification

Order	Survey Area		
	SITE_1_SANDY_HOOK	SITE_2_BARNEGAT_LIGHT	SITE_3_GREAT_BAY
Marine Mammals	6	5	34
Total	6	5	34

Table 8. Number of Targets Identified to Species

Order	Survey Area		
	SITE_1_SANDY_HOOK	SITE_2_BARNEGAT_LIGHT	SITE_3_GREAT_BAY
Harbor Seal	-	2	5
Species Unknown	6	3	29
Total	6	5	34

5.2.2 Bird Flocks

Removing duplicates, 310 bird flocks were found in imagery. Flock sizes were estimated unless images contained <10 individuals at which point individuals were counted. The minimum flock size was 7, and maximum flock size 2,550. Across all 310 flocks, mean flock size was 99 (Table 9). Flocks were mapped (Appendix B). All flocks were identified to species groups, and the species groups represented in order of frequency were gulls, wildfowl excluding geese, auks, shorebirds, geese, crows, vultures, terns and egrets. Within each species group some individuals were identified to species, and the full list with scientific names can be found in Appendix C.

Table 9. Number of Bird Flocks and Minimum, Maximum, and Mean Flock Sizes

Number of Flocks	Minimum Flock Size	Maximum Flock Size	Mean Flock Size
310	7	2,550	99

6 Discussion

The surveys were carefully planned to ensure that seals could be detected if they were in the area. On-the-ground updates of seal activity ensured that the surveys targeted the best possible representation of seal activity. The survey areas were intensively covered by overlapping imagery and the numbers of seals found during the surveys reflects seal activity for the optimal combination of tide and weather conditions at this time. The entire coastline was surveyed and imagery captured. These images are available for review should there be other areas of interest identified at a later date.

Bird flocks were imaged within and without of the target areas, and those outside of the target areas are available for review should an interest or need arise.

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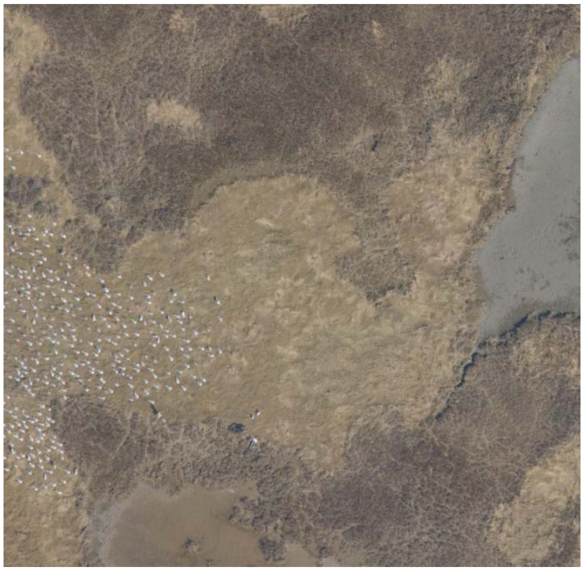
Appendix A: Example Images

Harbor Seal. Barnegat Light (39.766679, -74.095087).
Date: 2019-03-17

Harbor Seal. Nr Fish Island (39.510648, -74.340654).
Date: 2019-03-17

Harbor Seal. Fish Island (39.509089, -74.343501).
Date: 2019-03-17

Bird Flock. Nr Barnegat Light (39.7612,-74.1471.
Date: 2019-03-17



Bird Flock. Nr Barnegat Light (39.7654,-74.1378)
Date: 2019-03-17

Close-up of Bird Flock. Nr Barnegat Light (39.7654,-74.1378)
Date 2019-03-17

Appendix B: Locations of Bird Flocks

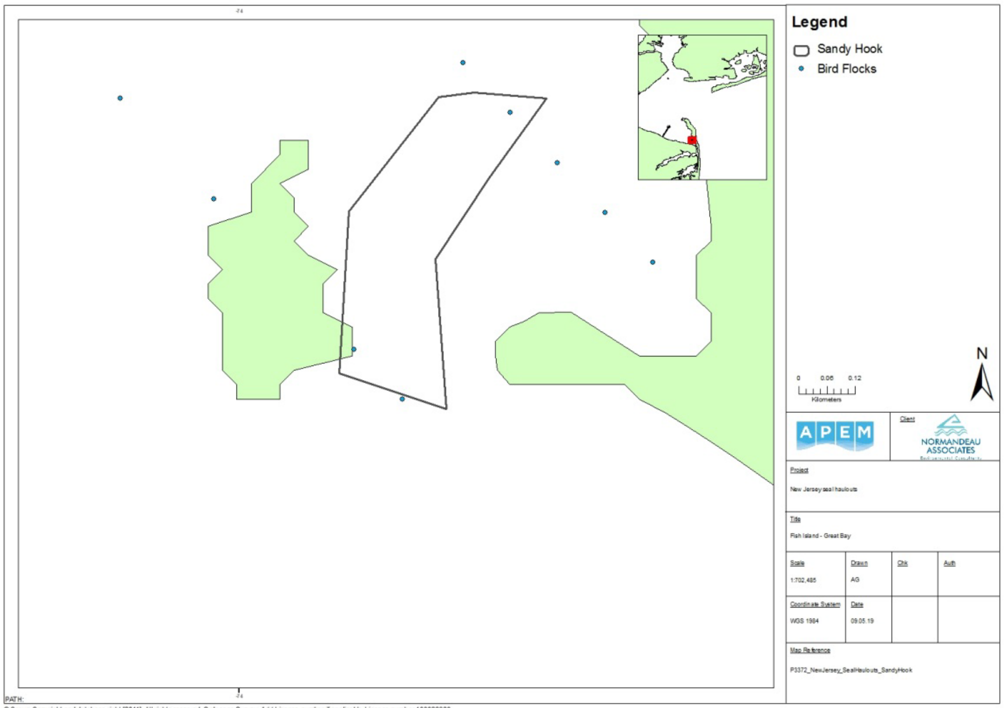


Figure 10. Sandy Hook bird flock locations.

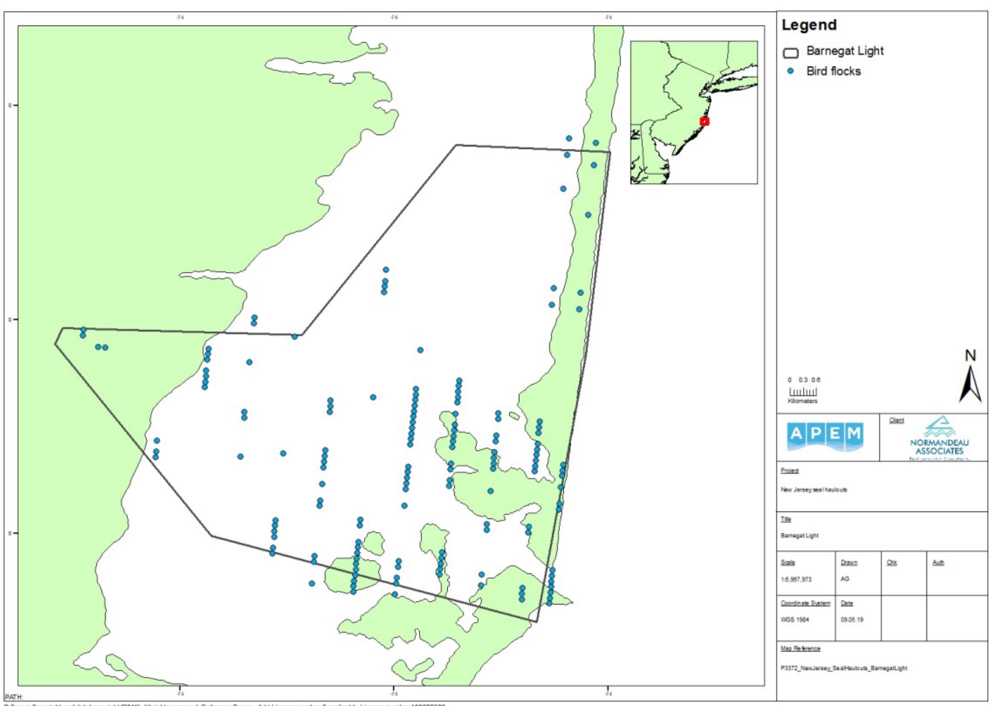


Figure 11. Barnegat Light bird flock locations.

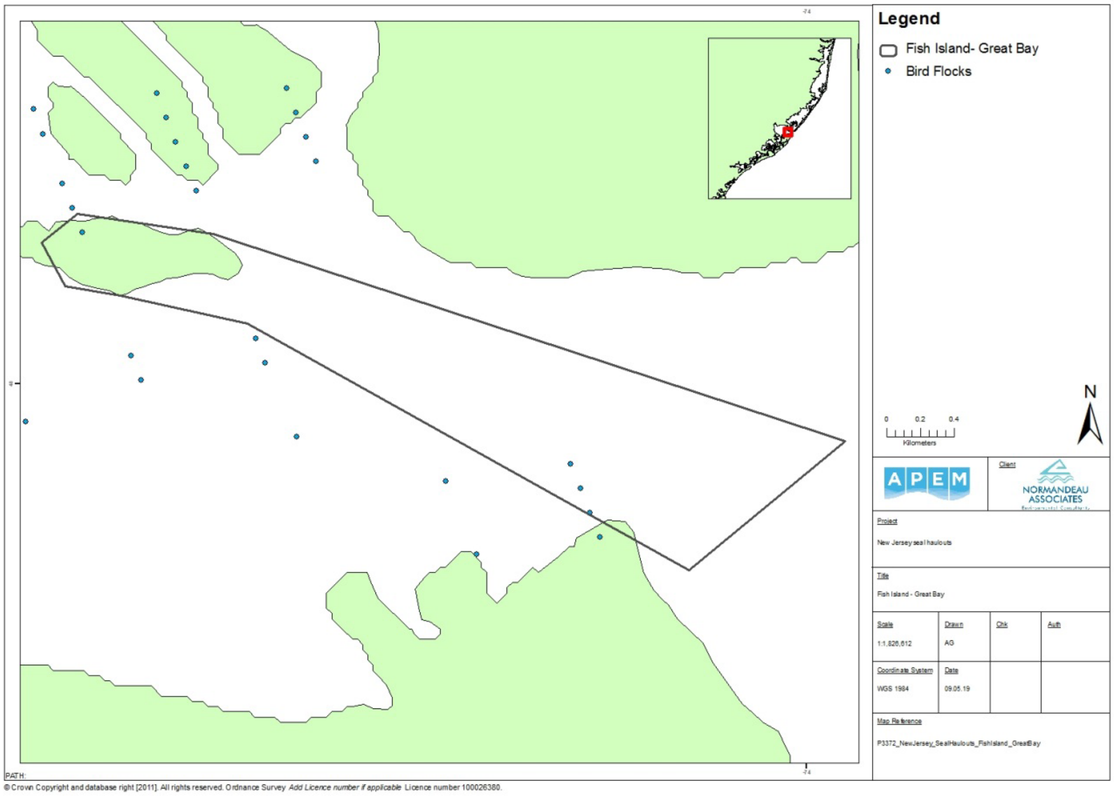


Figure 12. Fish Island bird flock locations.

Appendix C: Species Found in Imagery during Survey

List of Seal Species Found in Imagery during the Survey, by Site

Common Name	Scientific Name	Class	Family	SITE_1_SANDY_HOOK	SITE_2_BARNEGAT_LIGHT	SITE_3_GREAT_BAY
Harbor Seal	*Phoca vitulina*	Mammalia	Phocidae		X	X

List of Bird Species Found in Imagery during the Survey, in Taxonomic Order

Common Name	Scientific Name
Greater White-fronted Goose	*Anser albifrons*
Gadwall	*Anas strepera*
American Wigeon	*Anas americana*
American Black Duck	*Anas rubripes*
Mallard	*Anas platyrhynchos*
Green-winged Teal	*Anas crecca*
Long-tailed Duck	*Clangula hyemalis*
Common Merganser	*Mergus merganser*
Common Loon	*Gavia immer*
Great Egret	*Ardea alba*
Turkey Vulture	*Cathartes aura*
American Oystercatcher	*Haematopus palliatus*
Sanderling	*Calidris alba*
Razorbill	*Alca torda*
Atlantic Puffin	*Fratercula arctica*
Laughing Gull	*Leucophaeus atricilla*
Ring-billed Gull	*Larus delawarensis*
Bonaparte's Gull	*Chroicocephalus philadelphia*
Herring Gull	*Larus argentatus*
Lesser Black-backed Gull	*Larus fuscus*
Great Black-backed Gull	*Larus marinus*
Forster's Tern	*Sterna forsteri*
American Crow	*Corvus brachyrhynchos*

SAV Survey

Ocean Wind Offshore Wind (OCW01)

Submerged Aquatic Vegetation (SAV) Survey Report

Document Version

File Name	Preparer	Editor	Checker	Accepter	Approver
FINAL_OCW01_Oyster Creek_SAV Report_2021-01-19	JC	AD	DY		

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1. Introduction

Ocean Wind LLC (Ocean Wind), a subsidiary of Ørsted Wind Power North America LLC (Ørsted), is developing the Ocean Wind Offshore Wind Farm (Wind Farm Project or Project) to generate renewable power off the coast of New Jersey and transfer the electricity to load centers within New Jersey and the Mid-Atlantic region. Ocean Wind intends to develop, build, operate, and own a utility-scale offshore wind farm located approximately 15 miles off the of the coast of New Jersey within the OCS-A 0498 Lease Area (**Figure 1**). The Project will include turbines and infrastructure required to transmit power generated by the turbines to connection points with the Pennsylvania, Jersey, Maryland (PJM) electric transmission system or power pool. Up to two grid connections will be made at BL England and Oyster Creek. The offshore export cables will be buried below the seabed within federal and state waters and will connect with the onshore export cable at the onshore transition joint bays (TJBs) at the landfall location(s). For the Oyster Creek interconnection point, buried export cables from the wind farm area will make landfall at Island Beach State Park and then continue across Barnegat Bay and make landfall on the mainland at one of the three potential landfall locations (**Figure 2)**. The Project would be installed from 2023 through 2024 and commissioned and operational in 2024.

SAV along the New Jersey coast has been studied by various public and private entities over the last 40 years. Barnegat Bay has been extensively studied, with historical SAV mapping completed by the New Jersey Department of Environmental (NJDEP) from 1979 to 1987. Additional studies were completed by Rutgers University in the early 2000s (Lathrop and Haag, 2011). SAV beds provide shelter and forage habitat for a variety of estuarine fish and macrocrustacean species (State of New Jersey, 2017). Additionally, SAV beds provide dissolved oxygen to the water column and provides stability to sediments against erosion forces as a function of root/rhizome development and substrate binding (Bergstrom and Hurley, 2006). The SAV canopy modifies local hydrodynamics, promoting increased sedimentation by reducing water velocity and allowing fine particles to settle out of suspension.

Based on the desktop study review of existing SAV information, Ocean Wind developed a Project-specific SAV survey plan to collect additional information near potential landfall locations (Appendix A). The survey protocol was developed using existing state and federal agency protocols and those that were used for similar surveys in New Jersey. In addition, Ocean Wind coordinated with the NJDEP and the National Oceanic and Atmospheric Administration (NOAA) on the protocols and incorporated their feedback.

To fill in the data gaps from historical NJDEP and Rutgers University mapping and existing studies, Phase 1 Aerial Photography Surveys and Phase 2 In-water SAV surveys were conducted to identify the current presence and extent of SAV beds within the proposed export cable routes and landfall locations. The Phase 1 Survey is summarized below and has been included as Appendix B. Based on project design and changes to routing, a Phase 2 survey was not conducted for BL England study area. Phase 2 SAV surveys were targeted to focus on areas where the routes are likely to cross back bay areas where SAV habitat is present and therefore, only conducted in Barnegat Bay. Phase 2 SAV surveys are discussed in further detail below. Site photographs are provided in Appendix C and notable biological observations are provided in Appendix D.

2. Survey Area

The Phase 2 SAV surveys were conducted in Barnegat Bay, Ocean County, with a total survey area of approximately 0.08 square miles (approximately 200,000 m^2) (**Figure 2**). The SAV survey areas extend from the shoreline out to the edge of the SAV bed as identified in aerial surveys and confirmed on site. The Island Beach State Park (IBSP) survey area is located on the eastern side of the Bay and extends from the backside of the IBSP barrier island approximately 1,200 m (3,900 ft) out into the Bay. The Holtec Property landfall area is the northernmost potential landfall area located on the western side of the Bay north of the Oyster Creek mouth and extends approximately 200 m (650 ft) out into the Bay. The Bay Parkway landfall area is the middle potential landfall area on the western side of the Bay south of the mouth of Oyster Creek and the survey area extends 370 m (1,200 ft) out into the Bay. The Lighthouse Drive landfall area is the southernmost potential landfall area located on the western side of the Bay located north of Waretown Creek and extends 220 m (720 ft) out into the Bay.

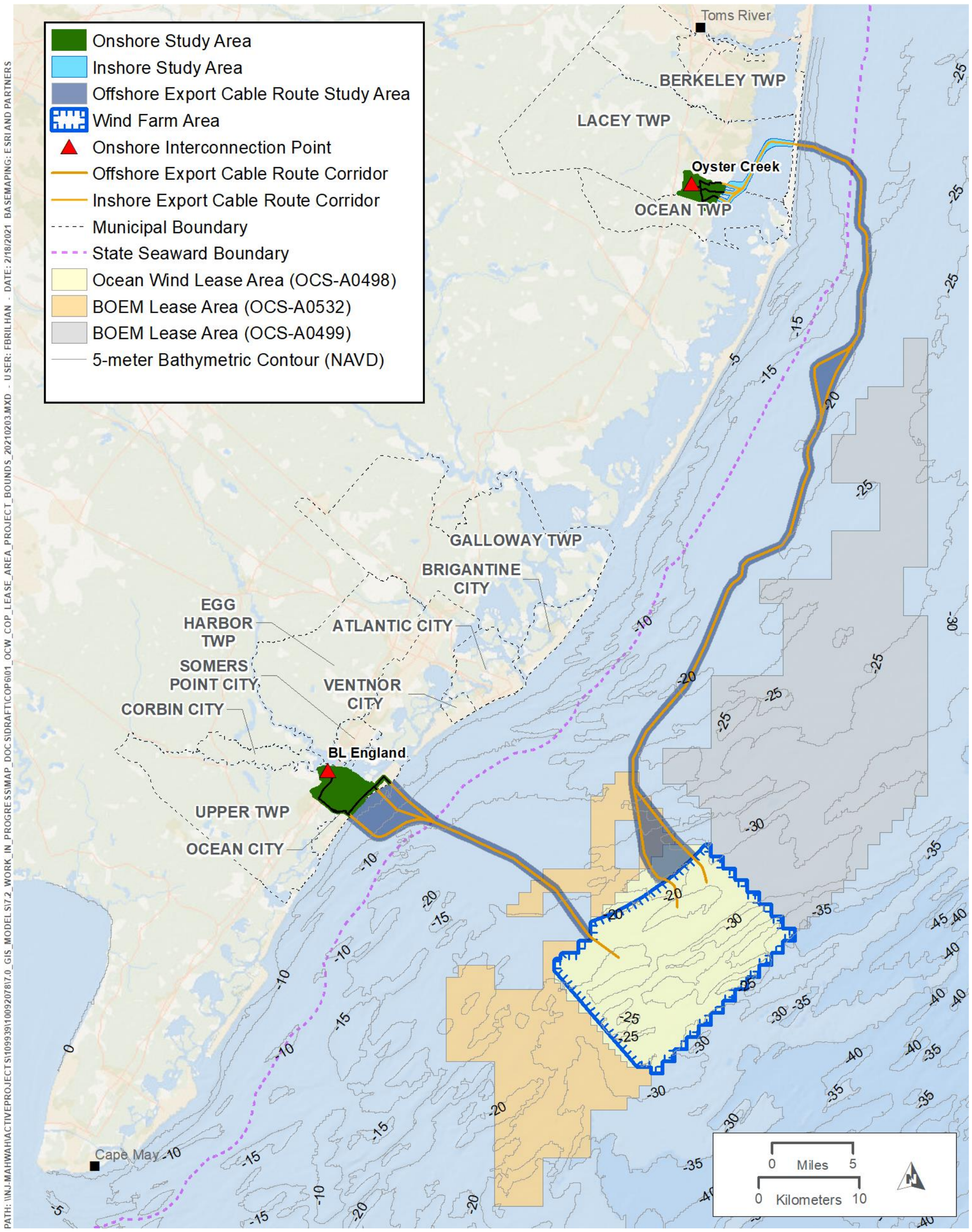

Figure 1. Project Area Overview Map.

Figure 2. Barnegat Bay Phase 2 SAV Survey Area

3. Methods

In October 2019 and October 2020, Phase 1 and Phase 2 SAV surveys were conducted at the anticipated project landfall area for Oyster Creek (**Figure 2**) to confirm the presence and extent of SAV beds located along proposed inshore export cable routes and potential landfall locations. The SAV survey method described here and provided in Appendix A, is based on methodology described in Lathrop et al. (2011) , the *Submerged Aquatic Vegetation Survey Guidance for the New England Region* protocol published in 2016 by a joint agency task force including the USEPA, NOAA, and the USACE (Colarusso and Verkade, 2016), and *Guidance for Submerged Aquatic Vegetation (SAV) Surveys as Related to the Submerged Vegetation Habitat Rule at NJAC 7:7E-3.6 (NJDEP 2015)*.

Surveying efforts were divided into two phases. The first phase of the survey (referred to as "Phase 1 SAV Survey") was conducted later in the growing season in October 2019 during periods of high visibility before the seasonal decline in water temperatures reduce growth of SAV. The presence/absence of SAV beds was determined within the study areas and their extents were mapped using aerial photography. The second phase of the survey (referred to as "Phase 2 SAV Survey") was conducted the week of 5 October 2020 and gathered more detailed information about the SAV beds identified in Phase 1 SAV Surveys using quadrat sampling along transect lines.

3.1 Phase 1 SAV Survey

The Phase 1 SAV Survey was carried out in a fixed wing aircraft using a Shearwater III camera system surveying at an altitude of approximately 1,112 m (3,650 ft) above sea level. High-resolution imagery was captured at a resolution of 4 centimeters (cm) (1.5 inches) ground sample distance (GDS) during 15 flight lines. Surveys were targeted to be complete within 90 minutes of either side of low tide to allow for maximum intertidal exposure and to facilitate the SAV mapping process. Global Positioning System (GPS) data were recorded for each aerial photograph's camera release point. The extent and estimated cover density of SAV beds were estimated from aerial photography of shallow areas (<6 ft water depth).

Due to the nature of the imagery collected over the Bay (i.e., sun glint, changing wave patterns between adjacent imagery), a combination of automated processing, which involved feeding the collected GPS data into photogrammetric processing software along with the imagery, and manual georeferencing of images, was required to produce mosaics. This allowed a mosaic to be generated for all areas where the bay bottom could be seen.[1] Once the mosaic was finalized, areas of SAV were digitized using Geographic Information System (GIS) Software (ArcMap Version 10.7.1).

Seagrass was mapped according to the following categories[2]:

- Sparse (10-40 percent cover)
- Moderate (40-80 percent cover)
- Dense (80-100 percent cover)

[1] For areas of deeper water where the sea bottom could not be seen (typically in areas more than 7 ft below mean sea level) in any of the imagery due to lack of light penetration, it was not possible to georeference the imagery or map SAV. Details for density for "patchy" SAV beds was documented in Phase 2 SAV Surveys.
[2] The delineation of these categories was based on the data from the study by Lathrop et al. (2006), which mapped seagrass cover in Barnegat Bay-Little Egg Harbor-Great Bay study area using these categories.

The resulting areas of SAV documented in the Phase 1 Survey were used to inform the more intensive Phase 2 SAV survey effort.

3.2 Phase 2 SAV Survey

The Phase 2 SAV Survey was conducted to gather more detailed information about the SAV beds using underwater camera/quadrat sampling along transect lines. The Phase 2 SAV Surveys documented the outer extents of the SAV beds identified in the Phase 1 SAV Survey and obtained representative information on SAV species and density from the outer edge of the beds into the shoreline. Beginning the survey with the identification of the outer edge of the SAV bed allows survey effort to be focused on those areas where SAV is actually present. The Phase 2 survey was confined to the 50 m (164 ft) areas on either side of the proposed cable route that overlaps with areas of SAV identified in the Phase 1 SAV Survey. The 50 m (164 ft) on either side of the potential cable route was surveyed as this is the potential area which could be impacted during cable installation. The survey was completed the week of 5 October 2020. Initial reconnaissance of the survey area was conducted using the following visual assessment methods: visual inspection from an elevated boat platform, bathyscope/viewing bucket from the surface, and a pole mounted underwater camera which provided a real time feed to an observer on the boat. This reconnaissance was performed to identify the presence/absence of SAV and to determine the outer edge of the SAV bed. Reconnaissance was conducted on sunny days, during a falling or lower tide, to facilitate optimal viewing capabilities

Following initial reconnaissance, transect lines were established in the SAV beds identified in the Phase 1 SAV Surveys. Transect lines were spaced 30 m (98 ft) apart and perpendicular to the export cable route and spanned the 50 m (164 ft) buffer on either side of the cable route. Within each transect line points for SAV sampling were spaced every 10 m (33 ft). At each transect point a GoPro Hero3 mounted to an adjustable pole secured above a 0.5 m x 0.5 m (0.25 m^2) quadrat frame divided into 4, 25 cm x 25 cm grid cells was lowered to the bottom to photo-document SAV and the benthic habitat (**Figure 3**). The camera was connected to a Wi-Fi extension cable to allow the camera feed to be viewed in real time by observers on the survey vessel. In the field and upon processing the photographs, the following data was recorded:

1. Date and time for each sampling transect.
2. Water depth at each sampling point (quadrat).
3. Water quality data (temperature, pH, salinity, dissolved oxygen, turbidity) at the beginning of each transect.
4. General sediment type characterized by visual observation (e.g., silt, mud, sand, shell hash) at each sampling point.
5. Estimated percent cover and density of SAV, per species, within a 0.25-m^2 quadrat divided into 25 cm x 25 cm grid cells.
6. Shoot length of 1-3 randomly chosen SAV blades within the quadrat, per species. Blades were estimated in place relative to reference markers on the quadrat. If, while watching the live camera feed, it was not possible to estimate blade length in place due to currents, samples were collected manually using a small three tine garden rake.
7. Estimated percent coverage (0-100 percent) per species. Surveyors recorded qualitative vegetative density as they surveyed SAV beds on the following scale:
    a. Sparse (1-10 percent cover);
    b. Low (11-25 percent cover);
    c. Moderate (26-50 percent cover), and
    d. High (>50 percent cover).
8. Notable biological observations (e.g., shellfish or algal beds, fish and macrocrustaceans) (Appendix D).

Based on field conditions and sampling logistics, the following modifications to the Project sampling protocol (Appendix A) were made:

- The quadrat size was modified from 1 m^2 to 0.25 m^2. Agency review of the sampling protocol requested 1 m^2 sampling quadrat size, if possible. However, for ease of equipment maneuverability during data collection and to ensure that the camera could be submerged with the entire quadrat frame in the camera view, quadrat size was modified (see **Figure 3** for equipment setup). Additionally, 0.25m^2 is consistent with sampling guidelines set forth by Colarusso and Verkade (2016).
- Transects were conducted perpendicular to the cable route instead of perpendicular to the shoreline. This change was made to better assess the potential impacts of the proposed export cable a linear feature and resulted in more sampling locations.
- Water quality measurements were collected at the beginning of each transect instead of at every point along the transect. Each transect point was spaced 10m apart, due to the close proximity of each point the collection of water quality information at each point would have resulted in hundreds of redundant water quality measurements.

3.2.1 Data Analysis

3.2.1.1 Percent Cover

To calculate the estimated percent coverage of the survey area, the SAV density results of the camera drops were divided into density categories based on visible percent coverage of SAV as part of Step 1:

- Absent (0 percent)
- Sparse (1-10 percent)
- Low (11-25 percent)
- Medium (26-50 percent)
- High (>50 percent)

In Step 2, the length and width of the survey areas were multiplied to get the total area (m^2). The percentage of each category generated in Step 1 were multiplied by the total area calculated in Step 2 to yield the representative percent cover per survey area.

3.2.1.2 Stem Density

Stem densities were determined during video reviews for the 0.25 m^2 quadrat sampling. The visible number of blades were counted within the 0.25 m^2 quadrat. When densities were very high and visibility of individual blades was limited, counts were capped at 250 stems/quadrat. These data were then multiped by 4 to extrapolate stem density per 1 m^2.

3.2.1.3 Blade Length

Blade length was estimated in place from the still images captured during the field survey using the ImageJ photo processing software. A custom macro was developed that set the scale of the image based on the length of the 25 cm (10 in) grid cell in the image. Once the scale was calibrated a reviewer manually drew a line over selected blades of the SAV. Stems selected for measurement were generally those where the grid cells of the SAV frame/grid or the currents in the area pushed the blades of SAV over horizontally such that the length of a stem could be estimated. The estimated length of the blade was recorded on the image and in a spreadsheet. In the instances where SAV was collected the blade length was measured on a ruler and photographed. Each blade length was measured to the nearest tenth of a centimeter. The SAV blades that were physically collected during the Phase 2 SAV survey were measured to the nearest tenth of a centimeter.

3.2.2 Sediment Sample Collection and Grain Size Analysis

Per the NJDEP (2015) SAV Survey Guidance document and the Project survey protocol, sediment samples were collected for grain size analysis. The sediment samples were collected on October 8, 2020, using a petite ponar grab from locations representative of the observed sediment types within each of the four potential landfall areas during the SAV survey (**Figure 4)**. The sediment samples were photographed, then homogenized, placed in glass jars, and sent to an analytical laboratory for grain size analysis consistent with the American Society for Testing and Materials (ASTM) methods D6913 and D7928. The results were reported according to the Wentworth (1922) grain size scale.

Figure 3. Quadrat Frame with Mounted GoProHero3 for SAV Sampling.

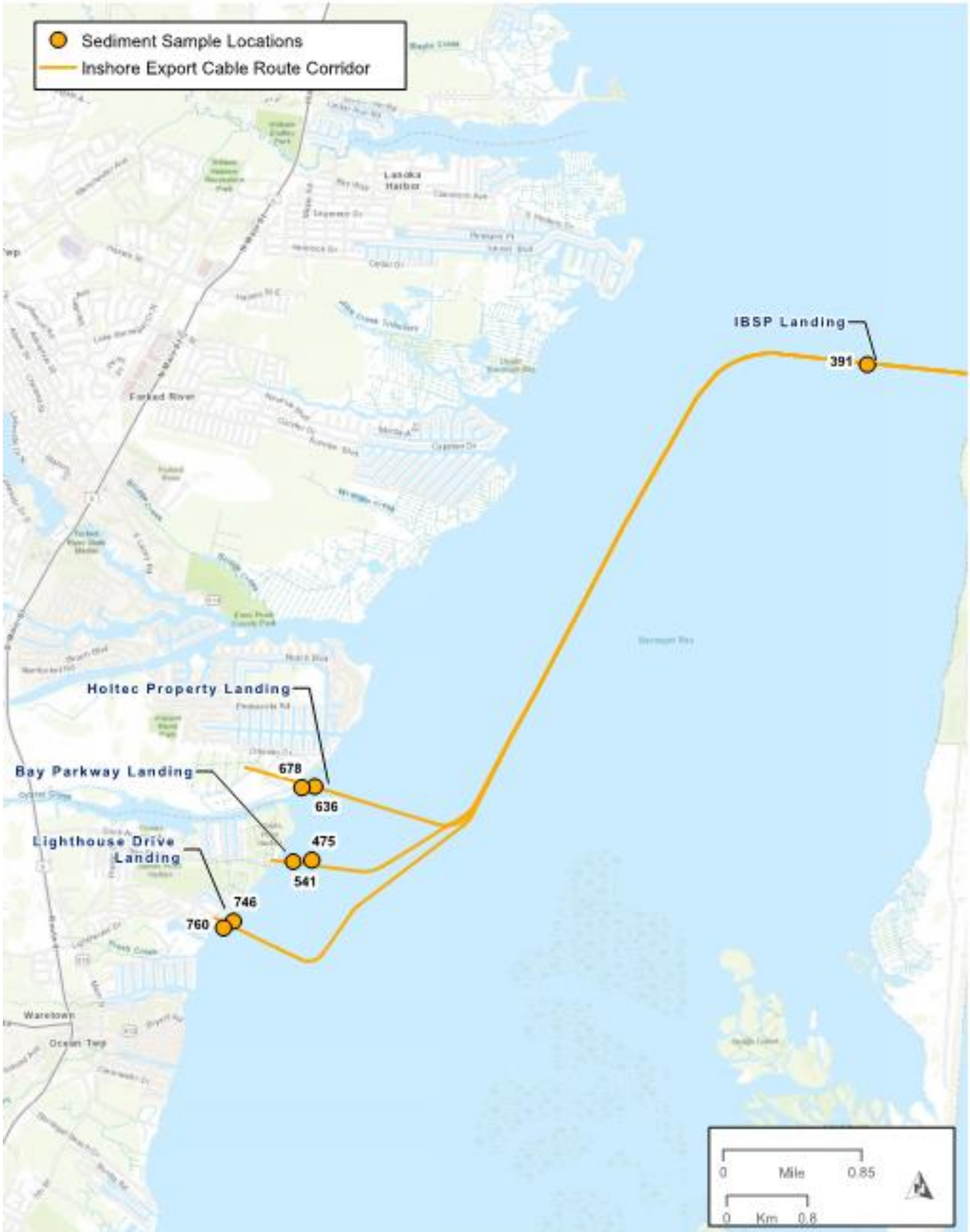

Figure 4. Sediment Sampling Locations.

4. Results

4.1 Phase 1 SAV Surveys

A total of 10,864 images were captured during the aerial survey. The coverage map for the Phase 1 SAV Survey area is shown in **Figure 5**.

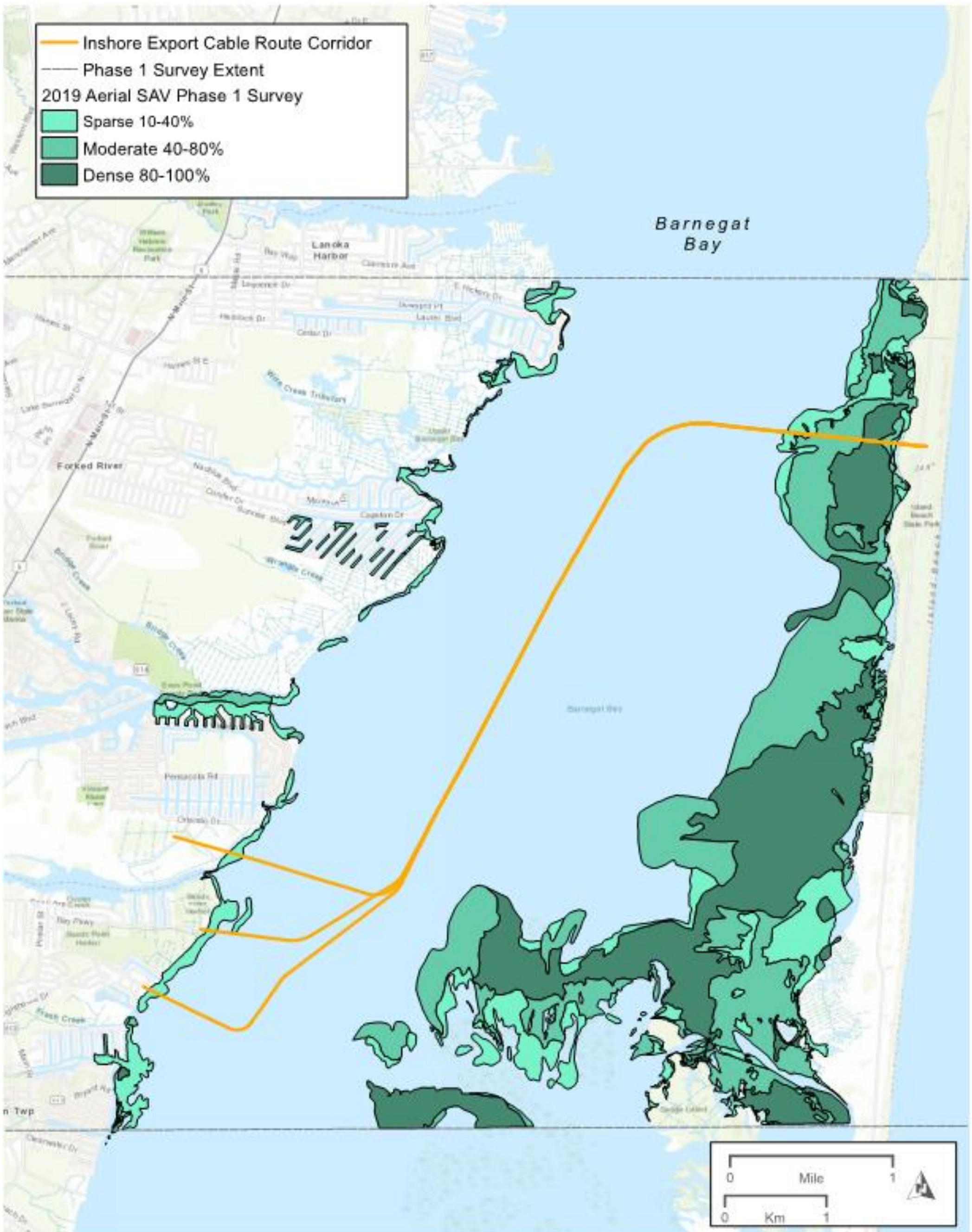

Figure 5. SAV Map of the Barnegat Bay Phase 1 SAV Survey Area

During the Phase 1 aerial survey, the area along the IBSP shoreline was mapped as predominantly moderate to dense SAV with an outer fringe of sparser coverage. Presumed SAV beds on the eastern shoreline extend more than 1,200 m (3,930 ft) from the shoreline in some locations based on the aerial imagery. For the three landfall areas along the western shoreline of the Bay a comparatively narrow band of sparse SAV extending from approximately 70-330 m (230-1,080 ft) was observed.

4.2 Phase 2 SAV Survey

At IBSP during the Phase 2 SAV survey, the outer edge of the SAV bed was observed 1,067 m (3,500 ft) from the shoreline and approximately 90 m (295 ft) from the edge of the SAV bed documented in the Phase 1 aerial survey. Depths in this area were 1-1.2 m (3-4 ft).

Due to shallower than anticipated depths, it was only possible to survey transects in the outer third of the IBSP landfall area. This area consists of a shallow shoal extending approximately 1,200 m (3,930) or more out from the shoreline of IBSP. To the north of IBSP, there appears to be an old channel with depths of up to 2.1 m (7 ft) based on nautical charts. The survey vessel had relatively shallow draft of ~0.6 m (~2 ft). To protect both the vessel and benthic habitat the survey vessel did not attempt to enter areas where depths were too shallow. Vessel counts and prop scars documented in Lathrop et al. (2017) are concentrated along the outer fringe of the shoal in the vicinity of the IBSP survey area, which indicates depths too shallow to be readily accessible by vessel (**Figure 6)**. Slightly to the south of IBSP survey area is a portion of Tice's Shoal which experiences heavy vessel traffic with greater vessel access closer to the shoreline.

SAV was documented in only one survey location within the Holtec Property survey area and had a depth of 1 m (3.2 ft). In the Bay Parkway survey area, the outer edge of the SAV beds was documented 60 m (197 ft) further out than what was documented in the Phase 1 survey and 380 m (1,248 ft) from the shoreline. The depth at the edge of the SAV bed was 1.6 m (5.2 ft). In the Lighthouse Drive survey area, the outer edge of the SAV bed is generally in the same area as what was documented in the Phase 1 survey and approximately 150 m (492 ft) from the shoreline. The depth at the edge of the SAV bed ranged from 1.2-1.4 m (3.9-4.7 ft).

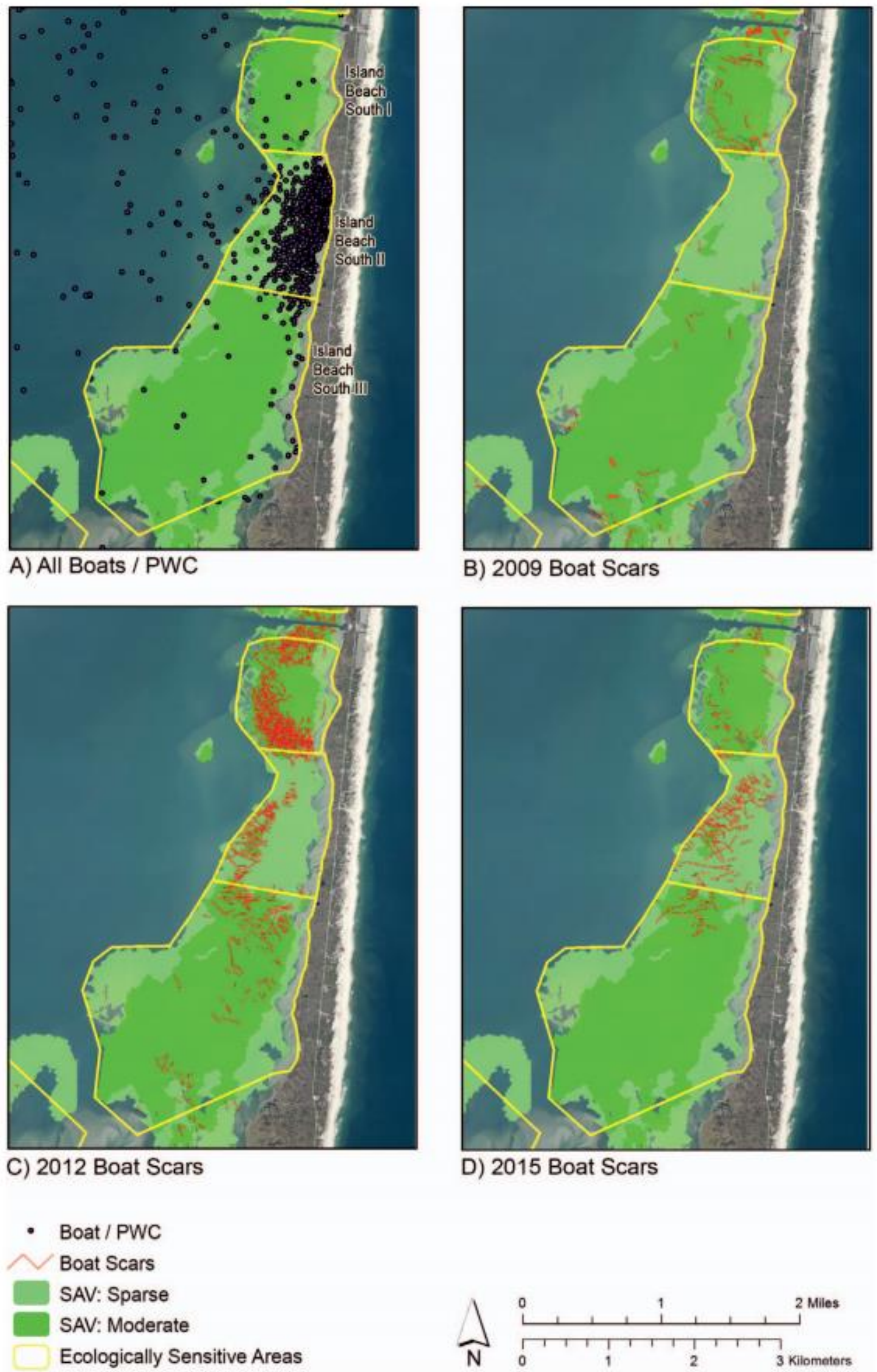

Figure 6. Figure excerpted from Lathrop et al. 2017 showing the distribution of watercraft and boat scar observations in the vicinity of the IBSP landfall area. The IBSP survey area is in the northern portion of each plot just to the south of the linear break in the SAV beds.

SAV was documented in only one survey location within the Holtec Property survey area and had a depth of 1 m (3.2 ft). In the Bay Parkway survey area, the outer edge of the SAV beds was documented 60 m (197 ft) further out than what was documented in the Phase 1 survey and 380 m (1,248 ft) from the shoreline. The depth at the edge of the SAV bed was 1.6 m (5.2 ft). In the Lighthouse Drive survey area, the outer edge of the SAV bed is generally in the same area as what was documented in the Phase 1 survey and approximately 150 m (492 ft) from the shoreline. The depth at the edge of the SAV bed ranged from 1.2-1.4 m (3.9-4.7 ft). Phase 2 SAV survey photograph is provided in Appendix C.

4.2.1 Water Depth and Quality

Water depths recorded for each sampling location and water quality measurements taken at the beginning of each transect are presented in **Table 1**. The average depth across sampling locations was 4.4 ft, average temperature was 18.4°C, average salinity was 26.7 ppt, average dissolved oxygen was 7.9 mg/L average pH was 7.9, and average turbidity was 2.9 NTU.

Table 1. Water Quality and Depth Summary.

Survey Area	Transect	Point ID	Depth (ft)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	pH	Turbidity (NTU)
IBSP	360-365	360	2.3	15.8	24.5	7.5	7.8	5.38
	376-366	376	3.6	17.2	25.8	7.8	8.2	4.46
	377-387	387	3.3	17.2	25.8	7.77	8	1.89
	388-389	398	3.2	17.2	25.8	7.6	8	2.26
	399-409	409	4.6	17.2	25.8	7.5	7.9	3.95
Bay Parkway	475-465	475	4.8	18.2	26.2	7.33	7.6	3.56
	475-465	465	5.6	18.2	26.4	7.27	7.6	11.46
	477-487	477	7.1	18.3	26.4	7.27	7.7	2.93
	477-487	487	4.5	18.4	26.4	7.52	7.6	2.2
	499-489	489	4.7	18.4	27	7.5	7.6	1.84
	510-500	510	4.7	18.5	26.8	7.43	7.7	3.55
	510-500	500	4.6	18.5	26.8	7.46	7.7	1.69
	522-512	512	4.8	18.5	27.4	7.7	7.7	1.63
	534-524	534	4.9	18.5	27.4	7.7	7.7	1.17
	545-535	545	4.1	18.6	27.4	7.8	7.8	2.06
	557-547	557	4.5	18.7	27.7	7.99	7.8	1.85
	569-559	567	3.8	18.8	27.7	8.5	7.9	1.38
	571-581	581	2.5	19	27.1	8.7	8.1	0.83
Holtec Property	619-629	619	5.9	17.2	25.8	7.5	7.9	3.95
	619-629	629	6.1	19.5	27	8.4	7.9	1.73
	631-641	641	5.7	19.7	26.7	8.5	7.9	2.67
	642-652	652	4.5	19.6	27	8.6	7.9	1.56
	663-663	663	4.1	19.7	26.7	8.7	7.8	2.38
	687-677	677	4.5	19.9	26.7	8.6	7.8	3.08
	687-677	687	2.9	19.9	26.6	8.92	7.7	2.39
	699-689	689	3.1	19.6	26.6	8.4	7.9	15.3

Survey Area	Transect	Point ID	Depth (ft)	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	pH	Turbidity (NTU)
Lighthouse Drive	710-700	710	5	18.3	27	7.5	8.1	1.88
	712-722	712	5.7	18.5	26.7	7.52	8.2	0.94
	724-734	734	3.9	18.3	27.3	8.7	8.2	0.78
	736-746	746	3.2	18.5	27.3	8.38	7.9	2.15
	758-748	758	2.7	18.6	27.1	7.75	8	1.7
	770-760	770	2.3	18.8	26.5	8.2	8.1	0.99
	777-772	772	4.3	18.9	26.9	8.14	8.1	1.22

4.2.2 Sediment Type

Sediments varied from fine, silty sand to sand with scattered cobble or shell hash. At Bay Parkway Landing, the dominant sediment type observed was sand. Holtec Property Landing consisted predominately of silty sand and sand and IBSP Landing was dominated by silty sand. Lighthouse Drive Landing sediment consisted predominately of silty sand and sand. Overall, the Phase 2 SAV survey area sediments consisted of sand and silty sand.

4.2.3 Grain Size

The grain size analysis results from the sediment samples collected during the Phase 2 SAV Surveys are reported in Table 2. Laboratory grain size analysis results are provided in Appendix E. Most of the samples consisted of medium to fine sand. There were no noticeable trends between sediment type and SAV density.

Table 2. Grain Size Analysis Results.

Grain Size	Sample ID						
	636	678	475	541	760	746	391
% Gravel	0	0	0	0	0	0	0
% Coarse Sand	2	3	0	3	5	0	0
% Medium Sand	65	24	9	25	15	8	13
% Fine Sand	32	54	89	49	67	88	86
% Silt or Clay	1	19	2	23	13	4	1
Landfall	Holtec Property	Holtec Property	Bay Parkway	Bay Parkway	Lighthouse Drive	Lighthouse Drive	IBSP

4.2.4 SAV Species, Percent Cover and Density

During the Phase 2 SAV Survey, a total of 283 camera drops were completed. Of those camera drops, 118 had SAV present, accounting for 41.7 percent SAV presence for the entire survey area combined. SAV is known to form patchy beds with areas of exposed sediment which is consistent with the observed intermittent presence of SAV at the camera drops. SAV was present in 36 percent of the camera drops in the outer portion of the IBSP area (**Figure 7**). These findings are consistent with the narrow band of sparse SAV observed during the Phase 1 SAV survey. Based on review of the photographs collected during the field survey and the SAV samples collected, observed SAV consisted almost entirely of eelgrass (*Zostera marina)* with widgeon grass (*Ruppia maritima*) only documented at a single location (Station 691) at the Holtec Property survey area.

The Holtec Property did have substantial coverage of macroalgae in many of the sampled locations, but SAV was only observed at Station 691. The findings of the Phase 2 survey at the Holtec Property Landing were inconsistent with the findings of the Phase 1 aerial imagery survey. Extensive macroalgae was found to be present at the Holtec Property Landing survey area during Phase 2 survey efforts, not sparse coverage of SAV (10-40 percent). The macroalgae present likely accounted for the sparse coverage that was documented during the 2019 aerial imagery mapping of the Phase 1 survey (**Figure 8**).

The Bay Parkway Landing had the highest percentage of SAV at 67 percent (**Table 3**). Compared to the Phase 1 SAV survey, SAV was observed over a slightly larger area within the Bay Parkway Landing survey area. The findings of the Phase 2 survey at Bay Parkway Landing survey area were consistent with sparse SAV coverage identified during the Phase 1 survey. Macroalgae was also found to be present at this location (**Figure 9**).

The Lighthouse Drive Landing had SAV present in approximately 47 percent of survey stations. The number of stations with SAV present were relatively evenly distributed between the sparse, low, moderate, and high percent cover categories s of SAV (**Table 4, Figure 10**). During the Phase 1 Survey, the aerial imagery captured sparse coverage and did not reveal the higher densities identified during the Phase 2 Survey.

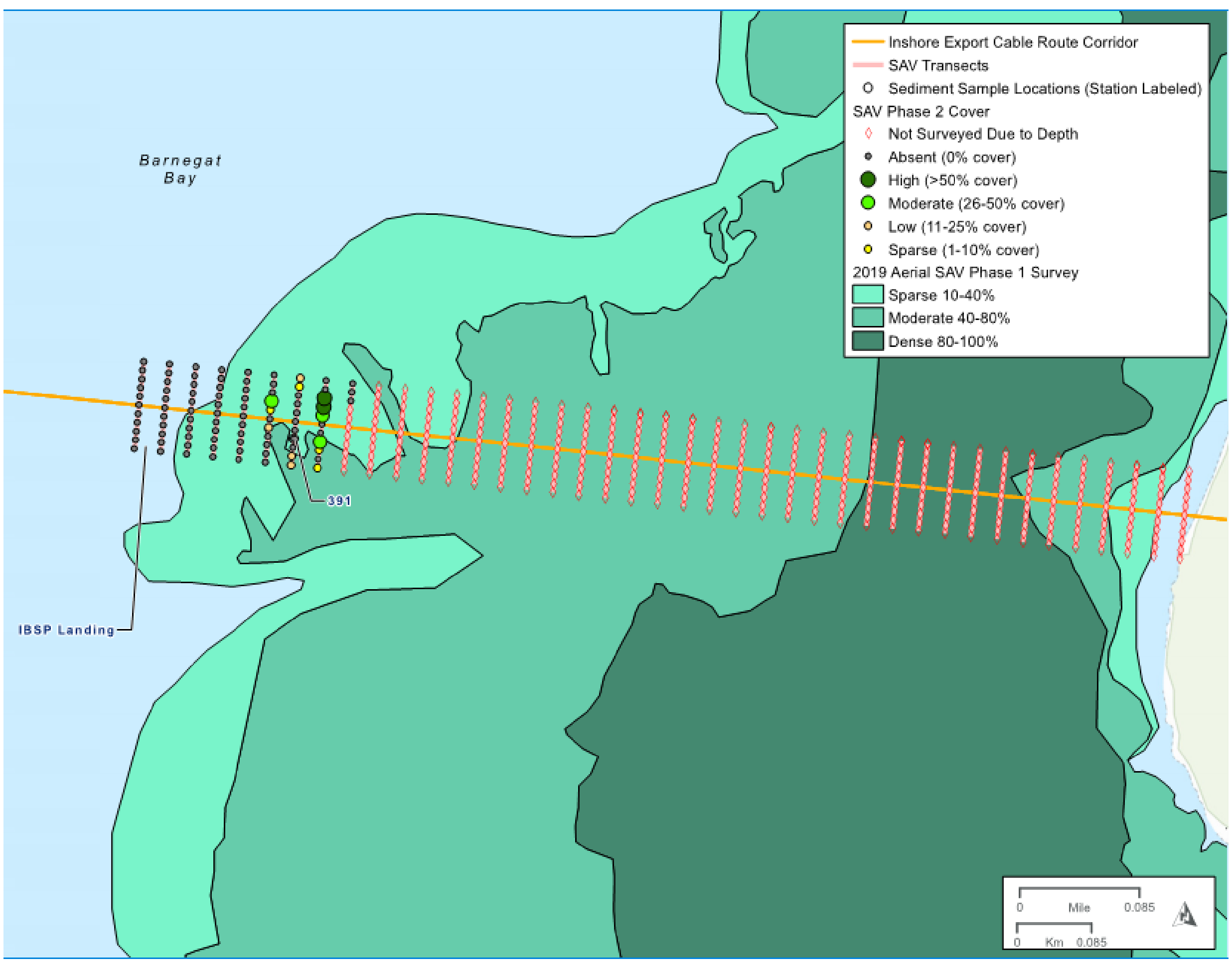

Figure 7. SAV Percent Cover Estimates at IBSP Landing.

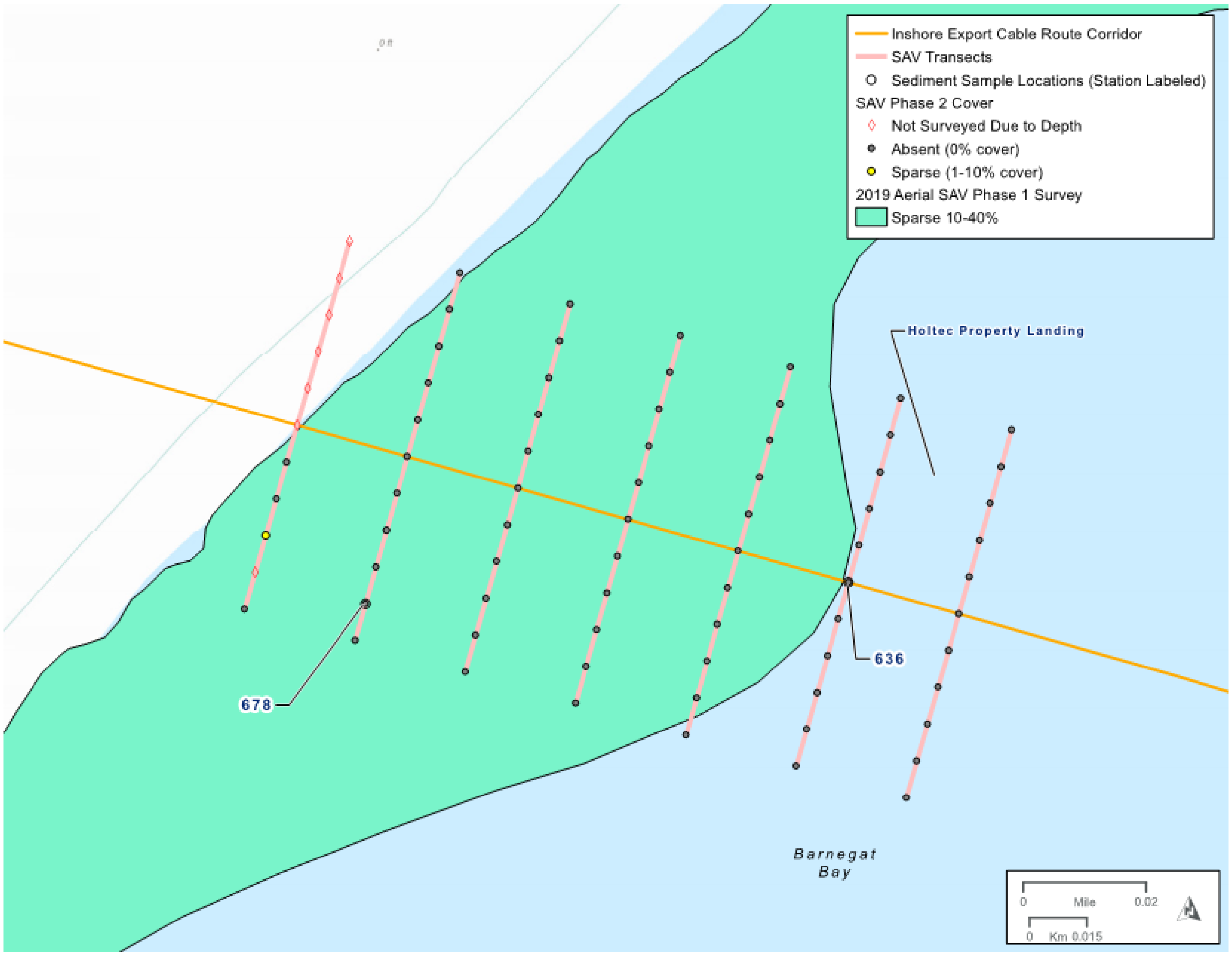

Figure 8. SAV Percent Cover Estimates at Holtec Property Landing.

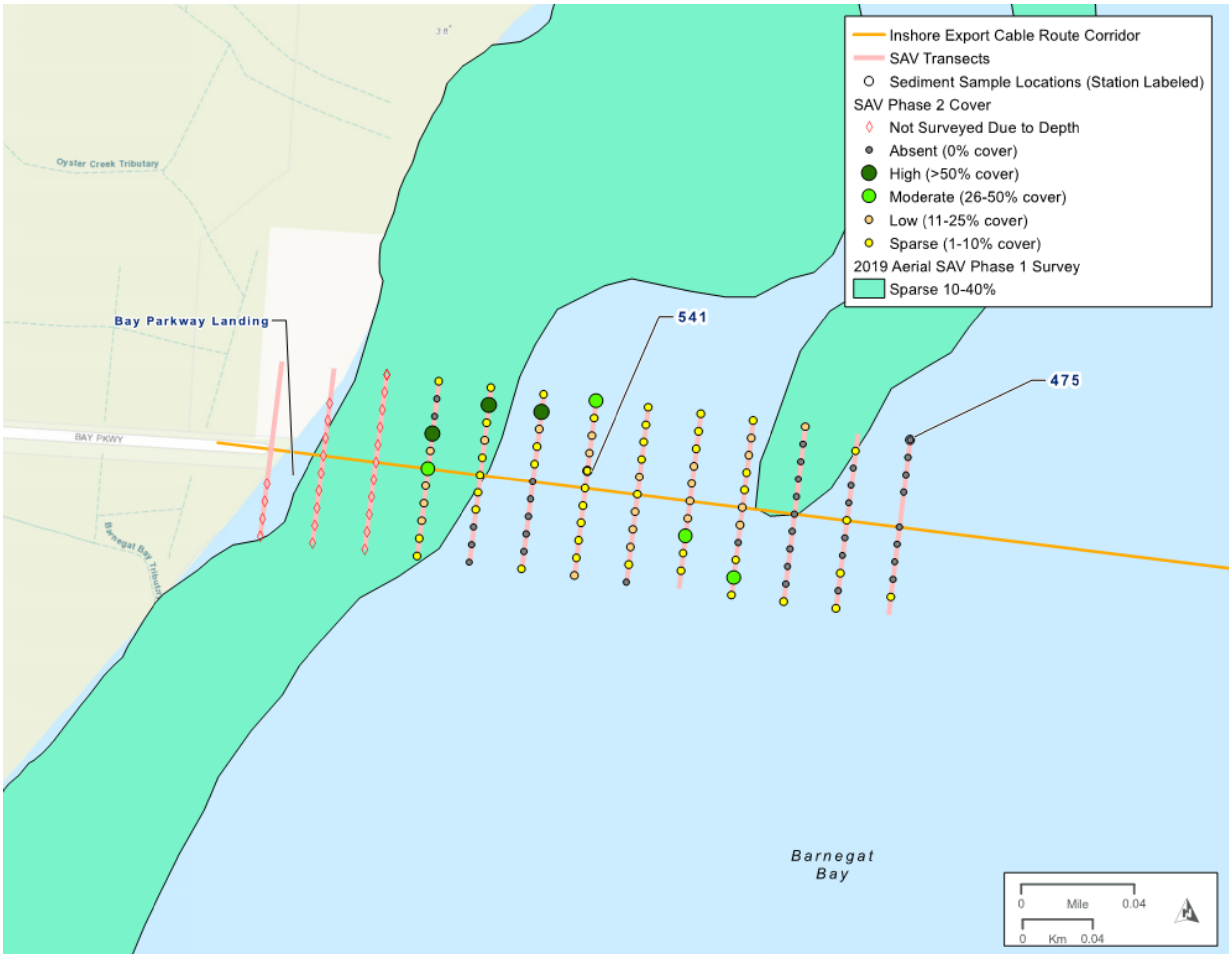

Figure 9. SAV Percent Cover Estimates at Bay Parkway Landing.

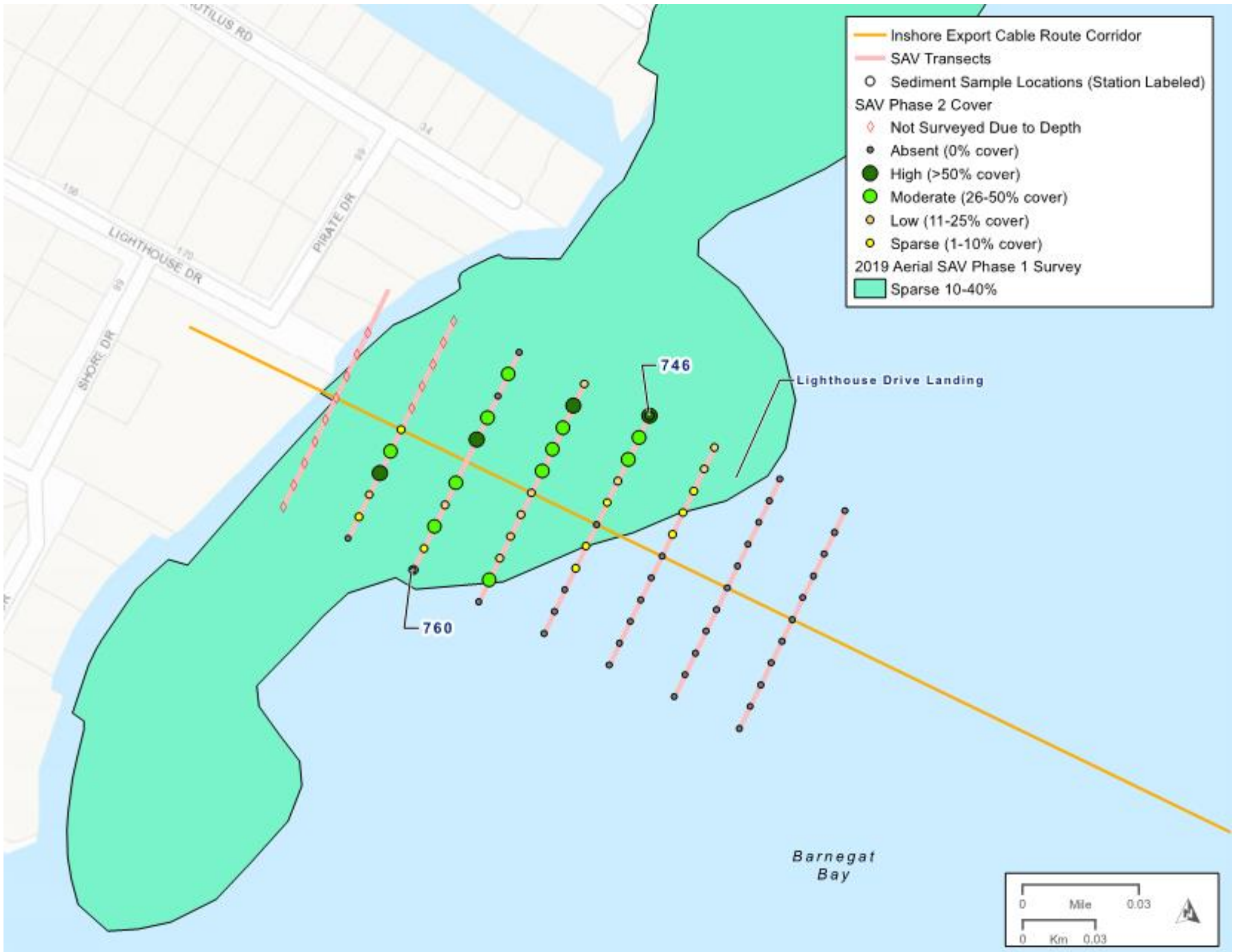

Figure 10. SAV Percent Cover Estimates at Lighthouse Drive Landing.

For IBSP Landing, the findings of the Phase 2 survey were consistent with the findings of the Phase 1 survey in the areas that were accessible by the vessel. There were patches of sparse to moderate SAV present in the outer fringe during the Phase 2 SAV survey, with smaller areas of high percent coverage. The outer edge of the SAV bed in the IBSP area was found to be closer to shore in the Phase 2 survey than documented in the Phase 1 aerial survey. (**Table 4, Figure 7**).

Table 3. Sampling Area SAV Presence and Percentage

Landing	Camera Drop Count	Drops with SAV Present	Percentage with SAV Present
IBSP	36	13	36.1
Bay Parkway	106	71	67.0
Holtec Property	70	1	1.4
Lighthouse Drive	71	34	47.9
Total	**283**	**119**	**42.0**

As discussed previously, Holtec Property Landing had SAV present at only one station and had the lowest percentage of stations with SAV present across all percent cover categories. The Bay Parkway Landing had the greatest percentage of stations in the sparse and low categories, at 39.6 and 20.8 percent, respectively (**Table 4**). Lighthouse Drive had the highest percent of stations in the moderate category and IBSP and Lighthouse Drive landings had the same percentage of stations at 5.6 percent in the high category. The locations with the greatest percentage of survey locations where SAV was absent were the Holtec Property Landing and IBSP, with 98.6 and 63.9 percent of sampled quadrats lacking SAV, respectively.

Table 4. Percentage of survey locations by estimated percent cover category of SAV by Survey Area.

Landing	Absent (0%)	Sparse (1-10%)	Low (11-25%)	Moderate (26-50%)	High (>50%)
IBSP	63.9	11.1	11.1	8.3	5.6
Bay Parkway	33.0	39.6	20.8	3.8	2.8
Holtec Property	98.6	1.4	0.0	0.0	0.0
Lighthouse Drive	52.1	12.7	14.1	15.5	5.6

The area of SAV in each of the percent cover categories was estimated by dividing the percentage of camera drop stations with SAV present in each percent cover category (**Table 4**) by the area (m^2) of each survey area. Due to the limited portion of the IBSP survey area that was able to be assessed for SAV during the Phase 2 survey, the estimates in **Table 5** are not representative of the unsampled areas.

Table 5. Area of SAV cover density by Survey Area.

Landing	Total Area (m^2)	Absent (0%) (m^2)	Sparse (1-10%) (m^2)	Low (11-25%) (m^2)	Moderate (26-50%) (m^2)	High (>50%) (m^2)
IBSP	120,000	76,680	13,320	13,320	9,960	6,720
Bay Parkway	37,000	12,210	14,652	7,696	1,406	1,036
Holtec Property	20,000	19,720	280	0	0	0
Lighthouse Drive	22,000	11,462	2,794	3,102	3,410	1,232

The minimum stem density was 0 (quadrats with no SAV present) for all four landings and the landing with the highest density was IBSP with >200 stems per meter squared (**Table 6**). There were a few IBSP Landing stations with high amounts of SAV present and the stem count was capped at 250 per 0.25 m^2 due to the density of the bed and difficulty reliably counting stems. The mean density was calculated for the sample stations where SAV was present. The highest mean stem density was at IBSP landfall, with 278 stems per m^2. Lighthouse Drive also had a high mean stem density at 219 stems per m^2.

Table 6. Stem Density Per 1 m^2.

Landing	Minimum	Maximum	Median	Mean for Stations With SAV Present
IBSP	0	>1000	0	278
Bay Parkway	0	448	20	85
Holtec Property	0	56	0	56
Lighthouse Drive	0	680	48	219

4.2.5 Blade Length

The total number of blades measured in place in reference to the quadrat frame was 254. The longest blade measured was in one of the quadrats from Bay Parkway at 50.3 cm (Table 7). The shortest length was at Bay Parkway Landing, with a length of 3.4 cm. Overall, the average length of the SAV blades was 13.8 cm.

Table 7. Number of Blades, Average Length, Minimum Length, and Maximum Length for Each Landing measured in place.

Landing	Number of Blades Measured	Average Length (cm)	Minimum Length (cm)	Maximum Length (cm)
IBSP	23	10.0	3.5	16.7
Bay Parkway	143	13.4	3.4	50.3
Holtec Property	2	5.2	4.8	5.5
Lighthouse Drive	88	15.5	5.0	27.5
Total	256	13.8	3.4	50.3

For the SAV blades that were physically collected, the longest blade measured was in one of the quadrats from Lighthouse Drive at 45.7 cm (**Table 8**). The shortest length was at IBSP, with a length of 8.9 cm. Overall, 103 SAV blades were measured with an average length of 25.1 cm.

Table 8. Number of Blades, Average Length, Minimum Length, and Maximum Length for blades physically collected for each landing.

Landing	Number of Blades Measured	Average Length (cm)	Minimum Length (cm)	Maximum Length (cm)
IBSP	24	20.4	8.9	35.6
Bay Parkway	44	24.9	10.2	35.6
Holtec Property	3	17.4	15.2	19.1
Lighthouse Drive	32	30.3	12.7	45.7
Total	103	25.1	8.9	45.7

5. Summary

The areas of SAV documented in the Phase 1 Survey completed in October 2019 were used to inform the more intensive Phase 2 survey effort. The Phase 2 SAV surveys were conducted to identify the presence, extent, density, and species composition of SAV beds within the proposed export cable routes at the four potential landfall locations. The Phase 2 SAV Survey was completed in October 2020 and a total of 283 camera drops were completed. SAV was documented in 41.7 percent of the survey locations. Of the three landfall areas on the western shoreline of the bay, the Holtec Property had the lowest percent cover of SAV, with SAV present at only a single survey station close to the shoreline. Based on review of the photographs collected during the field survey and the SAV samples collected, observed SAV consisted almost entirely of eelgrass with the exception of single location at the Holtec Property which contained widgeon grass. The results from this Phase 2 Survey provide the most recent information on SAV presence, density, and species composition along the export cable routes and will be used to support Project planning, routing and design.

6. Literature Cited

Bergstrom, P., and L.M. Hurley. 2006. Voluntary Estuary Monitoring Manual Chapter 18: Submerged Aquatic Vegetation. *Volunteer Estuary Monitoring Manual, A methods Manual, Second Edition*. United States Environmental Protection Agency. EPA-842-B-06-003.

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State of New Jersey, Department of Environmental Protection, Water Resource Management. 2017. *Barnegat Bay Restoration, Enhancement, and Protection Strategy: Moving Science into Action.*

Wentworth, C.K. 1922. A scale of Grade and Class Terms for Clastic Sediments. *The Journal of Geology*,30: 377-392.

Appendix A. OCW Submerged Aquatic Vegetation Survey Protocols

OCW Submerged Aquatic Vegetation Surveys

Background:

Submerged Aquatic Vegetation (SAV) occurs in shallow estuaries where sunlight can penetrate the water column and photosynthesis can occur. SAV beds provide shelter and a potential forage habitat for many organisms including spawning fish (NJDEP 2017). Additionally, SAV beds provide dissolved oxygen to the water which helps to stabilize sediment against erosion forces (EPA 2006). Buried export cables from the Ocean Wind Project will pass through coastal habitats and have the potential to intersect SAV beds, causing impacts to the vegetation. SAV surveys will be conducted to identify the presence and extent of SAV beds within the proposed export cable routes and landfall locations to determine the potential for impacts as a result of the proposed project. The planned surveys incorporate existing information on SAV generated by Rutgers University and the State of New Jersey as well as survey protocols from state and federal agencies (Attachment 1).

The proposed export cable route approach to B.L. England is approximately 17.0 miles long, originating from lease area OCS-A-0498. This route will make landfall along the coast of Ocean City, New Jersey. The cable will proceed though the coastal barrier to Peck Bay, part of the larger Great Egg Harbor Bay. While the exact layout of the proposed approach to Oyster Creek is in its conceptual planning phase, it will make landfall via horizontal directional drilling (HDD) at the barrier island containing Island State Park, emerging within a paved area where the Park Office Buildings are located (see Figure 1). The proposed HDD route will then be buried under the barrier island emerging in Barnegat Bay where it will continue west until making landfall on the New Jersey main land at one of four potential locations. Based on existing 1979 and 1986-1987 NJDEP SAV maps and studies conducted in 2009 by Rutgers University (Lathrop et al. 2011), SAV habitats could potentially exist in the shallow coastal areas (< 6 ft water depth) of the back-bay and costal shoreline areas along the proposed routes. SAV surveys will investigate the potential SAV habitat areas identified in Figures 1 and 2.

Statement of Work:

In October 2019 and May 2020, a SAV survey will be conducted at the anticipated project landfall areas for Oyster Creek and BL England (Figures 1 and 2) in order to identify the presence and extent of SAV beds located along proposed inshore export cable routes and potential landfall locations. The SAV survey method detailed here is based on methodology described in Lathrop et al. (2011) and the *Submerged Aquatic Vegetation Survey Guidance for the New England Region* protocol published in 2016 by a joint agency task force involving the USEPA, NOAA, and the USACE (Colarusso and Verkade, 2016).

Surveys will map the extent of SAV beds during the growing season which runs from May through October (Colarusso and Verkade, 2016). Surveying efforts will be divided into two phases. The first phase of the survey will be conducted later in the growing season in September/October during periods of clear water quality conditions before water temperatures reduce growth of SAV and will determine the presence or absence of SAV beds within the study areas and map their extents using aerial photography. The second phase will gather more detailed information about SAV using quadrat sampling along transect lines.

The proposed methodology has been modified from the aforementioned guidance documents to inform Project design and development in order to avoid, minimize and potentially mitigate impacts to SAV. Modifications include:

- Collection of updated aerial photography via aircraft will be conducted to accurately delineate the edges of SAV beds. Lathrop et al. (2011) utilized aerial photography via plane, while the joint agency New England SAV Guidance (Colarusso and Verkade, 2016) recommends using available aerial photography from the state or a university to determine the historical extents of SAV distribution.
- Spacing of the transects and quadrats for Phase 2 of the survey was modified based on size of the Project Area to collect representative SAV density and species data to support potential mitigation planning during permitting. Lathrop et al. (2011) utilized targeted transects and a stratified random sampling design to determine the location and spacing of their in-situ sampling locations while the joint agency New England SAV Guidance (Colarusso and Verkade, 2016) recommends transects running perpendicular to shoreline 5 meters apart (spacing dependent on size of the areas to be surveyed and type of project proposed) with 3 meter spacing of quadrats within the transects. , 50 m on either side was selected to capture a representative portion of the surrounding area in addition to the area where the cable will be placed as a conservative measure. As SAV growth is variable and can be patchy, the 50m buffer to be surveyed would provide information on the presence of SAV in the area surrounding the cable path. The 50m distance will encompass the bottom disturbance from cable installation and allow for the width of barges or other work vessels that would be performing the cable installation.
- No physical sampling or staging of equipment will occur on existing aquaculture leases. In the event that a sample transect were to intersect an aquaculture lease that transect would be shifted to the first available area beyond the lease or eliminated. The survey team will coordinate with MFA staff to ensure the lease areas are avoided.

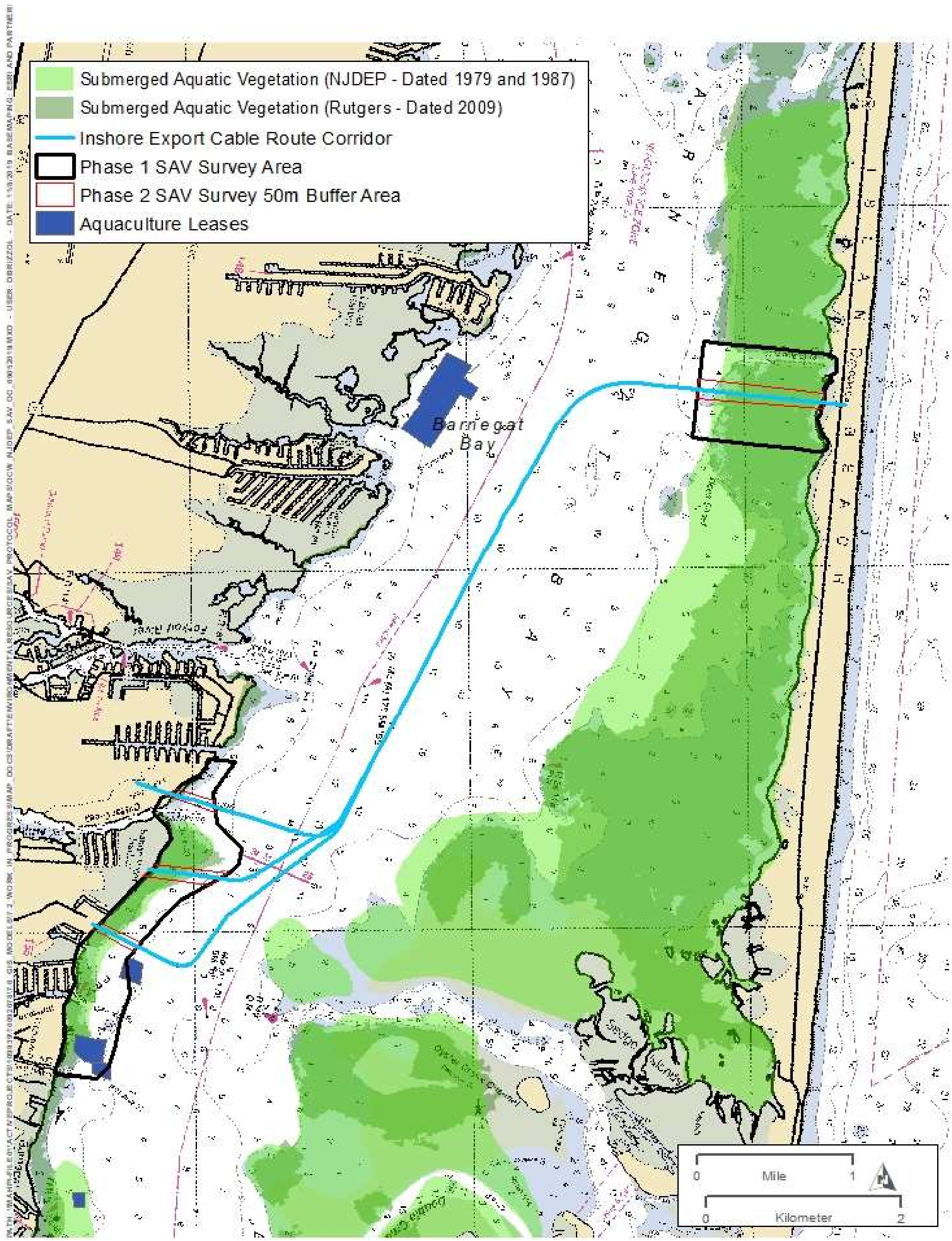

Figure 1. Barnegat Bay SAV Survey Limits

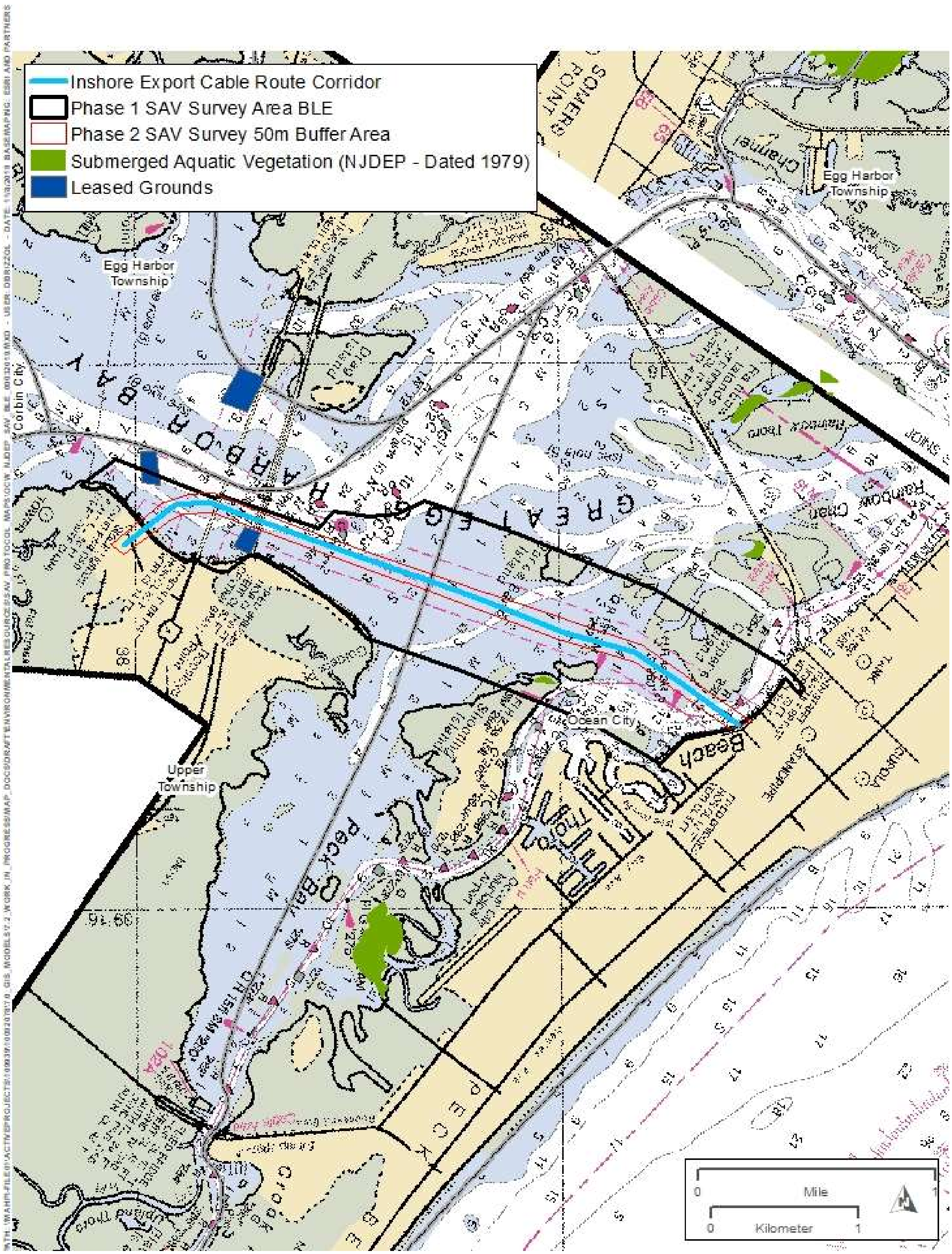

Figure 2. Great Egg Harbor SAV Survey Limits

SAV Survey Phase 1:

HDR will delineate SAV beds from aerial photography of shallow areas (<6 ft water depth) within an approximately 500m buffer of the proposed inshore export cable route and will extend sufficient distance from the shoreline to capture areas where SAV had been previously identified by the NJDEP and Rutgers studies. If weather conditions are suitable (calm winds, no precipitation, high visibility), a drone equipped with a camera will be used to support this survey. If weather conditions are not suitable for drone survey, aerial photography will be conducted using a plane will take place. Both drone and plane aerial surveys will yield high resolution, ortho-rectified imagery (direct overhead/plan view photography). Surveys will be conducted at low tide to facilitate viewing to the maximum depth possible. GPS coordinates will be taken along the SAV bed's perimeter, recording both the position and approximate water depth of each location. SAV beds will be surveyed as one continuous bed where applicable (details of density for "patchy" beds will be documented in phase 2).

SAV Survey Phase 2:

Phase 2 surveys will be conducted within the Phase 1 survey areas to "ground-truth" the extents of the SAV beds and obtain representative information on SAV species and density. The survey is anticipated to be completed in May 2020, when water clarity conditions are optimal. The goal of the Phase 2 survey is to gather more detailed information about the SAV beds identified in Phase 1 using a 0.5 square meter quadrat that is broken into 8 25cm x 25cm grid cells, along transect lines.

Phase 2 survey will begin with initial reconnaissance of the survey area from boat to confirm presence/absence of SAV using bathyscope/viewing bucket from the surface. The survey will be conducted on a sunny day, during a falling tide, when winds are calm to facilitate optimal viewing capabilities. Following initial reconnaissance, underwater photography will be utilized to document the SAV within each 0.5 square meter quadrat. This more detailed survey will be confined to the 50m area on either side of the proposed cable route that overlaps with areas of SAV identified in Phase 1 survey.

Transect lines will be established in SAV beds identified in Phase 1. Transect lines will be spaced approximately 30 meters apart and run perpendicular to the cable route . Start and end points of each transect line will be recorded using a GPS unit. Quadrat samples will be collected every 10 meters along each transect. Upon processing photographs, the following data will be recorded:

1. Date and time for each sampling transect.
2. Water depth at each sampling point (quadrat).
3. Water quality data (temperature, pH, salinity, dissolved oxygen, turbidity) will be collected at each sampling point.
4. General sediment type characterized by visual observation (e.g., silt, mud, sand, shell) will be collected at each sample point. Sediment samples will be collected for grain size analysis by sieving, at a frequency that is representative of the sediments within the survey area. A

minimum of 5 sediment samples will be collected per survey area. Results will be reported according to the Wentworth (1922) grain size scale.

5. Estimated percent cover and density of SAV, per species, within a 0.5-m^2 quadrat divided into 825cm x 25cm grid cells.
6. Shoot length of 1-3 randomly chosen SAV blades within the quadrat, per species. Blades will be estimated in place relative to reference markers on the quadrat. If it is not possible to estimate blade length in place, samples will be collected manually or using an appropriate tool, details regarding why a particular tool was chosen and a repeatable procedure will be provided in the report.
7. Estimated epiphyte percent coverage (0-100%) for each species. Surveyors will record qualitative vegetative density as they survey SAV beds on the following scale:
    a. Spare (1-10% cover);
    b. Low (11-25% cover);
    c. Moderate (26-50% cover), and
    d. High (>50% cover).
8. Notable biological observations (e.g., shellfish or algal beds, crabs or lobsters, and fish fauna).

Reporting

A SAV Survey Report will be prepared to summarize the findings of the field survey. The report will include the following:

- Description of the areas surveyed, results of desktop map review and summary of the habitat observed;
- Description of the survey methodology used to complete the field survey;
- Description and summary of areas of SAV identified in Phase 1 and Phase 2 surveys, including;
    - Date and time surveys were conducted.
    - Water depth at substrate for the shallowest and deepest edges of beds
    - General sediment type (e.g., silt, mud, sand, shell, etc.) and results of grain size analysis from sediment samples. Estimate of the percent cover of SAV and density within each 0.5-m^2 quadrat (for each species) and the mean for all quadrats across the entire area surveyed [e.g., barren, sparse (1-10% cover), low (11-25%), moderate (26-50%), high (> 50%, and shoots/blades per unit area.].
    - Shoot length measurement summary
    - Notable biological observations (e.g., shellfish or algal beds, crabs or lobsters, and fish fauna).
- Figures:
    - Figures showing the aerial photography of the Phase 1 survey areas, and areas of SAV that were identified.
    - Figures showing the Phase 2 transect lines and quadrat sample points and will include, depth, general sediment type, percent cover/density, estimated blade length, epiphyte coverage, and notable biological observations
- Tables summarizing the area of SAV within each of the survey areas.

Schedule:

Anticipated Project schedule and milestones are outlined in Table 1 below.

Table 1. Project Milestones

Item	Due Date
Survey plan approval by agencies	September 2019
Phase 1 Survey	September – October 2019
Phase 2 Survey	October2020
Data processing and analysis	October 2020
Draft Report	November 2020
Final Report	December 2020

Anticipated Project Staff and Qualifications:

The roster of anticipated project staff, their roles, and qualifications will be provided prior to performing survey and reporting activities.

References:

Colarusso, P. and Verkade, A. 2016. *Submerged Aquatic Vegetation Survey Guidance for the New England Region*. Joint Federal Agency Publication including NOAA, EPA, and USACE.

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Appendix B. APEM New Jersey Submerged Aquatic Vegetation Aerial Survey

New Jersey Submerged Aquatic Vegetation Aerial Survey

HDR Engineering, Inc

APEM Ref: P00004340

December 2019

Mark Wilkins, Lauren Lequime, David Campbell

Client: **HDR Engineering, Inc.**

Address: **500 7th Avenue**

New York, NY 10018-4502

Project reference: **P00004340**

Date of issue: **December 2019**

Project Director: **David Campbell**

Project Manager: **Mark Wilkins**

Other: **Lauren Lequime**

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VAT No. 47-4411075

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Revision and Amendment Register

Version Number	Date	Section(s)	Page(s)	Summary of Changes	Approved by
1.0	11/29/19	All	All	Created	DC
1.2	12/10/19	All	All	Client amendments made	DC

Contents

List of Figures

1. Introduction

1.1 Project Background

APEM were commissioned by HDR Engineering, Inc (hereby referred to as HDR) to undertake an aerial survey of two coastal areas in New Jersey. The aim of the survey was to capture high-resolution aerial photography in order to map submerged aquatic vegetation (SAV) in the two areas.

1.2 Survey Locations

The project involved surveying two locations, one in Barnegat Bay, Ocean County and the other in Great Egg Harbor, Cape May County. An overview of the two locations is shown in Figure 1.

Figure 1. Location of the two sites surveyed in New Jersey. Yellow denotes the Barnegat Bay site and red the Great Egg Harbor site.

The Barnegat Bay site measured 28 square miles in area and is shown in more detail in Figure 2.

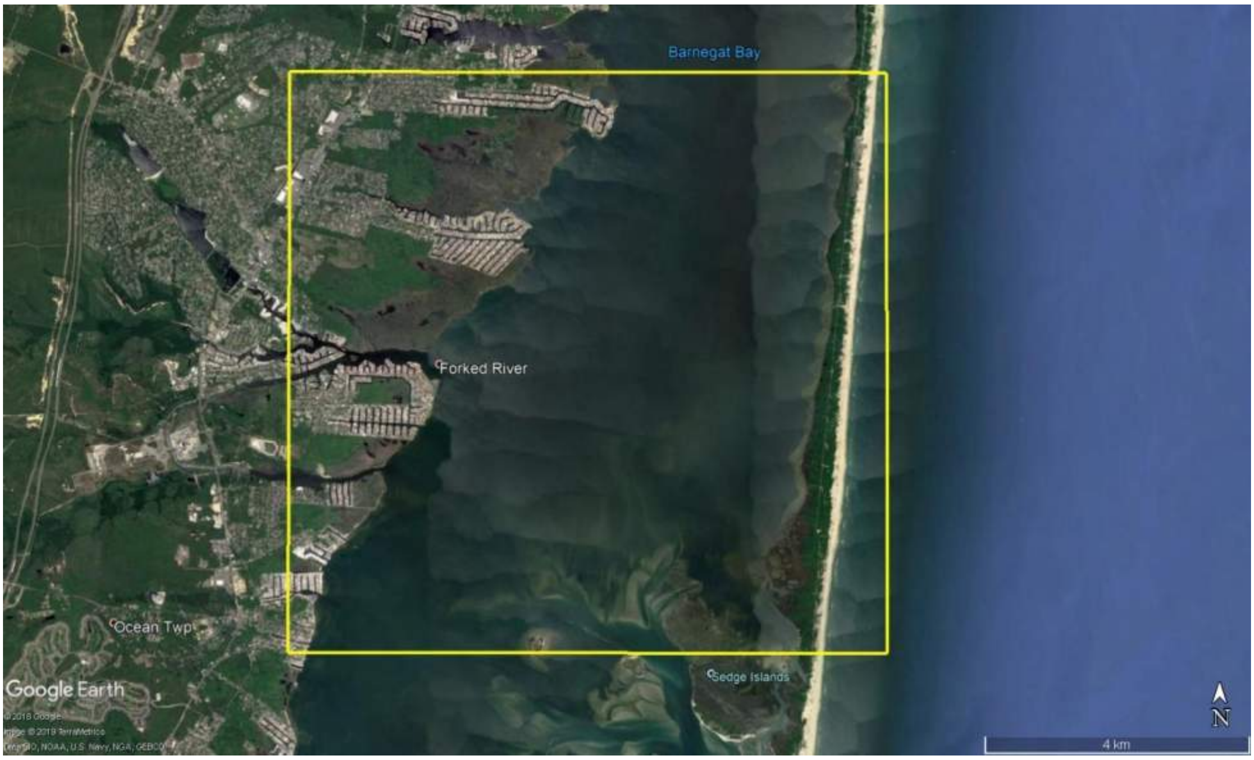

Figure 2. The Barnegat Bay survey area, outlined in yellow.

The Great Egg Harbor site measured approximately 13 square miles in area and is shown in more detail in Figure 3.

Figure 3. The Great Egg Harbor survey area, outlined in red.

2. Surveys and Data Processing

2.1 Aerial Survey

The aerial survey took place on October 7th 2019. The survey was carried out in a fixed wing aircraft using APEM's bespoke Shearwater III camera system surveying at an altitude of approximately 3,650ft above sea level. This allowed us to capture high-resolution imagery at a resolution of 4 cm ground sample distance (GSD). For Barnegat Bay, a total of 10,864 images were captured across 15 flight lines. For Great Egg Harbor a total of 7,299 images were captured across 10 flight lines. The survey was targeted to be complete within 1.5 hours either side of low tide, as this would allow for maximum intertidal exposure and help facilitate the mapping process.

Once the survey was complete, the data were downloaded and backed-up following APEM's stringent data management protocols.

2.2 Data Processing

The GPS data recorded on-board during the aerial survey were processed to produce location data for each aerial photograph's camera release point. These data were fed into photogrammetric processing software along with the imagery to produce georeferenced orthomosaics.

Over land, this photogrammetry process is able to create a seamless mosaic of the area. Over sea, however, it is often more problematic to generate the same type of seamless output due to the nature of the imagery (i.e. sun glint, changing wave patterns between adjacent imagery etc.). As such, a combination of automated processing and manual geo-referencing of images were required in order to achieve the required mosaic. This allowed a mosaic to be generated for all areas where the sea bottom could be seen within the imagery. For areas of deeper water where the sea bottom cannot be seen (typically in areas less than 7ft below mean sea level) in any of the imagery due to lack of light penetration, it was not possible to either georeferenced the imagery or map SAV. However, SAV has been documented to be very patchy and rare at depths of greater than 2m in New Jersey (Good *et al.,* 1978, Kennish *et al*., 2008). Therefore, it is unlikely these areas would contain SAV.

Once the mosaic was finalised, APEM marine biologists digitized areas of SAV using Geographic Information Software (GIS). Seagrass was mapped according to the following categories:

- Sparse cover; 10-40%
- Moderate cover; 40-80% cover
- Dense cover; 80-100% cover

The delineation of these categories was based on the data from the study by Lathrop *et al.* (2006), which mapped seagrass cover in the Barnegat Bay-Little Egg Harbor-Great Bay study area using these categories.

3. Results

The coverage maps for both survey areas are shown in Figures 4 and 5 below.

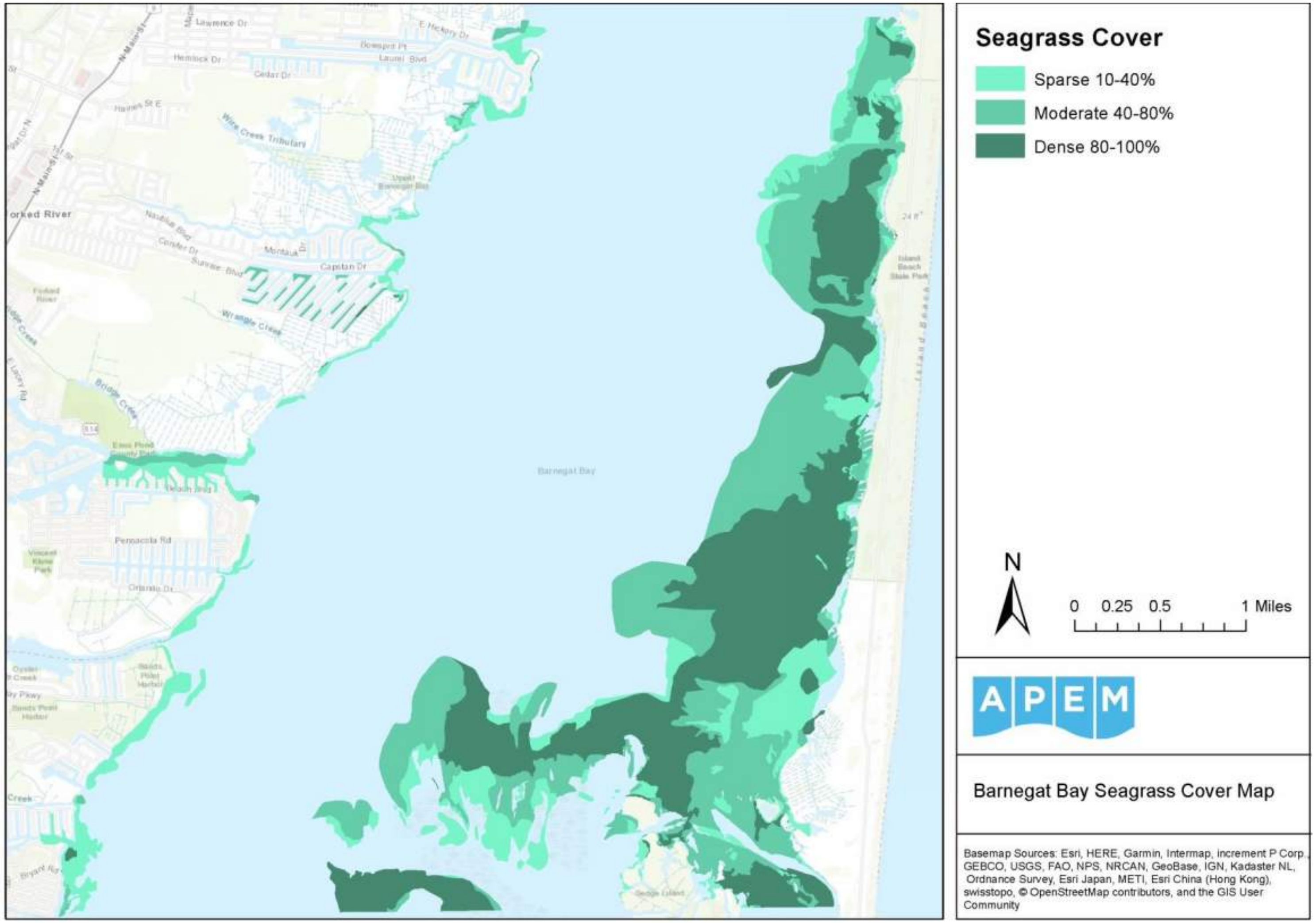

Figure 4 Seagrass coverage map of the Barnegat Bay survey area

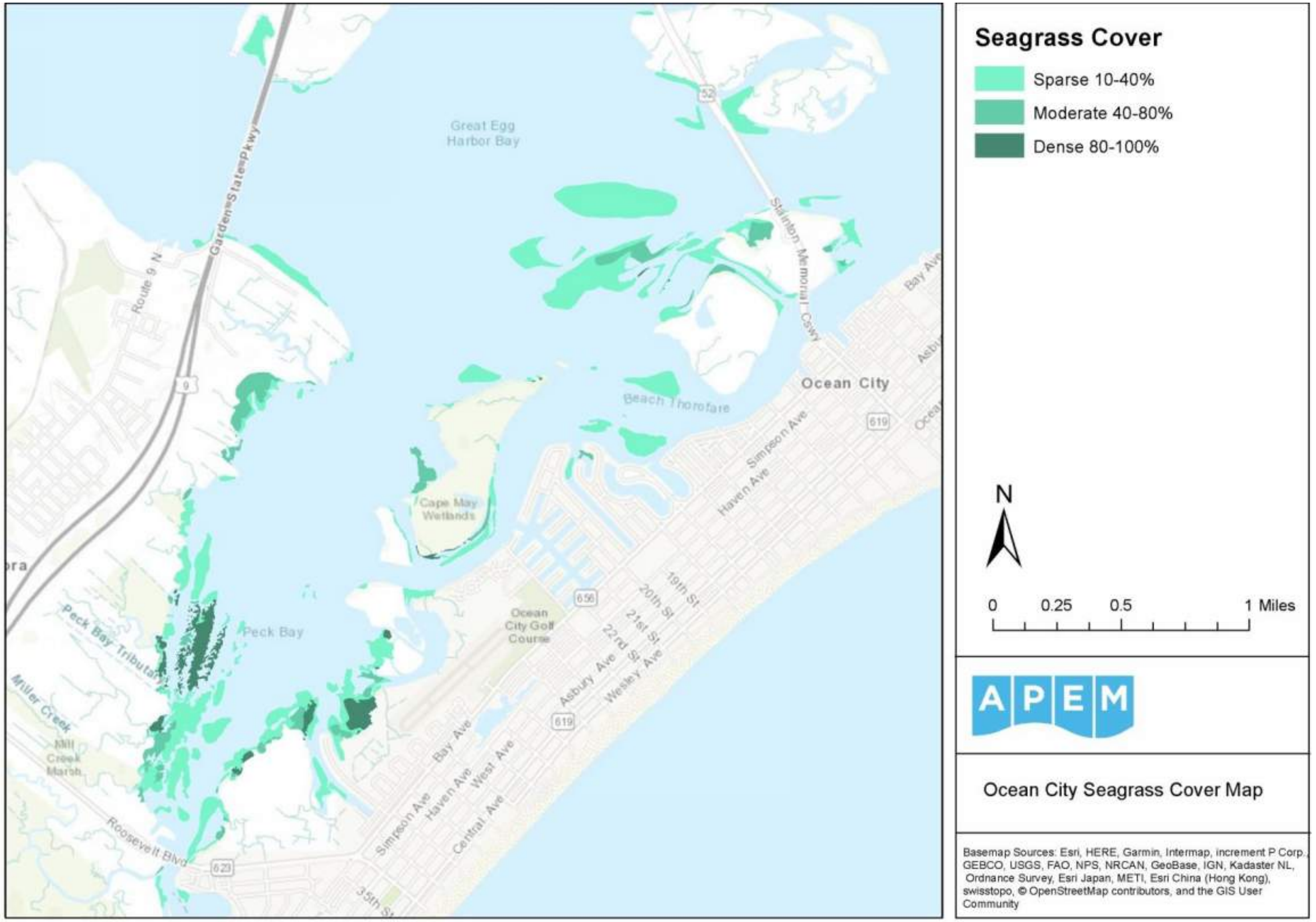

Figure 5 Seagrass coverage map of the Great Egg Harbor survey area

4. References

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Appendix C. Survey Photography

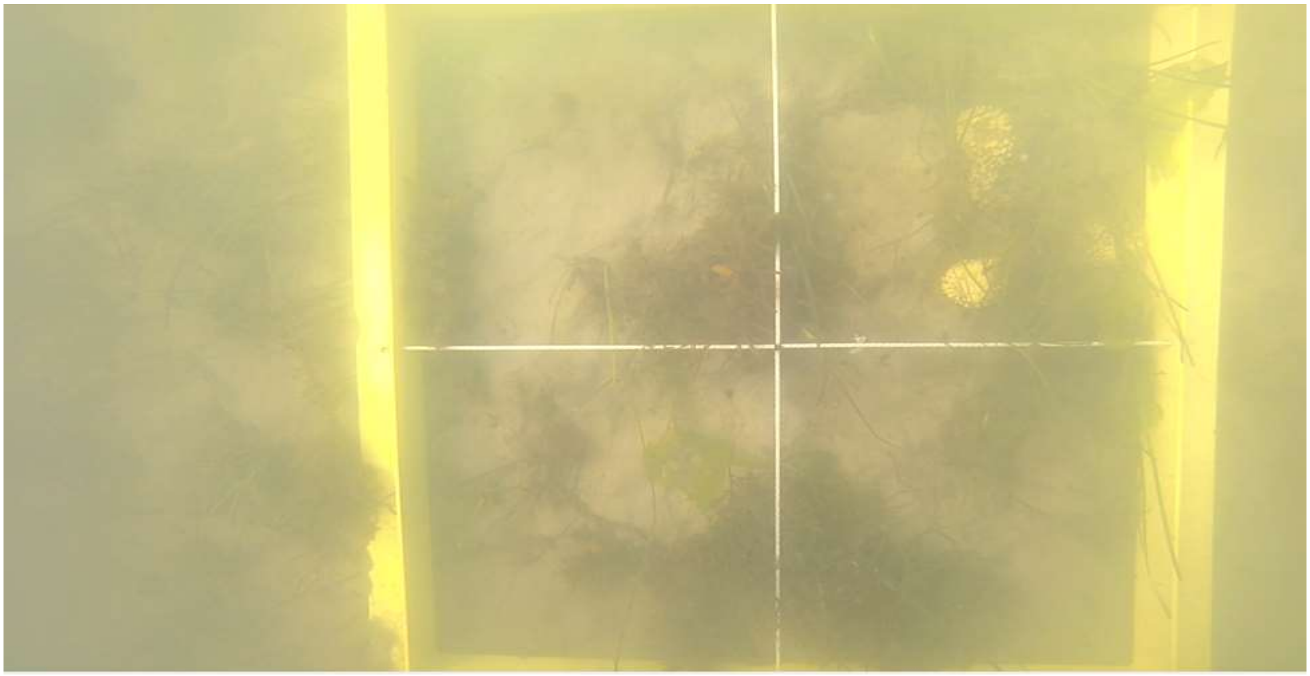


Photo 1: Bay Parkway Landing Station 507 with sponge, red, and green algae present.

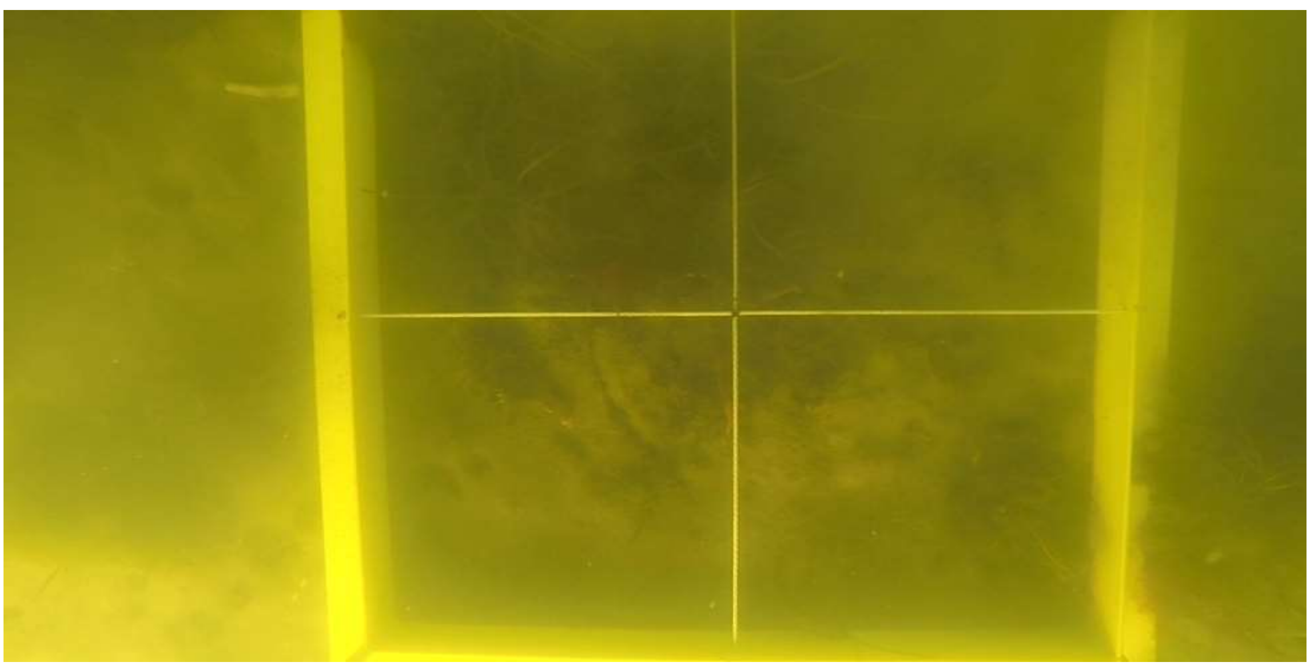


Photo 2: Bay Parkway Landing Station 521 with razor clam present.

Submerged Aquatic Vegetation Survey	**Ocean Wind Offshore Wind (OCW01)** **Oyster Creek SAV Survey Photographs**	DATE:	01/22/21	**PHOTO**
		CREATED BY:	JRC	**1 and 2**
		REVIEWED BY:	DJY	
		JOB NO:	10092078	

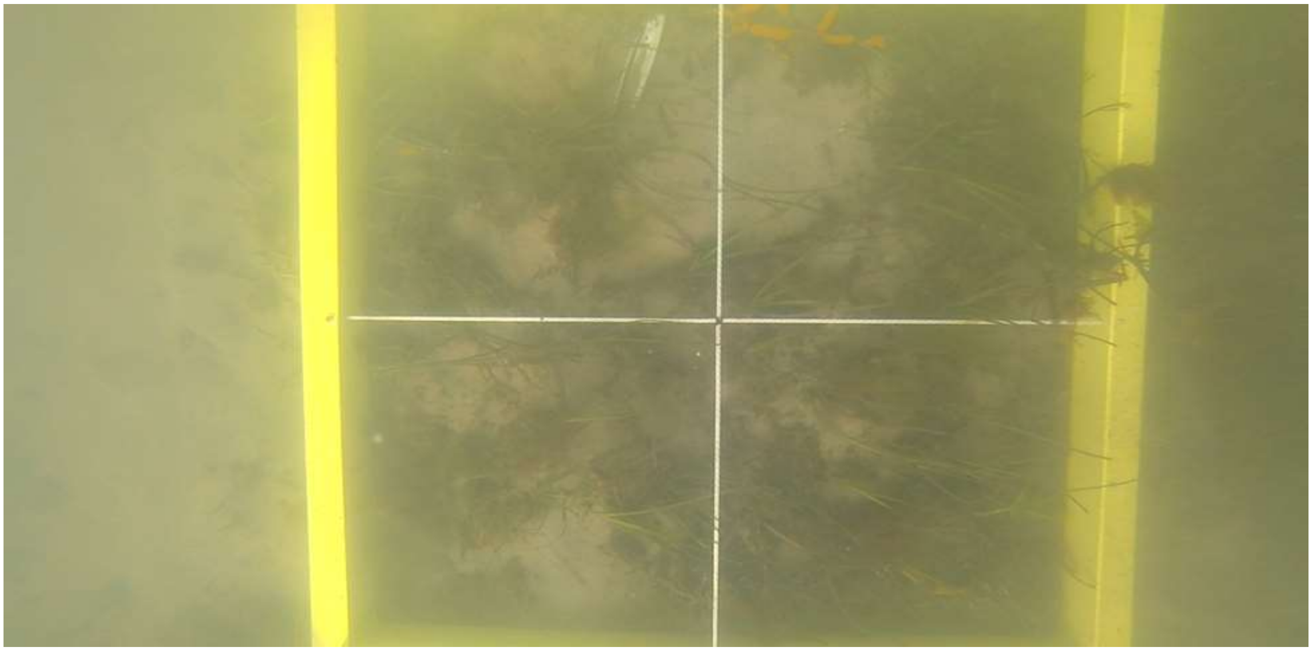


Photo 3: Bay Parkway Landing Station 560 with sponge, razor clam, and algae present.

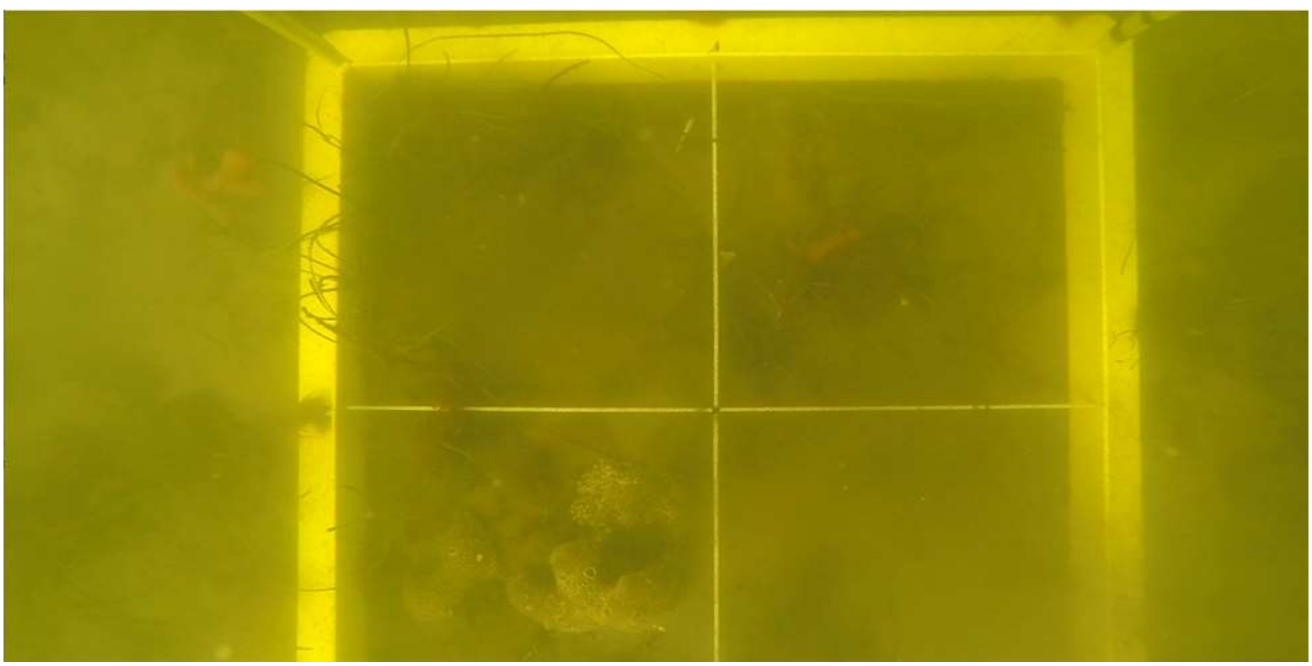


Photo 4: Bay Parkway Landing Station 535 with large sponge present.

Submerged Aquatic Vegetation Survey	**Ocean Wind Offshore Wind (OCW01)** **Oyster Creek SAV Survey Photographs**	DATE:	01/22/21	**PHOTO**
		CREATED BY:	JRC	**3 and 4**
		REVIEWED BY:	DJY	
		JOB NO:	10092078	

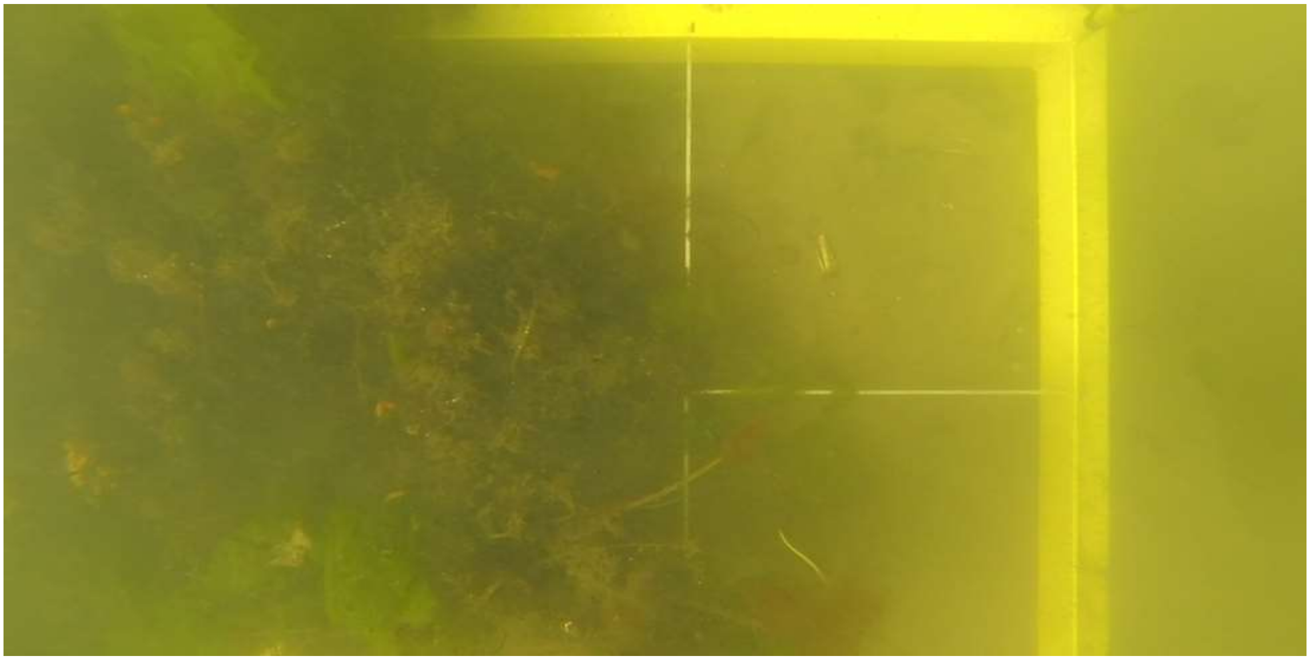


Photo 5: Bay Parkway Landing Station 557 with large algae growth and shell fragments present. Spare SAV growth.

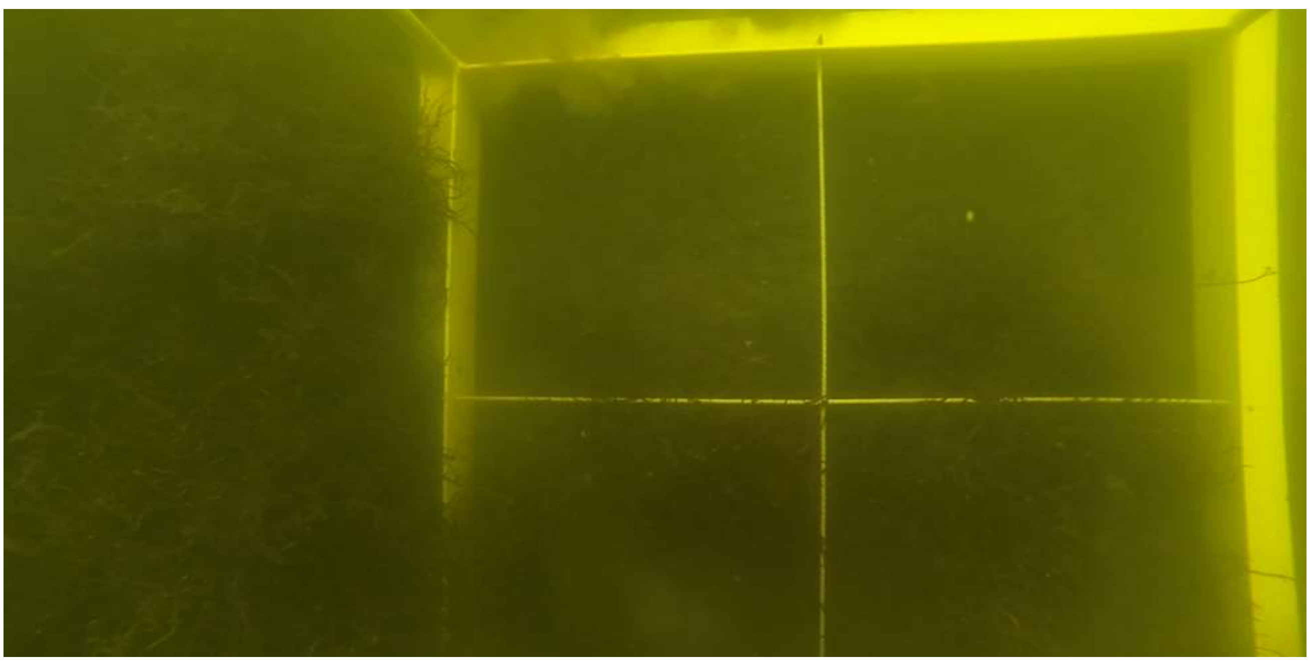


Photo 6: Holtec Property Station 638 with dense algae stand present.

Submerged Aquatic Vegetation Survey	**Ocean Wind Offshore Wind (OCW01)** **Oyster Creek SAV Survey Photographs**	DATE:	01/22/21	**PHOTO**
		CREATED BY:	JRC	
		REVIEWED BY:	DJY	**5 and 6**
		JOB NO:	10092078	

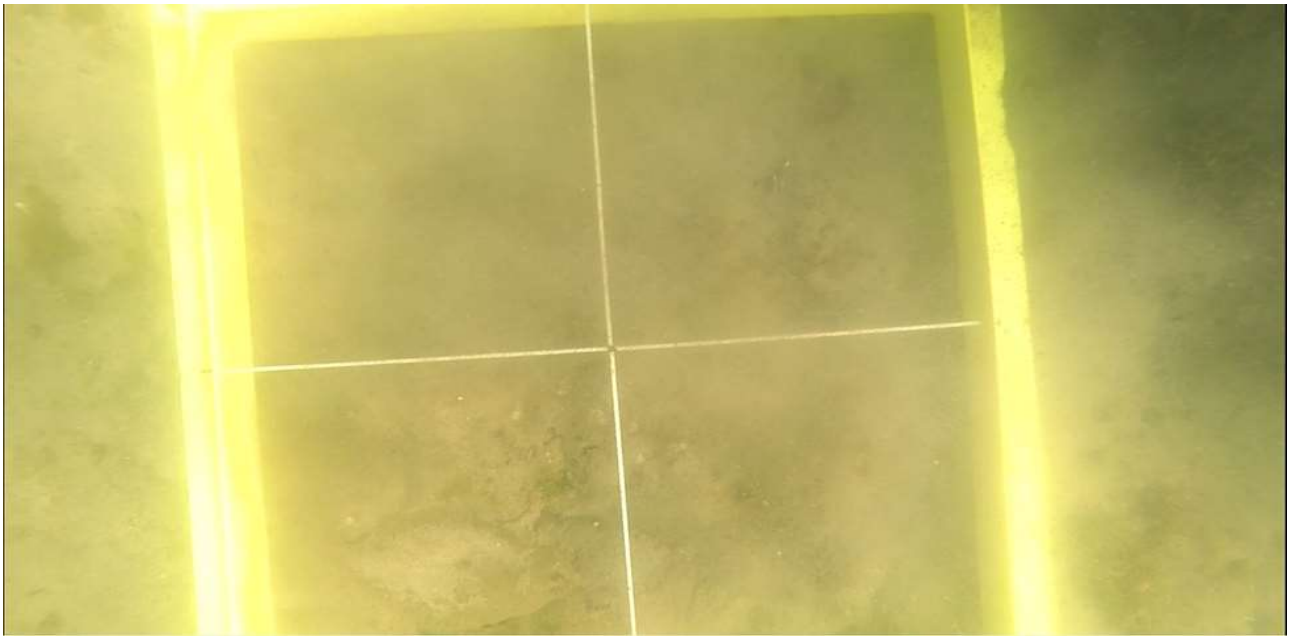


Photo 7: Lighthouse Drive Landing Station 715 with sandy bottom and juvenile summer flounder present.

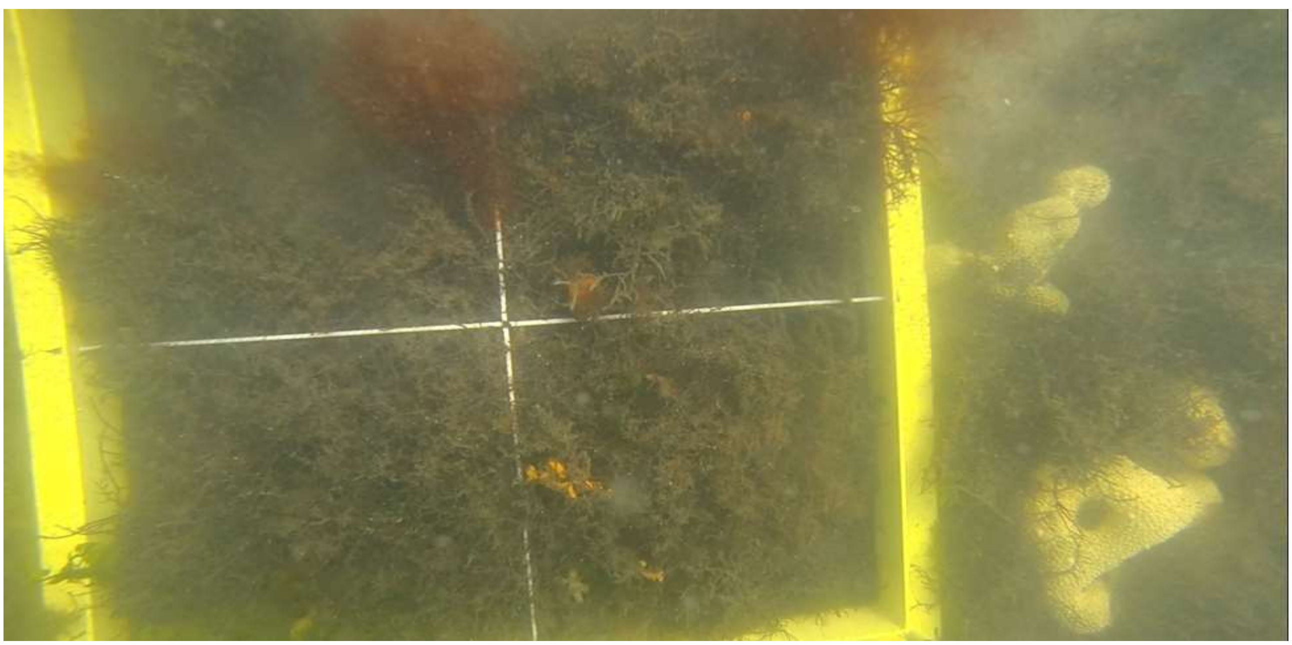


Photo 8: Lighthouse Drive Landing Station 724 with dense algae and large sponge present.

Submerged Aquatic Vegetation Survey	**Ocean Wind Offshore Wind (OCW01)** **Oyster Creek SAV Survey Photographs**	DATE:	01/22/21	**PHOTO**
		CREATED BY:	JRC	**7 and 8**
		REVIEWED BY:	DJY	
		JOB NO:	10092078	

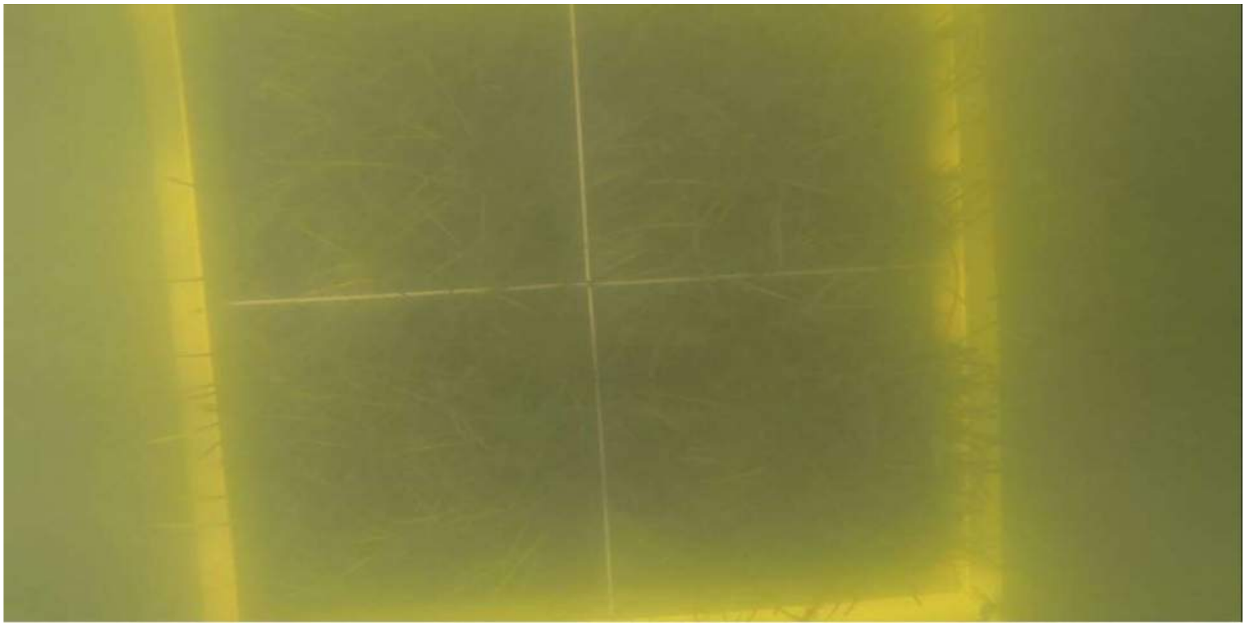


Photo 9: IBSP Landing Station 384 with thick patch of SAV present.

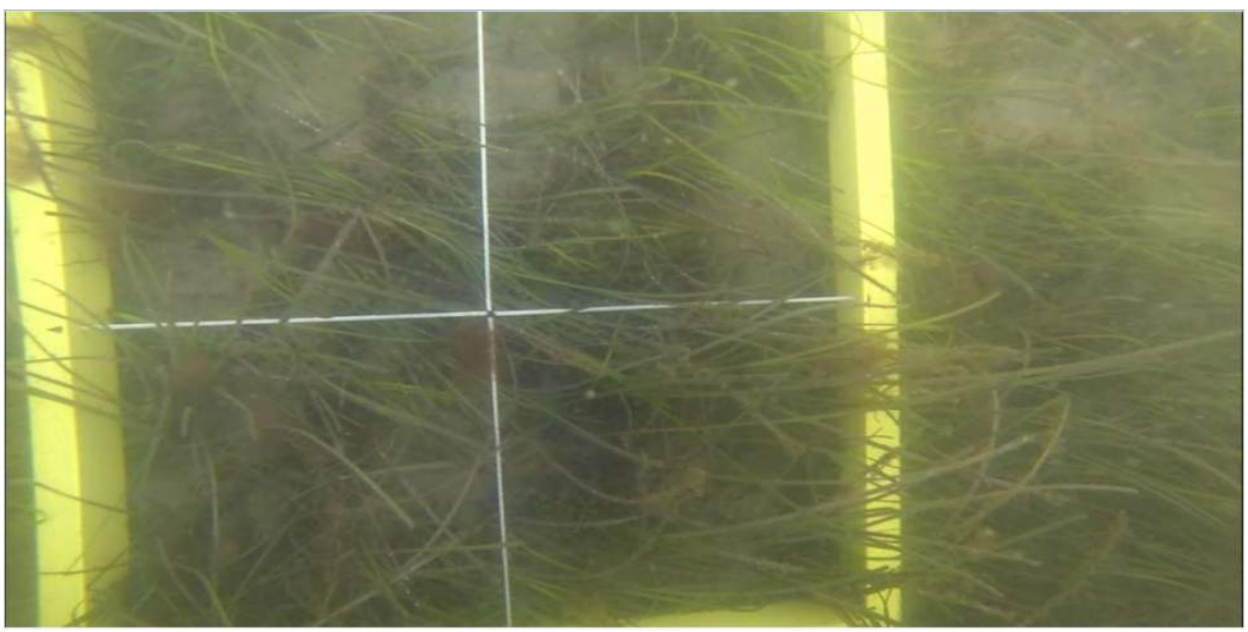


Photo 10: Lighthouse Drive Landing Station 757 with long stands of numerous SAV present.

Submerged Aquatic Vegetation Survey	**Ocean Wind Offshore Wind (OCW01)** **Oyster Creek SAV Survey Photographs**	DATE:	01/22/21	**PHOTO**
		CREATED BY:	JRC	**9 and 10**
		REVIEWED BY:	DJY	
		JOB NO:	10092078	

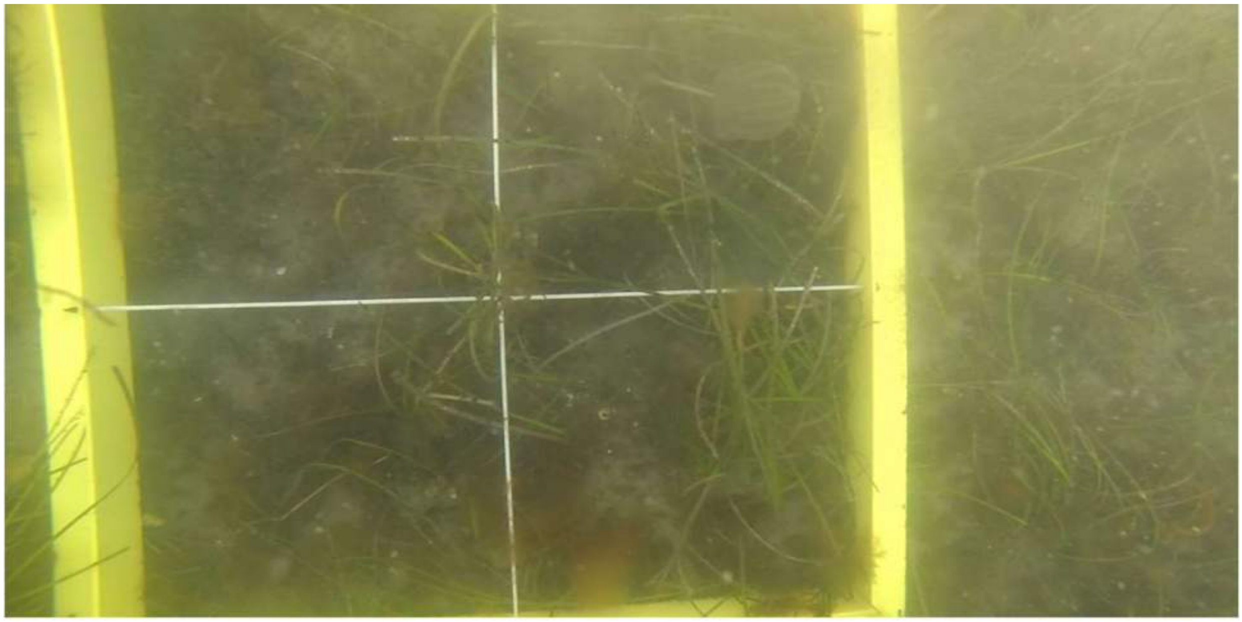


Photo 11: Lighthouse Drive Landing Station 753 with ctenophore, algae, and SAV present.

Photo 12: Photo of crab species brought up with Station 519 quadrant from Bay Parkway Landing.

Photo 13: Photo facing southwest at patchy SAV distribution at Lighthouse Drive Landing.

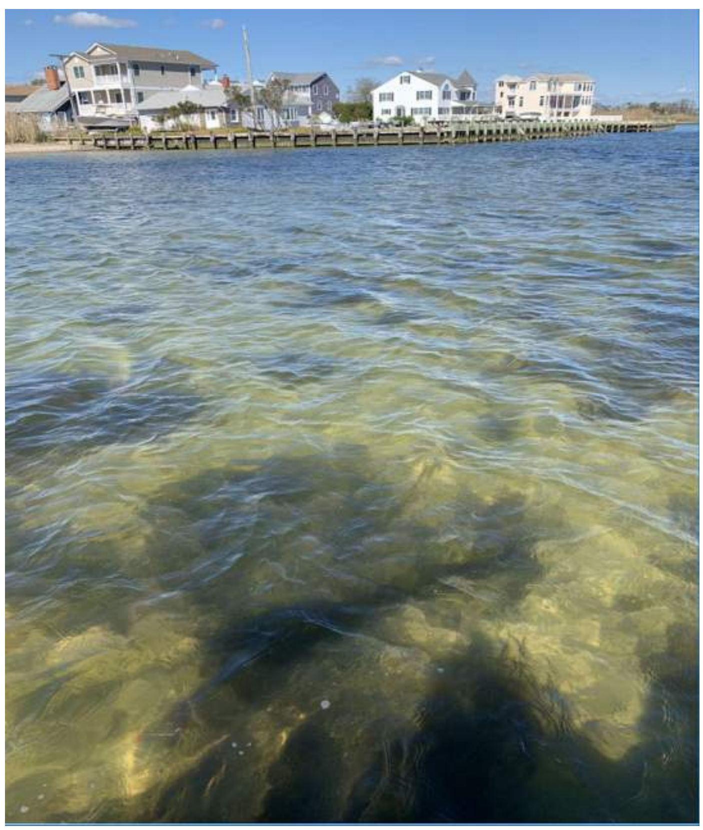


Photo 14: Photo facing northwest at patchy SAV distribution at Lighthouse Drive Landing.

Submerged Aquatic Vegetation Survey	**Ocean Wind Offshore Wind (OCW01)** **Oyster Creek SAV Survey Photographs**	DATE:	01/22/21	**PHOTO**
		CREATED BY:	JRC	**13 and 14**
		REVIEWED BY:	DJY	
		JOB NO:	10092078	

Photo 15: Photo showing Bay Parkway Landing shoreline, SAV rake, and camera frame in the water.

Photo 16: Photo facing west at Holtec Property Landing shoreline.

Photo 17: Photo showing SAV blades and seahorse at Bay Parkway Landing Station 528.

Photo 18: Photo showing sediment sample collected at IBSP Landing Station 391.

Photo 19: Photo showing sediment sample collected at Bay Parkway Landing Station 475.

Photo 20: Photo showing sediment sample collected at Bay Parkway Landing Station 541.

Photo 21: Photo showing sediment sample collected at Holtec Property Landing Station 636.

Photo 22: Photo showing sediment sample collected at Holtec Property Landing Station 678.

Photo 23: Photo showing sediment sample collected at Lighthouse Drive Landing Station 746.

Photo 24: Photo showing sediment sample collected at Lighthouse Drive Landing Station 760.

Submerged Aquatic Vegetation Survey	**Ocean Wind Offshore Wind (OCW01)** **Oyster Creek SAV Survey Photographs**	DATE:	01/22/21	**PHOTO**
		CREATED BY:	JRC	**23 and 24**
		REVIEWED BY:	DJY	
		JOB NO:	10092078	

Appendix D. Notable Biological Observations

Notable Biological Observations

While on the survey vessel at multiple locations, schools of baitfish, including Atlantic silversides (*Menidia menidia*) and juvenile Atlantic menhaden (*Brevoortia tyrannus*), were observed being chased by predatory fish assumed to be striped bass (*Morone saxatilis*) and bluefish (*Pomatomus saltatrix*).

During the review of camera drops, ctenophores were observed floating over several quadrats. Several sponge species were observed directly adjacent to the quadrat frame. The shells of Atlantic jackknife clams (*Ensis leei*) and biogenic mounds were observed in multiple quadrats. One small summer flounder (*Paralichthys dentatus*) was observed within one of the Lighthouse Drive Landing quadrats. Survey photography and notable biological observations are provided in Appendix B.

Appendix E. Sediment Sampling Results

TerraSense, LLC
Geotesting Laboratory

10/28/2020
TerraSense Project Number: 7736-20079

Subresults
Hampton-Clarke, Inc.
175 US Hwy 46 West
Fairfield, NJ 07004

Dear Subresults:

Re: Laboratory Test Results for 0101203 AD19744

The purpose of this letter is to present the results of the laboratory tests performed on the samples delivered to the TerraSense laboratory on 10/13/20. Testing was performed based on the assignment dated 10/13/20 by TR.

Test Results

Test results are reported on the accompanying test pages.

Test Comments

Testing was performed in general accordance to the ASTM or other methods as listed on the test pages. Deviations from the test standards are noted on these pages.

Limitations

Our professional services for this project have been performed in accordance with generally accepted engineering practices; no other warranty, expressed or implied, is made.

Sample Disposition

If we do not receive other instructions from you within thirty days, this material will be disposed of.

If you have any questions concerning the test results reported in this letter, please call us.

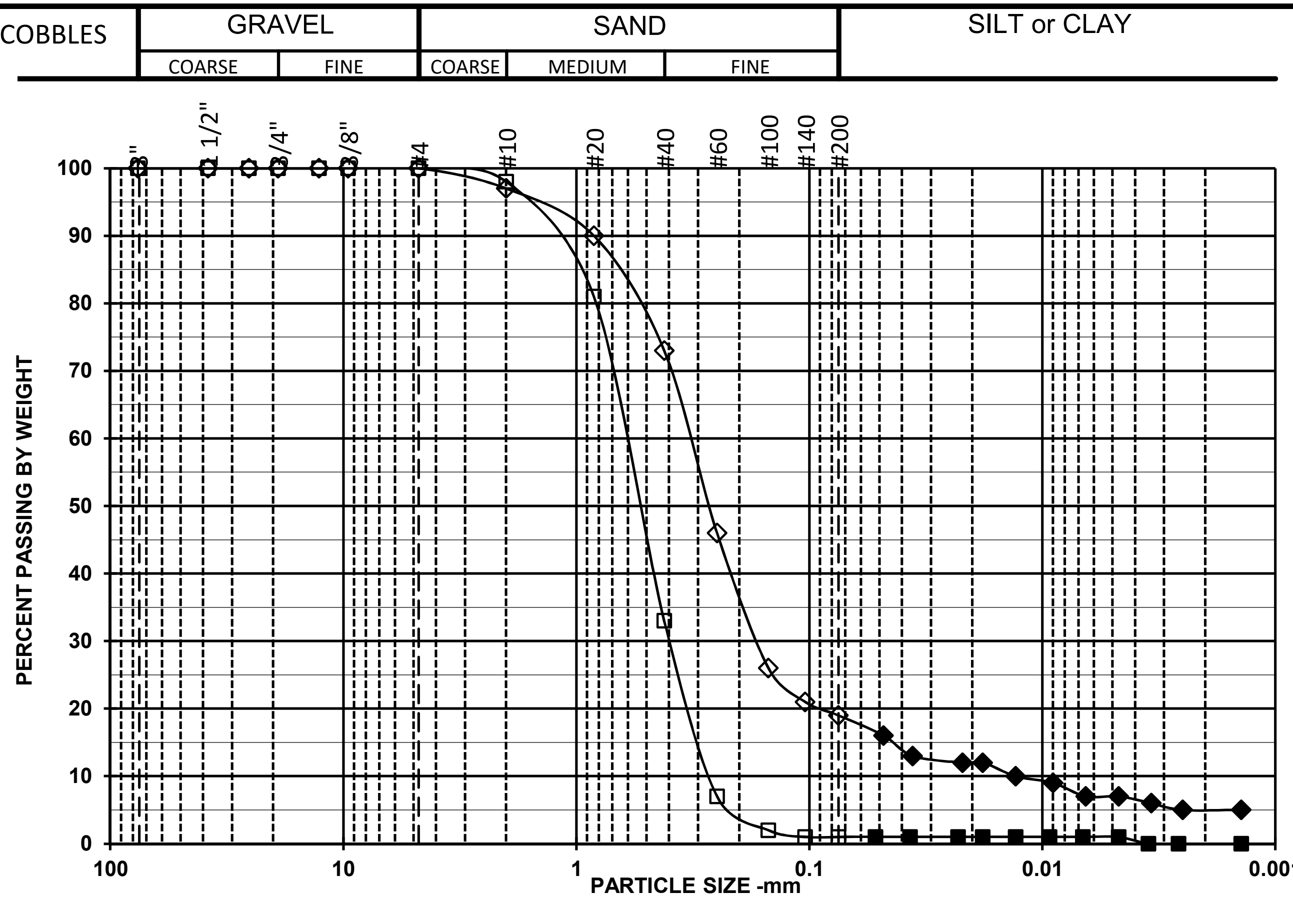
Sincerely,
TerraSense, LLC.
Rosella Thomas
Rosella Thomas
Managing Member

Enclosure:

Hampton Clarke #0101203
AD19744
LABORATORY TESTING DATA SUMMARY

GROUP ID	SAMPLE NO.	CLIENT ID	TEST DATE	IDENTIFICATION TESTS				REMARKS
				WATER CONTENT (%)	USCS SYMB. (1)	SIEVE MINUS NO. 200 (%)	HYDROMETER % MINUS 2 μm (%)	
AD19744	001	636	10/13/2020		SP	1	0	
AD19744	002	678	10/13/2020		SM	19	5	
AD19744	003	475	10/13/2020		SP	2	0	
AD19744	004	541	10/13/2020		SM	23	8	
AD19744	005	760	10/13/2020		SM	13	5	
AD19744	006	746	10/13/2020		SP	4	2	
AD19744	007	391	10/13/2020		SP	1	1	

Note: (1) USCS symbol based on visual observation and Sieve reported.



Open Symbols: Sieve analysis by ASTM D6913

Filled symbols: Hydrometer analysis by ASTM D7928 corrected for complete sample

Symbol	□	◇	○
Group#	AD19744	AD19744	
ID	001	002	
Client ID	636	678	
% +3"	0	0	
% Gravel	0	0	
% SAND	99	81	
%C SAND	2	3	
%M SAND	65	24	
%F SAND	32	54	
% FINES	1	19	
D_{100} (mm)	9.53	4.75	
D_{60} (mm)	0.62	0.326	
D_{30} (mm)	0.39	0.17	
D_{10} (mm)	0.26	0.013	
Cc	0.9	6.8	
Cu	2.4	25.1	

Sieve Size/ID #	Percent Finer Data		
6"	100	100	
4"	100	100	
3"	100	100	
1 1/2"	100	100	
1"	100	100	
3/4"	100	100	
1/2"	100	100	
3/8"	100	100	
#4	100	100	
#10	98	97	
#20	81	90	
#40	33	73	
#60	7	46	
#100	2	26	
#140	1	21	
#200	1	19	
5μ m	1	7	
2μ m	0	5	
1μ m	0	5	

SYMBOL	w (%)	LL	PL	PI	USCS	AASHTO	USCS DESCRIPTION AND REMARKS	DATE
□					SP		Grayish brown, Poorly graded sand organic mat'l noted	10/13/20
◇					SM		Grayish brown, Silty sand organic mat'l noted	10/13/20
○								

Hampton Clarke #0101203

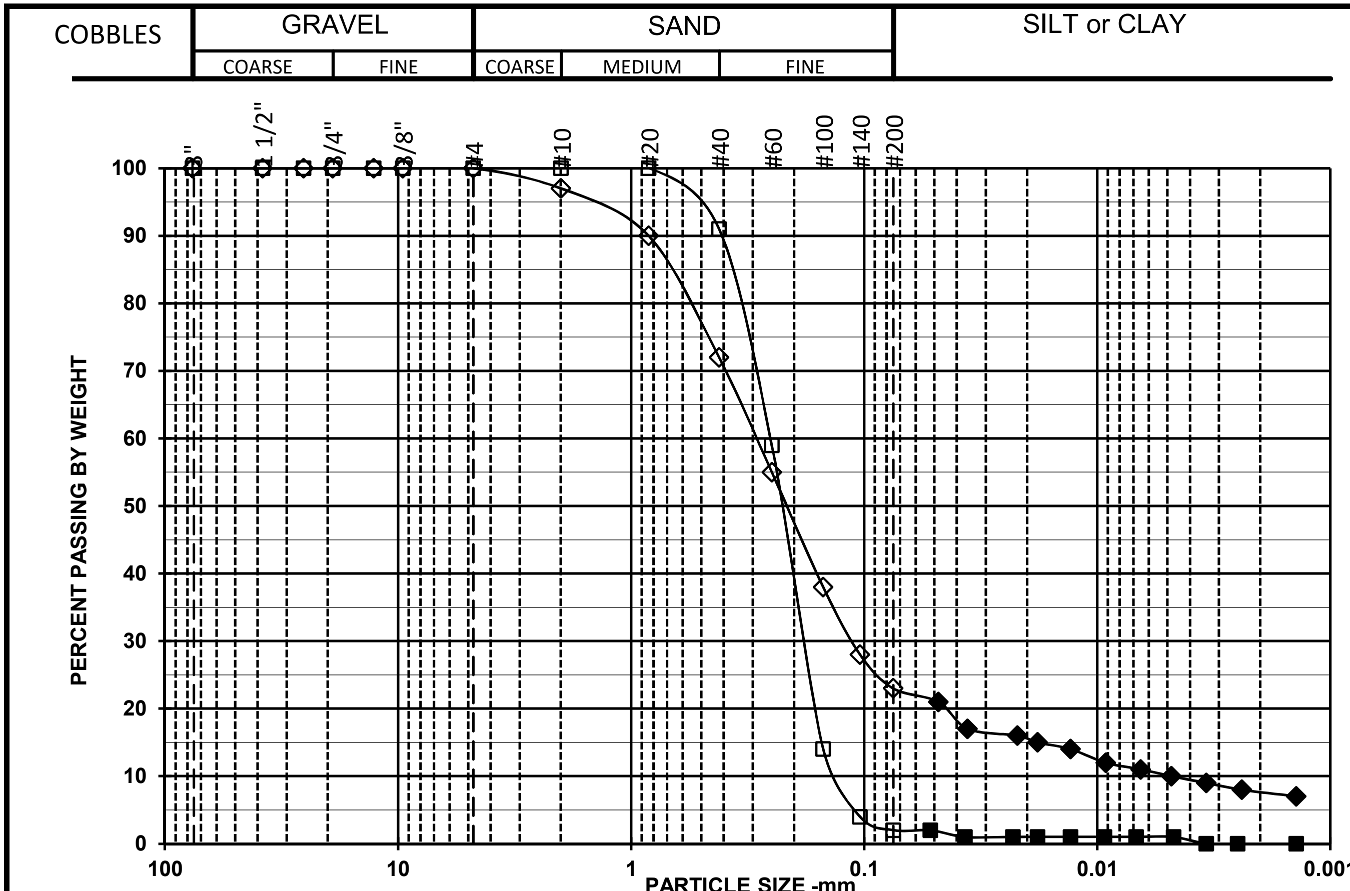
TerraSense, LLC #7736-20079

AD19744

PARTICLE SIZE DISTRIBUTION
ASTM D6913 & ASTM D7928

TerraSense Analysis File: GrainSizeV6Rev1a7 (09/20)

Siev1a.xlsx 10/27/2020



Open Symbols: Sieve analysis by ASTM D6913

Filled symbols: Hydrometer analysis by ASTM D7928 corrected for complete sample

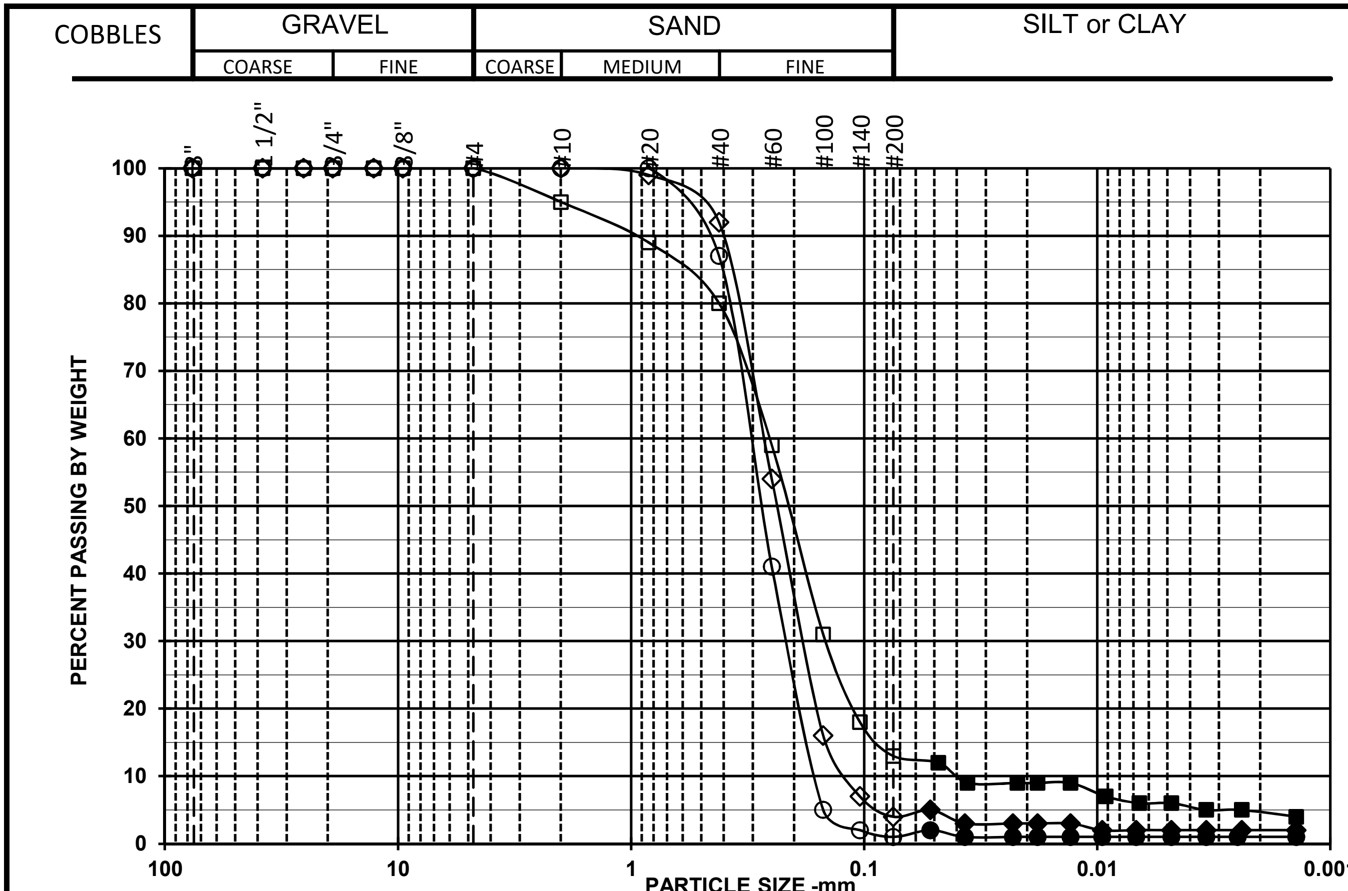
SYMBOL	w (%)	LL	PL	PI	USCS	AASHTO	USCS DESCRIPTION AND REMARKS	DATE
□					SP		Grayish brown, Poorly graded sand organic mat'l noted	10/13/20
◇					SM		Grayish brown, Silty sand organic mat'l noted	10/13/20
○								

Hampton Clarke	#0101203	AD19744
TerraSense, LLC	#7736-20079	

Symbol	□	◇	○
Group#	AD19744	AD19744	
ID	003	004	
Client ID	475	541	
% +3"	0	0	
% Gravel	0	0	
% SAND	98	77	
%C SAND	0	3	
%M SAND	9	25	
%F SAND	89	49	
% FINES	2	23	
D_{100} (mm)	9.53	4.75	
D_{60} (mm)	0.253	0.29	
D_{30} (mm)	0.18	0.11	
D_{10} (mm)	0.13	0.005	
Cc	1	8.7	
Cu	1.9	60.4	

Sieve Size/ID #	Percent Finer Data		
6"	100	100	
4"	100	100	
3"	100	100	
1 1/2"	100	100	
1"	100	100	
3/4"	100	100	
1/2"	100	100	
3/8"	100	100	
#4	100	100	
#10	100	97	
#20	100	90	
#40	91	72	
#60	59	55	
#100	14	38	
#140	4	28	
#200	2	23	
5µ m	1	10	
2µ m	0	8	
1µ m	0	6	

PARTICLE SIZE DISTRIBUTION
ASTM D6913 & ASTM D7928



Open Symbols: Sieve analysis by ASTM D6913
Filled symbols: Hydrometer analysis by ASTM D7928 corrected for complete sample

Symbol	□	◇	○
Group#	AD19744	AD19744	AD19744
ID	005	006	007
Client ID	760	746	391
% +3"	0	0	0
% Gravel	0	0	0
% SAND	87	96	99
%C SAND	5	0	0
%M SAND	15	8	13
%F SAND	67	88	86
% FINES	13	4	1
D_{100} (mm)	4.75	9.53	9.53
D_{60} (mm)	0.255	0.27	0.309
D_{30} (mm)	0.15	0.18	0.21
D_{10} (mm)	0.04	0.12	0.16
Cc	2.2	1	0.9
Cu	6.4	2.3	1.9

Sieve Size/ID #	Percent Finer Data		
6"	100	100	100
4"	100	100	100
3"	100	100	100
1 1/2"	100	100	100
1"	100	100	100
3/4"	100	100	100
1/2"	100	100	100
3/8"	100	100	100
#4	100	100	100
#10	95	100	100
#20	89	99	100
#40	80	92	87
#60	59	54	41
#100	31	16	5
#140	18	7	2
#200	13	4	1
5μ m	6	2	1
2μ m	5	2	1
1μ m	3	2	1

SYMBOL	w (%)	LL	PL	PI	USCS	AASHTO	USCS DESCRIPTION AND REMARKS	DATE
□					SM		Grayish brown, Silty sand organic mat'l noted	10/13/20
◇					SP		Grayish brown, Poorly graded sand shell fragments & organic mat'l noted	10/13/20
○					SP		Grayish brown, Poorly graded sand shell fragments & organic mat'l noted	10/13/20

Hampton Clarke #0101203

TerraSense, LLC #7736-20079

AD19744

PARTICLE SIZE DISTRIBUTION
ASTM D6913 & ASTM D7928

TerraSense Analysis File: GrainSizeV6Rev1a7 (09/20)

Siev1c.xlsx 10/27/2020

CHAIN OF CUSTODY RECORD

Hampton-Clarke, Inc.
175 US Hwy 46 West
Fairfield, New Jersey, 07004
Ph:800-426-9992 Fax:973-439-1458

7736-20079

Report To:
Hampton-Clarke, Inc.:
Attn:Reporting
175 Route 46 West
Fairfield, New Jersey 07004

Invoice To:
Hampton-Clarke, Inc.:
Attn:Accounting
175 Route 46 West
Fairfield, New Jersey 07004

Project #: 0101203

CocID#: 6931

FINAL RESULTS TO: subresults@hcvlab.com
PRELIM/VERBAL RESULTS TO: subresults@hcvlab.com

EDD: NEW JERSEY HAZRESULT OR EQUIS EZEDD REQUIRED FOR ALL DATA SUBMITTALS!

Turn Around Time: Standard **Preliminary Due Date:** 10/27/2020
Report Type: NJDEP-R (REDUCED) **Hard Copy Due Date:** 11/4/2020

Sample Number:	Client ID	Matrix:	Date Collected:	Time Collected:	Analysis Requested
AD19744-001	636	Soil	10/8/2020	10:20:00 AM	Grain Size with Hydrometer(ASTM D6913&D7928)
AD19744-002	678	Soil	10/8/2020	10:30:00 AM	Grain Size with Hydrometer(ASTM D6913&D7928)
AD19744-003	475	Soil	10/8/2020	10:48:00 AM	Grain Size with Hydrometer(ASTM D6913&D7928)
AD19744-004	541	Soil	10/8/2020	10:57:00 AM	Grain Size with Hydrometer(ASTM D6913&D7928)
AD19744-005	760	Soil	10/8/2020	1:58:00 PM	Grain Size with Hydrometer(ASTM D6913&D7928)
AD19744-006	746	Soil	10/8/2020	2:17:00 PM	Grain Size with Hydrometer(ASTM D6913&D7928)
AD19744-007	391	Soil	10/9/2020	8:21:00 AM	Grain Size with Hydrometer(ASTM D6913&D7928)

Relinquished By:	Accepted By:	Date:	Time:	Comments, Notes, Special Requirements, HAZARDS
[signature]	[signature] G Thomas	10/13/20	15:02	

[initials] 10/13/2020

Cooler Temp:__________

HC Lab Use Only: **Subcontracted Lab Id and Contact:** TERRASENSE, Greg Thomas, (973) 256-0494, LabID: H, 45H Commerce Way, , Totowa, NJ, 07512