

**Natural Resources Evaluation and Effects
Electric Boat South Yard Project**

Groton, Connecticut



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PROJECT BACKGROUND

Electric Boat Corporation (EB) owns and operates a shipbuilding facility along approximately 4,500 linear feet (lf) of Thames River shoreline in Groton, Connecticut. The facility has been the site of ship and submarine construction, maintenance, and overhauling activity since the early 1900s. To facilitate these shipbuilding activities, shoreline areas have been extensively filled and altered between the 1920s and 1970s. More specifically, coastal resource maps developed by the Connecticut Department of Energy and Environmental Protection (CTDEEP) classify the entire Thames River shoreline at the EB facility in Groton as a Developed Shorefront which is defined as “areas that have been highly engineered and developed, resulting in the functional impairment or substantial alteration of their natural physiographic features or systems”.

EB is proposing to modify portions of the facility as part of the Facility Master Plan (FMP) to accommodate construction and deployment of a new class of submarines for the United States Navy. Significant in-water construction activity associated with the FMP that is anticipated to occur in the southern portion of the facility (i.e., the South Yard Project Area) includes:

- Stabilization and/or bulkhead installation along approximately 1,250 linear feet (ft) of the Thames River shoreline that includes a footprint of permanent coastal fill totaling approximately 2,910 square feet (sq ft) for bulkhead installation, temporary effects associated with riprap repair within a 11,050 sq ft footprint, and removal of approximately 22,000 square feet (sq ft) of submerged bedrock;
- Installation of drilled shafts to support over-water building/pier infrastructure and dolphins and anchoring structures for vessel berthing with a footprint of permanent coastal fill totaling approximately 7,079 sq ft with an estimated 12,000 cubic yards (cy) of sediment removal;
- Creation of an access road that includes permanent fill of jurisdictional wetlands (1,750 sq ft);
- Construction of an assembly building/pier infrastructure that extends approximately 180,000 sq ft over the Thames River; and
- Dredging of an estimated 984,000 cy of sediment, including 2 ft over-dredge, within a footprint of approximately 923,250 sq ft to allow for the floating dry dock submersion basin, berthing for support and transport vessels, and staging of a floating dry dock.

This project is considered vital to national security and due to EB contractual provisions with the U.S. Navy, assembly of submarines must occur at the facility. As such, the proposed facilities are required to meet Navy submarine production needs. In advance of these efforts, EB and Stantec Consulting Services Inc. (Stantec) worked in consultation with the CTDEEP to arrive at a plan to characterize the present conditions and to evaluate the potential effects of the planned efforts.

As such, Stantec recently completed a comprehensive ecological characterization of the South Yard Project Area to confirm and establish baseline conditions (see Attachment A). The baseline ecological characterization was completed in accordance with a work plan that was submitted to and subsequently approved by CTDEEP prior to commencing field studies (Stantec 2017). This effort included field investigations of the terrestrial, intertidal, shoreline, and benthic habitats expected to be affected by the FMP activities, and a synthesis of recent and representative ecological data from other Thames River studies.

The purpose of this technical memo is to present a preliminary assessment of the proposed FMP project's effects on regulated coastal resources¹ in the South Yard Project Area and to describe these effects within the context of the site's baseline conditions as described in Attachment A. The activities affecting coastal resources will include permanent fill, construction of in-water structures

¹ As defined by Connecticut General Statutes (CGS), Chapter 444 Coastal Management, Section 22a-93.

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and associated shading, and sediment dredging in the river and are further described herein. Coastal resources identified within and adjacent to the South Yard Project Area are depicted in Figure 1 and detailed below. It is important to note that although the CTDEEP published coastal resource maps do not identify Rocky Shorefront habitats in the South Yard Project Area, habits demonstrating characteristics consistent with this habitat type were documented as described in Attachment A.

- Developed Shorefront
- Rocky Shorefronts
- Nearshore Waters
- Offshore Waters
- Freshwater Wetlands and Watercourses
- Coastal Hazard Areas
- Shellfish Concentration Areas
- Shorelands

The comprehensive ecological assessment did not find any of the following coastal resources within or adjacent to the South Yard Project Area: Coastal Bluffs and Escarpments, Beaches and Dunes, Intertidal Flats, Tidal Wetlands, Estuarine Embayments, or Islands. As such, there will be no impacts on these coastal resources. Furthermore, although Rocky Shorefronts were identified within or adjacent to the South Yard Project Area, this coastal resource is not anticipated to be affected by the FMP and is not analyzed further in this report.

The FMP activities in the South Yard Project Area resulting in permanent fill, construction of in-water structures and associated shading, and sediment dredging will affect Developed Shorefront, Nearshore Waters, Offshore Waters, Freshwater Wetlands and Watercourses, Coastal Hazard Areas, and Shellfish Concentration Areas. The nature and extent of the anticipated effects of each activity to each of these applicable coastal resources is described herein.

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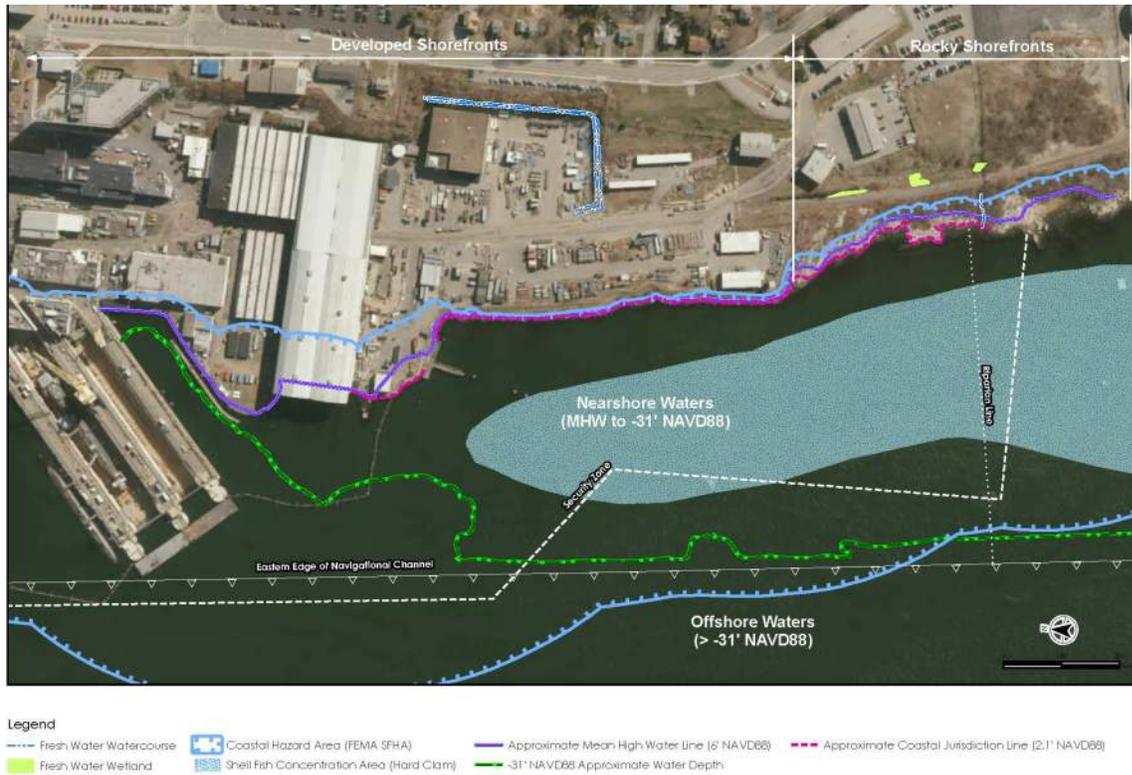


Figure 1. Coastal resources within and adjacent to South Yard Project Area

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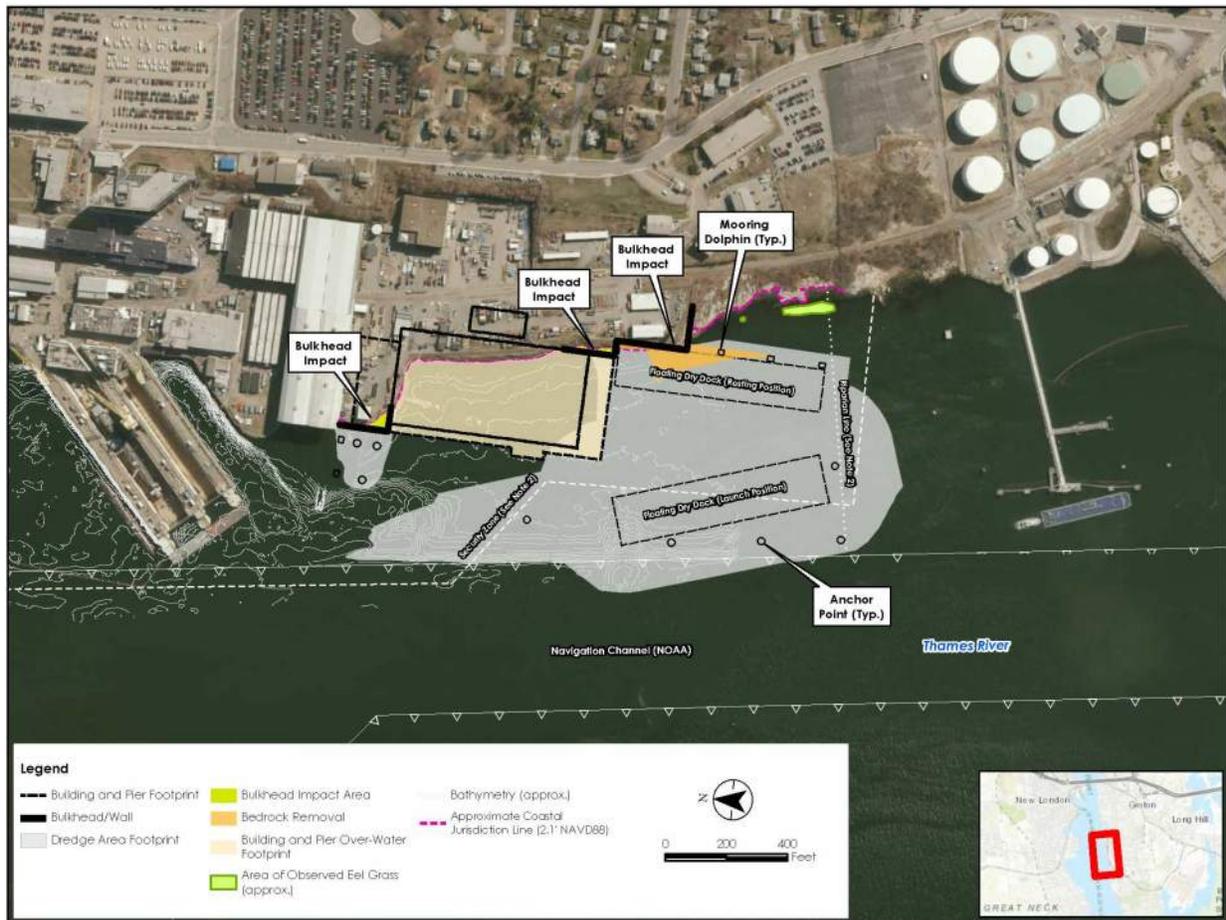


Figure 2. South Yard Project Area in-water construction activity

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ACTIVITY 1 – PERMANENT FILL

FMP activities in the South Yard Project Area that will result in permanent fill being placed within coastal resources include shoreline stabilization activities, installation of drilled shafts to support new over-water building/pier infrastructure and vessel berthing, and creation of a permanent access road. These activities will result in the permanent alteration and spatial loss of approximately 9,989 sq ft of coastal resources.

Shoreline Stabilization

Shoreline stabilization structures will be required to support the FMP program in the South Yard Project Area and assure that the buildings meet structural engineering and seismic requirements for submarine production. Shoreline stabilization will involve the construction of two bulkheads, temporary repair and maintenance of existing rip/rap Developed Shorefront (Figure 2), creation of berthing areas for shipyard supply vessels required for the submarine assembly process and provides lateral structural support for the new building/pier infrastructure. Shoreline stabilization activities are expected to be completed in the following sequence:

- Removal of bedrock using blasting methods.
- Install sheet pile bulkhead within existing riprap shoreline within Developed Shorefront resource area. Sheet piles to be placed in shallow Nearshore Waters using a crane mounted with vibratory hammer and/or oscillating drill equipment.
- Dewater bulkhead impoundment by pumping and discharging into a settling basin or other confined structure to allow settling-out of suspended sediments prior to discharge into Thames River.
- Install fill between bulkhead and shore and complete grading behind bulkhead.

Drilled Shaft Installation

The FMP requires waterward expansion of building/pier infrastructure to support the evolution of submarine building at the EB facility. Expansion over the Nearshore Waters resource is necessary due to the water dependent nature of the infrastructure and significant spatial limitations that currently exist in terrestrial areas of the South Yard Project Area. The over-water portions of the proposed building/pier infrastructure will be supported by drilled shafts that will be founded on bedrock below the substrate. Additional drilled shafts founded in bedrock will be required for vessel berthing. There will be a total of approximately 450 drilled shafts (3 ft to 4 ft in diameter); it is expected that drilled shafts for building/pier infrastructure will be spaced approximately 20 to 25 ft on center. Drilled shafts are anticipated to be installed according to the following construction sequence:

- Drill shafts through river substrates into bedrock using an oscillating drill from barge-mounted (offshore locations) and land-based (nearshore locations upon bulkhead installation) drilling equipment
- Remove sediment from shafts using auger, mechanical and/or hydraulic dredge methods.
- Dispose of sediment via placement as fill behind the proposed bulkhead and/or other approved locations.
- Place structural steel in shafts and fill with concrete.

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Access Road Creation

The creation of a permanent access road in the South Yard Project Area will be required for site egress, supply chain, and equipment movement purposes. The access road will be needed to support proposed FMP construction activities and for facility operations following construction. The alignment of the access road will require the three wetlands present in the southern extent of the South Yard Project Area to be permanently filled.

The proposed shoreline stabilization, drilled shaft installation, and creation of the access road will impact the following regulated coastal resources:

Developed Shorefront

Developed Shorefront coastal resource is defined as harbor areas that have been highly engineered and developed, resulting in functional impairment or substantial alteration of their natural physiographic features or systems. The existing Developed Shorefront in the South Yard area below the Coastal Jurisdiction Line (CJL) consists primarily of a steeply sloped intertidal and subtidal shoreline constructed of rock riprap (see descriptions and photos in Attachment A). The South Yard Project Area contains approximately 1,300 linear ft of Developed Shorefront; of which approximately 1,250 linear ft will be affected by shoreline stabilization activities (bulkhead installation and rip repair/maintenance).

Nearshore Waters

Nearshore Waters are defined in the CGS Chapter 444 as waters and substrates lying between mean high water and the approximate -10 meter (m)/ -33 ft contour (relative to mean low water). This is equivalent to a vertical elevation of approximately -31 ft in the North American Vertical Datum of 1988 (NAVD88). Water depths throughout the overwhelming majority of the South Yard Project Area are below the threshold for Nearshore Waters except where noted. Approximately 2,910 sq ft of intertidal and shallow subtidal habitats in the Nearshore Waters resource of the Thames River will be permanently filled by the proposed bulkheads. Approximately 7,079 sq ft of additional subtidal Nearshore Waters will be permanently filled by the proposed installation of the drilled shafts for building/pier and vessel berthing infrastructure.

As detailed in Attachment A, abundant species in the upper intertidal areas included green algae (*Prasiola stipitata*) and cyanobacteria (*Calothrix* sp) which formed a film on the rocky substrate. In addition, the mid and low intertidal zone support rockweed (*Fucus vesiculosus*), sea lettuce (*Ulva lactuca*), green algae (*Enteromorpha clathrata*), knotted wrack (*Ascophyllum nodosum*), dulse (*Palmaria palmata*), crustose coralline algae (Corallinales), yellow encrusting sponge (Porifera), hydroid (Hydroida), and sea lace (Bryozoa). These habitats are commonly inhabited by blue mussels (*Mytilus edulis*), northern rock barnacle (*Semibalanus balanoides*), common periwinkle (*Littorina littorea*), Eastern mud snail (*Tritia obsoleta*), and oyster drill (*Urosalpinx cinerea*).

The shallow (e.g., \leq -6 ft NAVD88) subtidal areas to be impacted by these activities are characterized by nearly vertical submerged riprap that terminates into more horizontal river bottom habitats that are generally homogenous and comprised of fine grained sediments. The hard, nearly vertical substrates are covered by a dense and diverse assemblage of green and red algae including sea lettuce, green algae, dulse, Irish moss (*Chondrus crispus*), laver (*Porphyra* sp.), and crustose coralline algae. Macroinvertebrates detected from underwater video in the shallow subtidal zone included hydroids, sea lice, and slipper snail (*Crepidula*

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adunca). The fine grained, habitat located at the toe of the riprap is generally devoid of flora but demonstrated sporadic mats of green algae (Attachment A).

Habitat characteristics in the deeper (e.g. -7 ft to -31 ft NAVD88) subtidal portions of the South Yard Project Area are based primarily on recent side scan imagery and results from ongoing geotechnical explorations. Underwater imagery indicates that surficial habitats in this area are generally homogenous and offer little to no natural bottom relief beyond anthropogenic features shown on side-scan signatures such as lobster/whelk traps, unidentified and miscellaneous debris, tires, and various anchoring structures. Sediment grain size throughout the deeper subtidal habitats are comprised of fine grained sediments that are occasionally comingled with shell hash.

Shellfish Concentration Areas

Portions of habitats in the South Yard Project Area in the Nearshore Waters are designated by the CTDEEP as a concentration area for the hard clam (*Mercenaria mercenaria*). This species as well as other non-commercial macroinvertebrates were detected in these habitats as described in Attachment A. Furthermore, the harvest of shellfish in the South Yard Project Area and in much of New London Harbor is prohibited due to potential for public health risks (CTDEEP 2013), and no recreational or commercial fishing for this species occurs in this location due to the established security zone (Figure 2).

Freshwater Wetlands and Watercourses

The permanent access road will be located in the southern extent of the South Yard Project Area. Existing habitats that will be impacted within the access road alignment include three individual wetlands that encompass a total area of approximately 1,750 sq ft (Figure 1). As described in Attachment A, a delineation was completed in these areas on August 28, 2017 that concluded the three wetlands meet the U.S. Army Corps of Engineers (USACE) definition of a Waters of the United States and are consistent with the definition provided in CGS Chapter 440 Wetlands and Watercourses, Section 22a-38.

Coastal Hazard Areas

Coastal Hazard Areas are land areas that are inundated during coastal storm events or subject to erosion induced by such events, including flood hazard areas as defined and determined by the National Flood Insurance Act. Terrestrial areas in the South Yard Project Area are identified in Flood Insurance Rate Maps 0502J and 0504J and are currently occupied by existing infrastructure and impervious surfaces that are expected to be modified as part of the proposed FMP activities.

ACTIVITY 2 – CONSTRUCTION OF IN-WATER STRUCTURES

The over-water portions of the building/pier infrastructure will be supported by the drilled shafts and will overshadow approximately 180,000 sq ft of Nearshore Waters and associated benthic habitats (Figure 2). The concrete deck for the proposed building and pier infrastructure will be approximately 3-feet in depth and will be installed incrementally in sections as the drilled shafts are installed. Concrete for the deck sections will be pumped from land (landward sections) and barge based (riverward sections) equipment.

The floating dry dock will consist of an approximately 95,000 sq ft structure that draws approximately 18 ft of water in the resting position located along the shoreline. The dry dock will be constructed off-

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site and delivered to the South Yard Project Area for the sole purpose of launching fully assembled submarines. Submarine launching will require that the floating dry dock move from its resting position along the Thames River shoreline to the submersion basin (Figure 2) for a period of approximately one month per year until the launch is completed. The dry dock will remain tethered while in the launching and resting position.

Based on conversations with CTDEEP and USACE shading impacts resulting from the project do not apply to areas that first need to be dredged. These include the resting position of the floating dry dock (proposed for dredging to -22 ft NAVD88) and approximately 40,000 sq ft along the south facing perimeter of the building/pier infrastructure (Figure 2). As such, the shading discussion provided below is only applicable to 140,000 sq ft of over-water building/pier footprint that is not anticipated to be dredged and will be permanently shaded by the concrete deck.

Shading Effects Discussion

The effects of large, pile supported structures on fishes and other aquatic organisms have been well-studied, most notably in New York Harbor within the Hudson River Estuary (Able et al. 1998, 1999, 2013; Able and Duffy-Anderson 2005; Duffy-Anderson and Able 1999; Grothues and Able 2010; Grothues et al. 2016; Metzger et al. 1999, 2001; Munch et al. 2017). The New York Harbor area is presumed to exhibit estuarine conditions similar to those found in the urban, developed shorelines of the Thames River where the proposed project is located.

Most of the fish species observed in the shallow water areas of the Hudson River estuary during the pier studies were juvenile and young-of-the-year (YOY) individuals, which are life stages commonly found in Northeastern estuarine habitats. Species commonly detected in the Hudson River estuarine system included striped bass (*Morone saxatilis*), Atlantic tomcod (*Microgadus tomcod*), black sea bass (*Centropristis striata*), cunner (*Tautoglabrus adspersus*), winter flounder (*Pseudopleuronectes americanus*), northern pipefish (*Syngnathus fucus*), Atlantic menhaden (*Brevoortia tyrannus*), naked goby (*Gobiosoma bosc*), and spotted hake (*Urophycis regia*) (Able and Duffy-Anderson 2005, Grothues et al. 2016). Many of these species are commonly observed in the Thames River estuary (see Attachment A).

Able et al. (1998) found that Atlantic tomcod and winter flounder dominated early summer species assemblage in their study sites in shallow open water, pile field, and under-pier areas, while YOY striped bass were more common in the late summer season at the study sites. YOY fishes dominated collections at pile field and open water sites, where abundance and species richness were high. Fish abundance and species richness were typically low under piers, with only rare occurrences of YOY life stages. American eels (*Anguilla rostrata*) were the most common in catch under piers, with contrasting results at the other two site types. The only species of fish routinely caught under piers were those that do not rely solely on vision to forage, including Atlantic tomcod, American eel, and naked goby. Able and Duffy-Anderson (2005) believed that the majority of fish species collected under large piers are only transient or accidental visitors and that typical inhabitants of these areas are macroinvertebrates species and select fish species that do not primarily rely on visual cues for foraging.

While schools of smaller pelagic fish species such as Atlantic silverside (*Menidia menidia*), bay anchovy (*Anchoa mitchilli*), and alewife (*Alosa pseudoharengus*) were generally most abundant in open water areas during the day, large congregations of these forage species were also detected at the edge or under large pier structures during nocturnal periods, and to a lesser extent during the day. This was demonstrated in a 2009–2010 study using sonar detection at a 22-acre square pier (Pier #40) in Manhattan, NY (Able et al. 1998; Able et al. 2013; Able and Duffy-Anderson 2005).

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The effects of piers on fishes, invertebrates, and aquatic habitats beneath piers appear to be primarily related to intense² and constant shading by the decking or platforms. Other variables such as water circulation/reduced flow, sedimentation, temperatures, and dissolved oxygen that could be affected by the installation and placement of large piers have not been identified as significant factors. Researchers studying the effects of larger piers in the Hudson River estuary have evaluated how species distribution and abundance and feeding and growth can vary according to four general locations associated with a given pier. More specifically, the research generally grouped organism behavior and habitat response according to under-pier, pier edge, pile field³, and open water areas as described below.

Grothues et al. (2016) found that the relative abundance of small pelagic fish species was generally consistent between open water and along pier edges; however, abundance of these species was comparatively lower in the under-pier areas. Other researchers suggest that abundance and diversity of small pelagic species is generally lower under large piers compared to pier edge, pile field, and open water habitats (Able and Duffy-Anderson 2005; Grothues et al. 2016; Munch et al. 2017). This trend appears to hold true during daylight as well as during nocturnal periods in industrialized and urban areas where there is artificial light. Though uncommon, larger (i.e., 25 – 850 cm) pelagic fish species were slightly more abundant in open water and were common under the pier within 15 to 20 ft of the edge where there is ambient light penetration.

The most dramatic under-pier and pier-edge effects were observed with larger predatory fish species, particularly striped bass and bluefish (*Pomatomus saltatrix*), that likely utilize the shade provided in pier-edge areas (up to 20 ft from the edge) to ambush prey that were observed to be abundant in the edge areas and the open water habitats immediately adjacent. Most large predatory fish were found in pier-edge and under-pier areas during dawn, dusk, and nocturnal periods (Grothues et al. 2016). Grothues and Able (2010) suggest that some small pelagic fish/prey species may use pier-edge areas as a surrogate shoreline in industrialized areas.

In a 2-year study at a 20+-acre municipal pier, Duffy-Anderson and Able (2001) found that feeding intensity of visual foraging species such as YOY winter flounder and tautog (*Tautoga onitis*) was significantly higher in open water areas compared to pier edge or under-pier habitats. Duffy-Anderson and Able (1999) observed low or negative growth rates for caged winter flounder and tautog under large piers as compared to positive growth rates in open water and pier edge stations. The same feeding trend was not observed for non-visual predators such as YOY Atlantic tomcod which exhibited similar growth rates in open water, pier-edge, and under-pier areas up to 120 ft from the pier edge. The authors suggest that YOY tomcod and other non-visual predators may be able to exploit the under-pier habitats, even though they may be suboptimal.

Duffy-Anderson and Able (1999) collected three species of decapod crustacean in the Hudson River study area, including blue crab (*Callinectes sapidus*), grass shrimp (*Palaeomonetes pugio*), and sand shrimp (*Crangon septemspinosa*). The mean decapod capture per unit effort (CPUE) was higher at pier edge and open water sites compared to under-pier areas. However, Able and Duffy-Anderson (2005) found the abundance of decapod crustaceans to be high across all pier habitat types, and concluded that, unlike the results for fishes where under-pile abundances were clearly depressed, decapods were capable of utilizing all the habitats, including under-pier areas.

² As found under large piers, unlike more minor shading cast by buildings adjacent to the river.

³ Pile fields consist of upright pilings from old piers where the decks had been removed. These areas represent habitats where pilings provide the artificial vertical structure and flow circulation effect of piers without the intense shading.

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Grothues et al. (2016) indicated the large (i.e., several acres or more in size) urban piers can degrade habitat value for estuarine benthic fish. Munch et al. (2017) believe that overwater structures and shading generally reduces total fish abundance (prey and predator), and that intensely dark aquatic environments reduce habitat value by impairing fishes' visual tasks, reducing prey availability, and reducing habitat connectivity along shorelines. The relevant literature reviewed consistently identifies extreme shading as a principal factor in limiting fish abundance and distribution under large urban, pile-supported structures; however, effects along the edges of these structures appear to be guild-specific and related to feeding behavior and life history characteristics. Able et al. (2013) assume that the most dramatic negative responses to piers are due to the role that vision plays, even in turbid estuary waters. Their study found that light regimes differed according to depth and pier orientation (i.e., shade effects differed on each side). Able et al. (1998) found that light intensity levels in open and pile-field sites were $>566 \mu\text{m}^{-2} \text{s}^{-1}$ at 0.5 m depths and $>9 \mu\text{m}^{-2} \text{s}^{-1}$ on the bottom, whereas levels under the piers were $<0.12 \mu\text{m}^{-2} \text{s}^{-1}$ throughout the water column.

To summarize, some of the more relevant research findings related to the shading effects of pier are:

- Fish abundance and diversity for YOY life stages are typically lower under piers than in pier-edge or more open shallow water habitats;
- For some fish species, such as winter flounder and tautog that are visual predators, shaded under-pier environments appear to cause low or negative growth rates as compared to pier-edge and open water conditions, possibly due to effects on foraging success;
- Other species such as Atlantic tomcod, naked goby, and American eel are more likely to inhabit under-pier environments because they do not rely solely on vision for foraging and prey detection. These species exhibited similar growth rates in open water, pier-edge, and under-pier areas up to 120 ft from the pier edge;
- Pelagic schooling fish utilize the pier-edge and under-pier environments. Large schools have been found to travel under the interior portions of large (20+ acre) piers, but typically are more abundant in the pier-edge and open habitats;
- Larger pelagic and predatory species such as striped bass and bluefish utilized the partially-shaded areas at pier edges, with highest abundance up to 15 ft under the pier and declining with further distance under the pier. Use of pier edge areas may be a prey ambush strategy; and
- Shading does not appear to negatively affect the abundance of less mobile, non-fish species (macroinvertebrates and shellfish) living in under-pier environments to the same extent as finfish.

While interior portions of the building/pier infrastructure in the South Yard Project Area will shade the regulated coastal resources described below, there is some degree of uncertainty when quantifying the effects on fishes and benthic life. As the literature suggests, the actual impacts of shading on mobile finfish species should be evaluated on a site-specific basis and consider factors such as the pre-construction habitat quality, water clarity, water depth and the building/pier/dry dock orientation in relation to sunlight. The proposed infrastructure and resulting shading will affect the following regulated coastal resources:

Nearshore Waters

Approximately 140,000 sq ft of Nearshore Waters resources will be covered by the interior (non-dredged) portions of the concrete decking for the building/pier infrastructure. The effects on

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finfish due to permanent shading of Nearshore Waters resources caused by the interior portions of the proposed over-water structures is complex. Some shifts in fish abundance and diversity in shaded environments is expected. There may be an increase in both small pelagic fish and larger predatory species in the pier-edge areas, with a reduced level of use in interior under-pier areas, particularly by fish that rely on visual cues.

It is important to note that while shading does have a strong negative impact on submerged aquatic vegetation (SAV) such as eelgrass (*Zostera marina*), no SAV was detected within the proposed building/pier footprint (Figure 2). Drilled shafts in the shaded portion of the pier and building footprint that is not being dredged will contain numerous vertical surfaces for colonization by marine organisms.

Shellfish Concentration Areas

A portion of the interior (non-dredged) existing habitats that will be permanently shaded by the proposed over-water structures are designated by the CTDEEP as a concentration area for the hard clam (*Mercenaria mercenaria*). While this species as well as other non-commercial macroinvertebrates were detected in these habitats (Attachment A), the literature suggests that shading effects to sedentary benthic invertebrate species are likely to be minimal. Furthermore, the harvest of shellfish in the South Yard Project Area and in much of New London Harbor is prohibited due to potential for public health risks (CTDEEP 2013), and no recreational or commercial fishing for this species occurs in this location due to the established security zone (Figure 2).

ACTIVITY 3 – DREDGING

Dredging of Nearshore and Offshore Waters in the South Yard Project Area is necessary to support FMP activities. Dredging will be completed primarily by mechanical methods and will occur within a footprint that encompasses approximately 923,250 sq ft (Figure 2) and will be completed utilizing Best Management Practices (BMPs) to minimize adverse impacts to aquatic species. The total estimated dredge volume (including sediment removed from drilled shafts) is approximately 996,000 cy (including 2 ft over-dredge), most of which is expected to be suitable for offshore disposal. Dredging is being completed for the following purposes:

- Dredging to a controlling elevation of -22 ft NAVD88 for vessel berthing of floating dry dock in the resting position along the shoreline and sea shuttle along western side of proposed building/pier infrastructure in the Nearshore Waters resource. Existing water depths in this area range from -12 ft to -18 ft NAVD88.
- Dredging to a controlling elevation of -42 ft NAVD88 for vessel egress associated with the dry dock submersion basin. Existing water depths in this area range from -18 ft to -42 ft NAVD88. This will occur primarily in a Nearshore Waters resource, though a small proportion of Offshore Waters are present immediately adjacent to the navigation channel.
- Creation of a deep submersion basin for the floating dry dock to launch submarines. This will require dredging to a controlling depth of -87 ft NAVD88 to accommodate the footprint of the floating dry dock with an assumed 3.5:1 side slope. Existing water depths in this area range from -16 ft to -42 ft NAVD88.

The proposed dredging will affect Nearshore Waters, Offshore Waters, and a Shellfish Concentration Area as described below:

Vessel berthing and movement areas: The differences between existing depths and the proposed -22 ft and -42 ft (NAVD88) controlling dredge depths required for the vessel

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movement and berthing areas are generally consistent with those associated with conventional navigation improvement, maintenance, or modification projects. Dredging in the proposed vessel berthing and movement areas will temporarily impact Nearshore and Offshore Waters, and Shellfish Concentration Areas due to removal of substrate and the associated organisms. There will also be temporary impacts to water quality and fisheries due to sedimentation and turbidity consistent with unconfined dredging.

Turbidity in the water column would remain high during active dredging but will quickly return to baseline conditions once the dredging is completed. Additional detail regarding the dredge-related turbidity levels are described by the hydrodynamic model that was developed for the project and included as Attachment M3 to the CTDEEP permit application.

As is typical of shallow dredging projects, the upper layer of existing substrate and the benthic organisms it supports will be removed, but re-colonization of the benthic invertebrate community is expected to occur at the new depths. The dredging footprint does not overlap with established SAV resources (eelgrass) that were detected in the South Yard Project Area (Attachment A, Figure 2)

Benthic and pelagic fish species inhabiting the South Yard Project Area will be temporarily displaced during shallow dredging but would be expected to return to these areas post dredging. The return of benthic feeders will likely coincide with the recolonization of the dredge areas by macroinvertebrates.

In summary, benthic habitats in the vessel berthing and movement areas will be temporarily disrupted during dredging but are expected to recover. The USACE (New York District) completed a monitoring program from 2005 to 2012 to assess re-colonization of macroinvertebrates following maintenance and improvement dredging activity in four large New York and New Jersey navigational channels (USACE 2013). Monitoring was completed prior to dredging and approximately one to two and a half years following maintenance and improvement dredging in all areas. Results indicated rapid recolonization by opportunistic and prolific reproductive species one-year post-disturbance; the species composition transitioned to a more stable community that provides trophic support and is indicative of pre-disturbance conditions thereafter (USACE 2013).

Although the effects of the new dredged depths in the vessel berthing and movement areas may temporarily change the species composition, abundance, and habitat use as compared to baseline conditions, the post-dredge benthic habitats are expected to exhibit characteristics that are consistent with the Thames River Navigational Channel and other areas at the EB facility which are routinely dredged to the depths similar to those being proposed.

Floating dry dock basin: The proposed floating dry dock requires water depths of -87 ft NAVD88 for the launching of fully assembled submarines. Existing depths in the area proposed for the floating dry dock basin range from -16 ft to -42 ft NAVD88; approximately -14 ft to -40 ft mean low water (MLW). The basin will have a flat floor and 3.5:1 side slopes. Like other proposed dredging areas in the South Yard Project Area, the existing substrate and its benthic community will be removed. However, due the relatively significant changes in depth required for the dry dock submersion basin compared to other dredge areas (vessel berthing and movement) in the South Yard Project Area, there is the potential for additional and/or permanent effects to the benthic community due to changes in water circulation, dissolved oxygen (DO), and other water quality parameters.

ELECTRIC BOAT CORPORATION, GROTON FACILITY SOUTH YARD, NATURAL RESOURCES EVALUATION AND EFFECTS

To investigate post-construction conditions in the dry dock submersion basin, a hydrodynamic model of the South Yard Project Area that includes the basin and other vessel berthing and movement dredge areas was developed using the Delft3D software package. A general summary of the model development and preliminary output is described herein and a technical report describing the modeling efforts completed in support of the project is provided as Attachment M3 to the CTDEEP permit application.

The findings of the hydrodynamic investigation indicate that post-construction conditions in the dry dock submersion basin will have minimal influence on water quality. Water particle hydraulic residence time was used as a proxy to quantify the potential changes in circulation and mixing relative to the existing and proposed conditions. Changes in flow velocities and hydraulic residence times under the post-construction condition were computed during spring and neap tidal cycles under high and low riverine flow conditions. Results show that the presence of the deep dry dock submersion basin elongates the hydraulic residence time on the order of a couple of hours. While there is a small potential (1 out of the total 51,480 particles simulated) for a particle to remain in the dry dock submersion basin longer than 48 hours, those particles that may remain for a longer period would be surrounded by and mixing with particles with much less residence time, allowing a transfer of oxygen from the particles of short residence time into the particles with the relatively longer residence time. Considering that changes in hydraulic residence time in the deepest portions of the dry dock submersion basin are on the order of hours across 90% of the footprint, the effect of post-construction conditions to oxygen levels is identified as minimal and temporary.

SUMMARY OF RESOURCE EFFECTS

Elements of the FMP in the South Yard Project Area include activities such as the permanent filling and the temporary dredge impacts associated with vessel berthing and movement whose impacts, from a regulatory perspective, are clearly defined. The primary purpose of this report was to assess the potential impacts associated with overshadowing and construction of the dry dock basin which are highly contingent upon site specific conditions.

Preliminary hydrodynamic model output demonstrated that stagnation will not occur in the deepest portions of the dry dock basin and that post-construction vertical mixing and water velocities will occur at a level that is generally consistent with existing conditions. The assessment of overshadowing effects within the interior portions of pier and building footprint (i.e. those not proposed for dredging) are based on available information and need to be interpreted within the context of the existing habitat value and functions in the affected area. Based on the findings of recent baseline ecological studies in the South Yard Project Area, the habitats that will be impacted by shoreline stabilization, drilled shaft installation, and concrete deck placement (overshadowing) support species that are common inhabitants among Developed Shorefronts in large estuarine systems. While the natural bedrock shorelines located in the southernmost extent of the South Yard Project Area did contain eelgrass habitats and were utilized frequently by shorebirds, these habitats are not expected to be directly impacted. As such no impacts to unique assemblages of aquatic species are expected as a result from FMP activities in the South Yard Project Area.

As it pertains to terrestrial wildlife, shoreline stabilization will require removal of the narrow (15 to 20 ft) strip of vegetation between the Developed Shorefront and the storage yard. This vegetation likely provides little habitat value due to the current industrial uses occurring immediately adjacent. Similarly, the increased noise, water turbidity, vessel traffic, and overall human presence generally associated with dredging and construction activities will likely displace wildlife resources such as shorebirds and waterfowl on a temporary basis.

ELECTRIC BOAT CORPORATION, GROTON FACILITY SOUTH YARD, NATURAL RESOURCES EVALUATION AND EFFECTS

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AND EFFECTS**

**ATTACHMENT A ECOLOGICAL BASELINE CHARACTERIZATION
REPORT**

**Ecological Baseline Characterization
Electric Boat South Yard Project**

Groton, Connecticut



Prepared for:
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May 15, 2018

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LIST OF ATTACHMENTS

Attachment 1 Benthic Macroinvertebrate Taxonomy Results

Attachment 2 Intertidal and Shallow Subtidal Photo Log

Attachment 3 Wetland and Watercourse Photo Log

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1.0 PROJECT DESCRIPTION AND PURPOSE

Electric Boat Corporation (EB) owns and operates a shipbuilding facility along approximately 4,500 linear feet (ft) of Thames River shoreline in Groton, Connecticut. The facility has been the site of ship and submarine construction, maintenance, and overhauling activity since the early 1900s. To facilitate these shipbuilding activities, shoreline areas were extensively filled and altered between the 1920s and 1970s. EB is proposing to expand portions of the Groton facility (EB facility) as part of the Facility Master Plan (FMP) to accommodate construction and deployment of a new class of submarines for the U.S. Navy, a project that is considered vital to national security. In-water construction activity associated with the FMP is anticipated to occur in the southern portions of the facility (i.e., the South Yard Project Area).

The objective of this Ecological Baseline Characterization report is to describe baseline (pre-construction) conditions in the Thames River and the South Yard Project Area using available and representative existing information and present the results of the ecological field studies that were completed by Stantec Consulting Services Inc. (Stantec) in 2017. The data presented herein are used to evaluate potential risk to regulated natural resources associated with the proposed South Yard Project Area activities and to inform potential compensatory mitigation requirements for unavoidable impacts. The locations of the proposed in-water facility modifications are depicted in Figure 1, and includes:

- Stabilization and/or bulkhead installation along approximately 1,250 linear feet (ft) of the Thames River shoreline that includes a footprint of permanent coastal fill totaling approximately 2,910 square feet (sq ft) for bulkhead installation, temporary effects associated with riprap repair within a 11,050 sq ft footprint, and removal of approximately 22,000 square feet (sq ft) of submerged bedrock;
- Installation of drilled shafts to support over-water building/pier infrastructure and dolphins and anchoring structures for vessel berthing with a footprint of permanent coastal fill totaling approximately 7,079 sq ft with an estimated 12,000 cubic yards (cy) of sediment removal;
- Creation of an access road that includes permanent fill of jurisdictional wetlands (1,750 sq ft);
- Construction of an assembly building/pier infrastructure that extends approximately 180,000 sq ft over the Thames River; and
- Dredging of an estimated 984,000 cy of sediment, including 2 ft over-dredge, within a footprint of approximately 923,250 sq ft to allow for the floating dry dock submersion basin, berthing for support and transport vessels, and staging of a floating dry dock.

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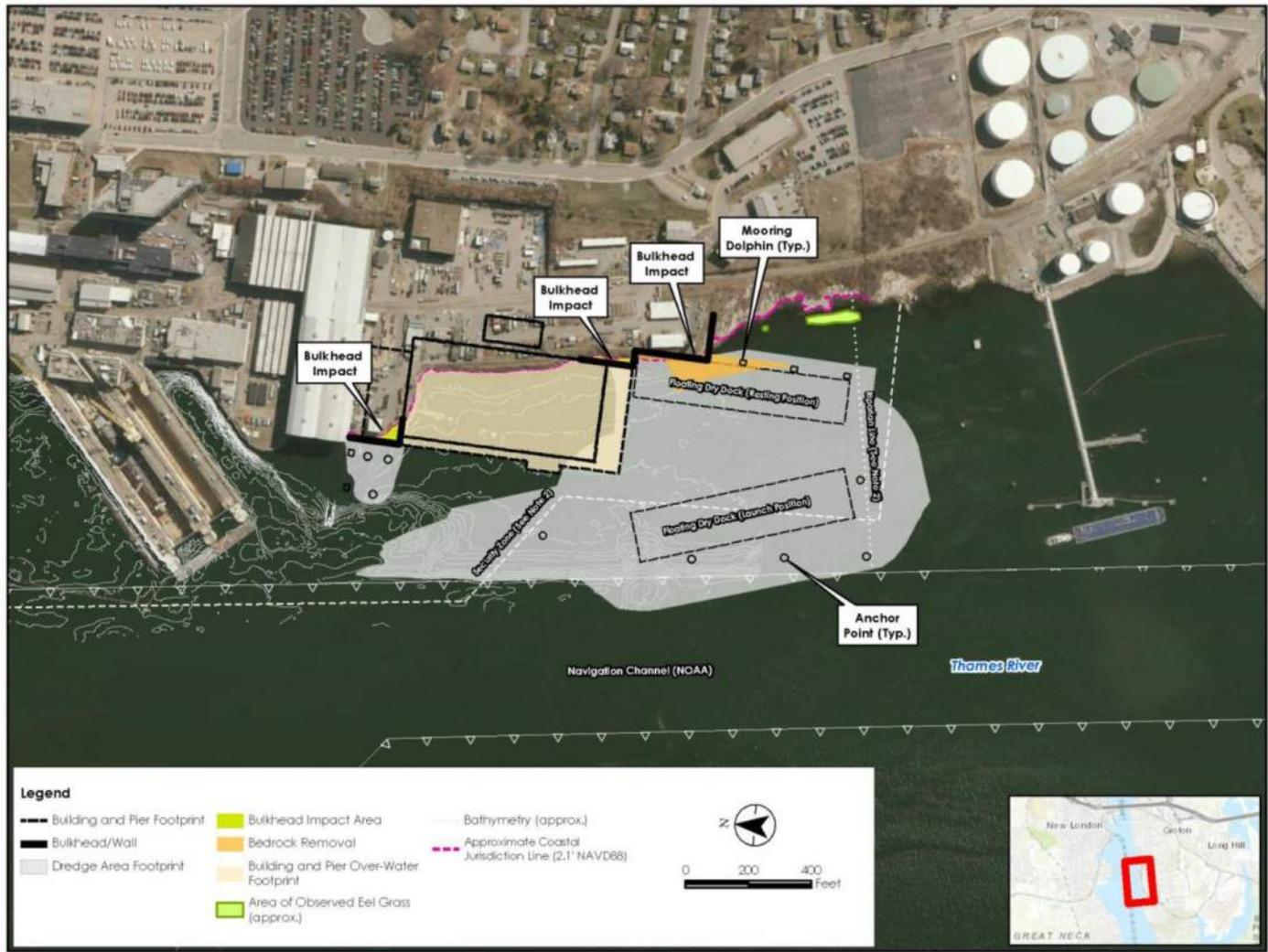


Figure 1. In-water FMP activities in the South Yard Project Area

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2.0 THAMES RIVER

The Thames River is a tidal estuary that extends from the confluence of the Yantic and Shetucket rivers in Norwich south to where it drains into Long Island Sound. The Thames River is tidally influenced throughout its entire 15-mile length and ranges in width from 1,300 ft to 1.5 miles. The Thames River federal navigational channel is maintained to -40 ft mean low water (MLW) and is approximately 160 ft wide adjacent to the EB facility. The navigational channel enables passage of submarines to and from the EB facility and the Naval Submarine Base New London (SUBASE-NLON), which is located approximately 2.5 miles upstream. The river and the navigational channel are also well traveled by commercial and recreational vessels utilizing several public, private, and commercial docking and mooring facilities and terminals, located primarily in New London and Groton.

The Thames is a typical estuarine system, with freshwater entering from tributaries and runoff and saltwater entering from Long Island Sound. The mean tidal range in the general vicinity of the EB facility is 2.6 ft with a spring tidal range of 3.1 ft. Due to the relatively small size of the Thames River tributaries, the volume of saltwater in the estuary is relatively large compared to freshwater contributions. The average tidal velocity between the SUBASE-NLON and the mouth of the Thames River is estimated at approximately 1 ft per second (ft/sec) but shows considerable variation based on location, depth, and tide direction (Woodard & Curran 2014). Estimates for freshwater and saltwater flushing times for the Thames River have been calculated at 0.5 to 2 days near the surface and 19 days in deeper areas of the estuary (Woodard & Curran 2014).

The Thames River has been classified by the Connecticut Department of Energy and Environment (CTDEEP) as a Class SB coastal and marine water body (CTDEEP 2011). Designated uses for Class SB waters include habitat for marine fish and other aquatic life, commercial fishing and harvesting, recreation, industrial water supply, and navigation (CTDEEP 2013). In addition to direct runoff, the river receives both storm water and treated effluent from industrial discharges and public water treatment facilities. Treated sewage from the City of Groton discharges to the river north (upriver) of the EB facility, while the Town of Groton's primary sewage treatment facility discharges to the south (downriver) of the EB facility.

3.0 AFFECTED NATURAL RESOURCES AND HABITATS

The baseline characteristics of natural resources and habitats that could be affected by construction activity in the South Yard Project Area were compiled using existing and representative information, where available, and supplemented with field surveys that were completed by Stantec from August 28 to October 27, 2017. Sources of existing site specific and Thames River natural resource data include historical sediment data from Resource Conservation and Recovery Act (RCRA) investigations at the EB facility; geotechnical, bathymetric, and side-scan sonar surveys from the South Yard Project Area; United States Coast Guard Academy (USCGA) fisheries surveys in the Thames River; and a comprehensive

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ecological survey program that was recently completed at the SUBASE-NLON by Tetra Tech (2016).

Review of this available information indicated that supplemental field surveys would be needed to sufficiently characterize baseline conditions of certain site-specific resources and habitats. These supplemental field surveys included assessments of benthic macroinvertebrates, shoreline and intertidal habitats, presence of wetlands and watercourses, and shorebird use in the South Yard Project Area. Stantec provided the CTDEEP with a work plan that outlined the methodology of these proposed field surveys on August 9, 2017. CTDEEP¹ reviewed and approved Stantec work plan on August 18, 2017, also indicating that the sampling of finfish done by others (i.e., Tetra Tech and the USCGA) in the area is representative of the fish assemblage local to the South Yard Project Area. The results of the field surveys and summaries of the existing information utilized to describe baseline conditions of resources and habitats that could be affected by construction activities in the South Yard Project Area are described below. Where appropriate, coastal habitats and resources follow the nomenclature of Connecticut General Statutes (CGS), Chapter 444 Coastal Management, Section 22a-93 Definitions.

3.1 NEARSHORE AND OFFSHORE WATERS

The South Yard Project Area encompasses approximately 30 acres of primarily Nearshore Waters, which are defined by Connecticut CGS Chapter 444 as intertidal and subtidal waters and substrates lying between mean high water and the -10 meter (m)/ -33 ft contour (relative to mean low water MLW). This is equivalent to a vertical elevation of approximately -31 ft in the North American Vertical Datum of 1988 (NAVD88). Offshore Waters, defined in Connecticut CGS Chapter 444 as waters and their substrates lying seaward of (i.e., deeper than) the -10-meter depth contour, are limited to the areas of the South Yard Project Area directly adjacent to the navigational channel. EB has conducted numerous facility-wide surveys to document and describe surficial habitats in support of routine maintenance dredge activity. A hydrographic survey focused in the South Yard Project Area was completed in October 2017 to characterize bathymetry and surficial substrates using multibeam echo sounder equipment.

The bathymetric data indicate the river bottom deepens abruptly within the first 100-ft west of the shoreline, then includes a gentle sloping gradient to approximately -26 ft NAVD88, followed by an increasing slope in areas directly adjacent to the navigational channel. Recent geotechnical investigations indicate that depth to bedrock in the South Yard Project Area ranges from -20 ft NAVD88 immediately adjacent to the shoreline to greater than -100 ft NAVD88 in the portions adjacent to the navigational channel. The sediments overlying bedrock are generally consistent throughout and characterized as organic silts with greater than 80% fines.

The 2017 hydrographic survey was completed throughout the South Yard Project Area using an R2 Sonic 2024 Multibeam Echosounder and indicate that surficial habitats are generally homogenous and offer little to no natural bottom relief beyond the boulders located in the shallowest shoreline environments. There were anthropogenic side-scan signatures detected in

¹ David Ellis, CTDEEP

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the South Yard Project Area, including lobster/whelk traps, unidentified and miscellaneous debris, tires, and various anchoring structures such as dolphins and pilings.

The data from these surveys suggest that the nearshore waters habitats in the South Yard Project Area are devoid of complex heterogeneous habitats, offer minimal bottom relief, and are composed of fine grained material. Similar surveys completed at the SUBASE-NLON in 2014 and 2015 also characterized nearshore waters adjacent to the facility as "very homogenous bottom habitat" (Tetra Tech, Inc. 2016).

3.2 BENTHIC MACROINVERTEBRATES

Benthic grab sampling for macroinvertebrates was conducted in nearshore waters of the South Yard Project Area on August 28, 2017. The methodologies for sample collection were consistent with protocols utilized for the recent macroinvertebrate characterizations at the SUBASE-NLON as well as historical assessments conducted at the Groton facility in support of RCRA activities.

Sediment samples to assess the benthic infaunal community were collected using a petite Ponar sampler at the 10 locations depicted in Figure 2. These locations were selected to assess existing conditions at locations expected to be impacted by in-water construction and for comparison with unaffected reference areas (sample MB-10 and historical RCRA data). At each sample location, a volume of approximately 2 liters of sediment was collected from the upper 6 inches of substrate. This target volume required multiple grab samples at each location that were composited for analysis. Each grab was examined for acceptability, with a goal of at least 50% full per grab. Upon retrieval, grab samples were visually inspected in the field and photographed, and general observations of sediment texture, odor, and color were recorded in field logs. Sediment collected for benthic community analysis was then rinsed and sieved in the field using a 500-micron (μm) mesh screen. Sieved material was then transferred to a properly labeled plastic jar containing 10% buffered formalin. Actual sample locations were recorded in the field using a handheld Global positioning system (GPS) capable of sub meter accuracy. An underwater video camera was also lowered to the bottom at each sample location to record a visual of the substrate type.

Samples were sent to Ecological Associates Inc. for sorting, enumeration, and speciation. Meiofauna such as harpacticoid copepods, nematodes, and ostracods were not sorted for benthic infaunal studies. Organisms were preliminarily enumerated and sorted into major taxonomic groups including annelids, crustaceans, mollusks, echinoderms and "others" (minor invertebrate phyla). To ensure every sample met a >90% removal of all organisms, at least 10% of sorted material from each sample underwent Quality Control by a separate taxonomist. An estimated percent sorting efficacy was calculated by dividing the number of organisms found in the original sort by the total number of organisms detected in the 10% quality assurance re-sort. Organisms found during the re-sorting process were added to those found during the initial sorting efforts.

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Figure 2. Baseline surveys completed in the South Yard Project Area

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Sorted organisms were identified to the lowest practical taxonomic level, except for oligochaetes, which were identified to Class level. A reference collection was established where at least one specimen of each taxon encountered was placed into a 1-dram vial containing 70% (or greater) ethanol. Total abundance, species richness, percent dominant taxon, true diversity, and the Simpsons Index of Diversity metrics were calculated for each sample. The benthic macroinvertebrate results from the laboratory are provided as Attachment 1. Results from samples collected in the South Yard Project Area (samples MB-1 through MB-10) are summarized in Table 1 below.

Visual and video observations at the sample locations confirmed the presence of fine grained sediments in the uppermost substrate layer. Samples taken from shallower water depths contained a greater proportion of shell hash than samples from deeper waters. Representative photographs of the sediment surface in the deep subtidal portions of the South Yard Project Area are included in Attachment 2.

Table 1. Summary of benthic macroinvertebrate sampling results in the South Yard Project Area.

Sample	Total Abundance	Species Richness	Percent Dominant Taxa	True Diversity	Simpson's Index of Diversity
MB-1	438	40	26.9	16.362	0.891
MB-2	150	25	19.3	13.619	0.899
MB-3	113	32	18.6	18.585	0.925
MB-4	299	32	38.8	10.774	0.815
MB-5	179	30	26.3	14.333	0.888
MB-6	130	20	21.5	11.330	0.886
MB-7	99	27	27.3	12.604	0.874
MB-8	565	34	32.9	9.562	0.828
MB-9	287	27	40.4	9.451	0.800
MB-10	105	27	21.9	14.210	0.895

A total of 99 taxa totaling 2,365 individuals were identified from the 10 sample locations in the South Yard Project Area. Abundance varied by sample site, with Site MB-8 having the highest abundance (565 individuals) and MB-7 having the lowest (99 individuals). Species richness ranged from a high of 40 taxa at MB-1 to a low of 20 taxa at MB-6. Site MB-3 had the lowest percent dominant taxon (18.6%) and Site MB-9 the highest (40.4%). The eight sites located in shallow (<-20 ft NAVD88) water (MB-1 through 5, 7, and 8) exhibited higher average total abundance (263) and species richness (31.4) than the three sites (MB-6, 9, and 10) located in water depths between -21 and -42 ft NAVD88 (total abundance of 174 and species richness of 24.6).



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Abundant macroinvertebrates among all the samples included the polychaetes (*Mediomastus* and *Cossura* sp.), the American slipper limpet (*Crepidula fornicate*), the Atlantic nut clam (*Nucula proxima*), and the amphipod crustacean (*Microdeutopus anomalus*). Polychaetes and molluscs were the most abundant major taxonomic group at five sites each, while an amphipod crustacean dominated a single site.

Site MB-3 had the second lowest number of individuals (113), but the highest true diversity (18.6). The reason for this is the relatively high number of taxa (32), combined with the lowest proportion of the dominant organism (18.6%) than any other site. Conversely, Site MB-9 had the lowest true diversity and Simpson's index scores due to the abundance of the Atlantic nut clam (40.4% of the total). Sites MB-4, MB-8, and MB-9 had high populations dominated by one or two species, and the nearly identical low values can be considered indistinguishable from a true diversity perspective. True diversity and Simpson's index scores were influenced by evenness of the population distribution, with populations dominated by a single species scoring a lower true diversity score than smaller populations with an even distribution of taxa.

Highly-abundant taxa detected in the South Yard Project Area are generally considered pollution-tolerant. Opportunistic polychaete species considered tolerant to pollution were found at these sites. The *Capitella* spp. and *Nephtys incisa* are tolerant of trace metals (Chang et al. 1992), and *Mediomastus* spp. are opportunistic species tolerant of impaired waters (Ingole et al. 2009). The Atlantic nut clam (*N. proxima*) can also tolerate impaired water (Chang et al. 1992). Amphipods are considered more sensitive to pollutants than polychaetes or molluscs, but *Microdeutopus* spp. are known to have a clumped abundance that often masks the effects of impaired waters (Sanz-Lazaro and Marin 2009). The first or second most abundant organism found at each of the ten locations is a pollution tolerant taxon (Chang et al. 1992).

A portion of the South Yard Project Area in the nearshore waters zone falls within an area technically designated by the CTDEEP as a shellfish concentration area for the hard clam (*Mercenaria mercenaria*). While the habitats present in the nearshore waters areas of the South Yard Project Area are consistent with those typically preferred by the hard clam (fine grained sediments and water depths to -28 ft NAVD88) and support populations of this species (Attachment 1), the harvest of shellfish in the South Yard Project Area and in much of New London Harbor is prohibited due to potential for public health risks², and no recreational or commercial fishing for this species has occurred in this location due to the established security zone (Figure 1).

² Sources: (a) State of Connecticut, Department of Energy and Environmental Protection, Shellfish (hardclam, softclam, and oysters) GIS data layer, published 1997; (b) Department of Energy and Environmental Protection, September 2013 GIS map of Shellfish Bed Classifications and Closures for the impaired segments in the New London/Groton Estuary, from the Estuary 11: New London/Groton Watershed Summary, September 2013.

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3.3 FINFISH

Historical finfish monitoring efforts by the USCGA date back to the 1974 and offer a robust time series to assess changes in species population structure and abundance (USGCA 2016). This survey has been completed annually since 1992 between August and October. The USCGA survey includes trawl and seine collection techniques that are focused in the area between the SUBASE-NLON and the Gold Star Memorial Bridge (approximately 1.5 miles upriver from the EB South Yard) as depicted in Figure 3. The survey includes trawl net samples in shallow (15–30 ft) and deep (40–50 ft) waters of the Thames River channel habitats as well as seine samples in the shallower subtidal areas.

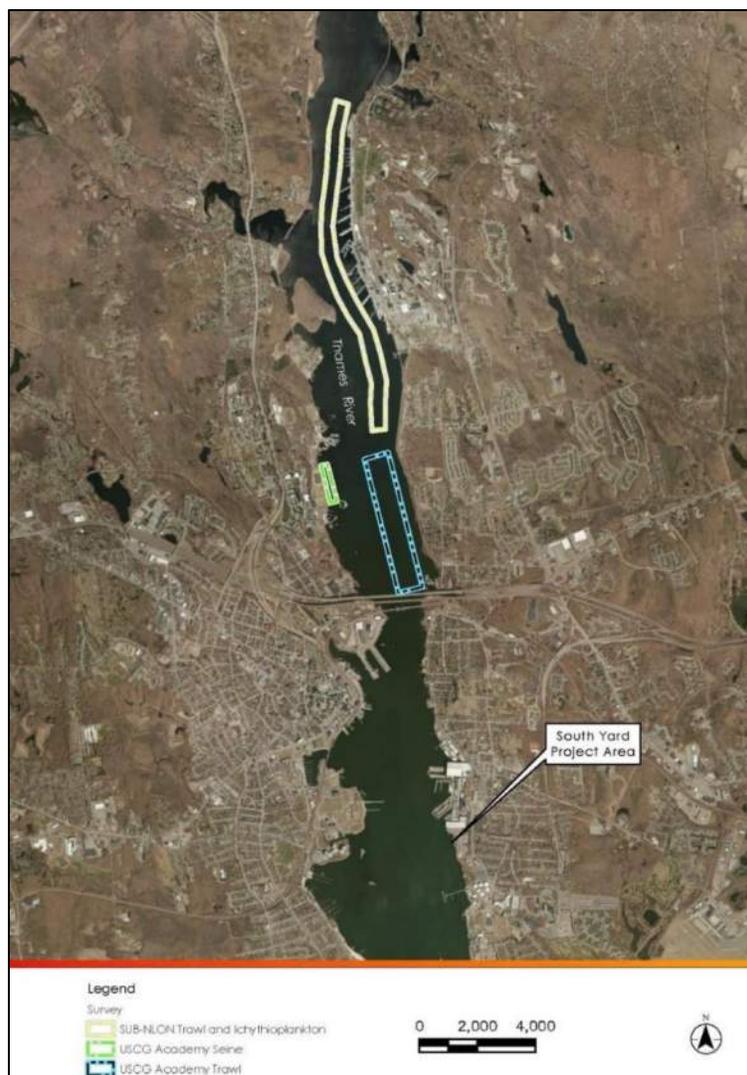


Figure 3. Fisheries monitoring programs in the Thames River

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Table 2 organizes the species detected in the USCGA surveys by guild based on ecological niche and habitat preferences.

Table 2. Fish Species Guilds Established for the USCGA Survey Data

Guild	Meaning	Species Included
CD	Cold Temperate-Demersal	Cunner, Hake (Silver), Stickleback, Tomcod
CE	Cold Temperate-Epibenthic	Fundulus-mummichog, Sculpin (Longhorn), Toadfish, Fourbeard Rockling, Flounder (Fourspot), Flounder (Windowpane), Flounder (Winter), Flounder (yellowtail), Hake (Red), Hake (White), Sculpin (Grubby), Searobin (Northern), Skate (little), Oyster Toadfish
CP	Cold Temperate-Pelagic	Mackerel (Atlantic), Alewife, Herring (Atlantic), Smelt
WD	Warm Temperate-Demersal	Gunnel, Smooth Dogfish, Silversides (tidewater), Blackfish (Tautog), Kingfish, Lizardfish, Mullet, Scup (Porgy), Seabass (Black), Sheepshead Minnow, Silversides (Atlantic), Spot, Weakfish
WE	Warm Temperate-Epibenthic	Cusk eel, Fundulus-killifish, Hake (Spotted), Pipefish, Seahorse (lined), Fundulus diaphanus (banded killifish), <i>Lucania parva</i> (rainwater killifish), Fundulus majalis (striped killifish), Hake (Spotted), Hogchoker, Northern Pipefish, Blowfish (N. Puffer), Eel (American), Flounder (Gulf Stream), Flounder (Smallmouth), Flounder (Summer), Goby, Searobin (Striped)
WP	Warm Temperate-Pelagic	Mackerel (Spanish), Anchovy, Bass (Striped), Bluefish, Butterfish, Herring (blue back), Jack (Crevalle), Menhaden, Shad
SP	Subtropic-Pelagic	Big Eye, Lookdown, Moonfish
SD	Subtropic-Demersal	Banded Rudderfish

3.3.1 USCGA Seines

The percentage of finfish by guilds captured in USCGA seines from August to October 1992–2015 are summarized in Figure 4. Warm temperate demersal (WD) species ranged from 44% to 61% of species observed during this time, with Atlantic silverside (*Menidia menidia*) and spot (*Leiostomus xanthurus*) composing a large percentage of species abundances in this guild.

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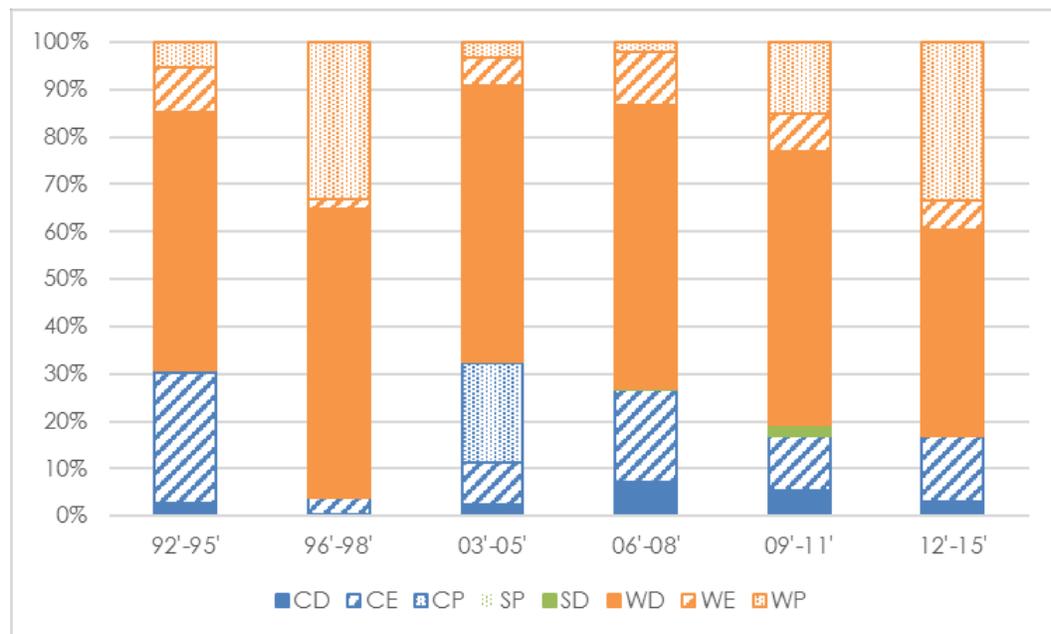


Figure 4. Percent Composition of Fish Species Guilds Collected in USCGA Seines from 1992 to 2015

Warm temperate pelagic (WP) species ranged from a high of 33% percent composition from 1996 to 1998 to under 3% from 2003 to 2008 to a consistent increase back to 34% by 2015. The most dominant species in this grouping was the menhaden (*Clupeidae* sp.) followed by bluefish (*Pomatomus saltatrix*).

Warm temperate epibenthic (WE) species ranged from 10% of species sampled in 1992 to 1995 to 2% in 1996 to 1998 and were consistently between 6% and 11% of species sampled from 1999 to 2015. The most dominant WE species observed during this time was the banded killifish (*Fundulus diaphanus*) and the striped killifish (*Fundulus majalis*).

Cold temperate epibenthic (CE) species were 27% of the finfish sampled from 1992 to 1995, with winter flounder (*Pseudopleuronectes americanus*) comprising a large percentage of species sampled during this time period. This grouping remained under 10% of the species sampled from 1996 through 2005. From 2006 through 2015, CE species ranged from 12% to 19% with mummichog (*Fundulus heteroclitus*) being the most dominant species during that time range.

Cold temperate pelagic (CP) species demonstrated a relative increase from 2003 through 2005, comprising 21% of species observed, with relatively low percent composition during other time periods. The increase from 2003 through 2005 was due to an increase in alewife (*Alosa pseudoharengus*) captures in this time range.

Cold temperate demersal (CD) species ranged from a low of <1% of the guilds captured from 1996 to 1998 to a high of 7% of the guild species captures from 2006 to 2008. The two most

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dominant species in this grouping were stickleback (*Gasterosteidae* sp.) and cunner (*Tautoglabrus adspersus*).

Subtropical pelagic (SP) species were consistently <1% of species sampled from 1992 to 2015 with a lookdown (*Selene vomer*) capture in 1993 and a moonfish (*Monodactylidae* sp.) capture in 2004. Subtropical demersal (SD) species were not observed in seine samples from 1992 to 2007. Banded rudderfish (*Seriola zonata*), an SD species, were observed from 2008 to 2011, comprising 2% of species observed during this trawl. SD were not observed from 2012 to 2015 (Figure 4).

3.3.2 USCGA Trawls

The percentage of finfish by guilds captured in USCGA trawl samples from 1992 to 2015 is summarized in Figure 5. Similar to seine results, warm temperate demersal (WD) species were the most frequently sampled guild from 1992 to 2015. WD species ranged from a low of 48% in 1992–1995, to a high of 81% of species sampled in 2003–2005, to 58% of species sampled by 2015. The most dominant species observed in this group from 1992 to 1998 was the Atlantic silverside with a high of 86% of all species observed in 1997. From 1998 to 2015, the scup (*Stenotomus chrysops*) was the most abundant species observed.

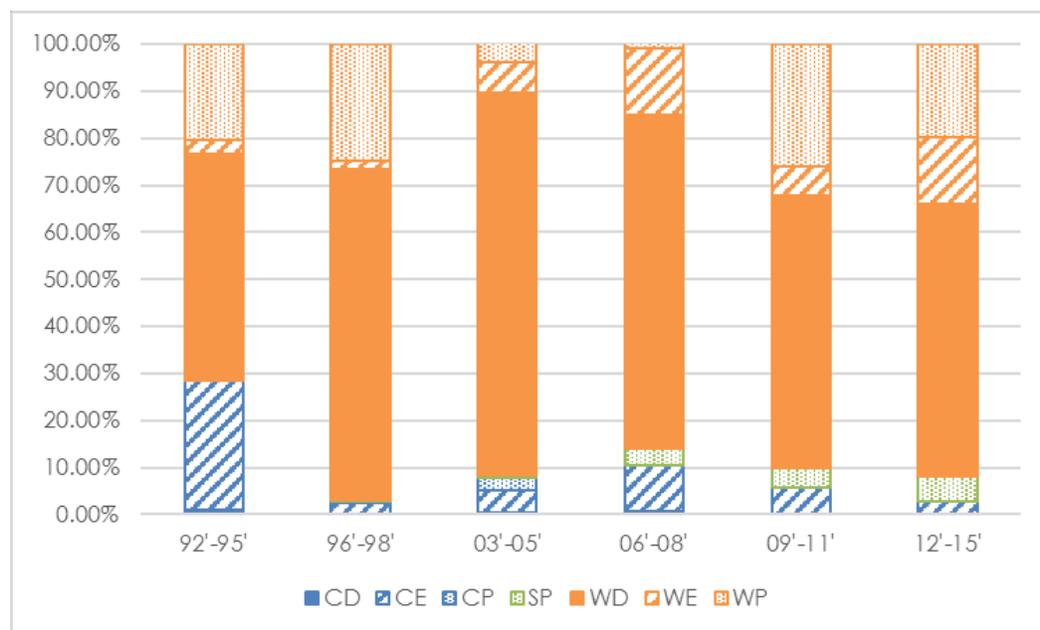


Figure 5. Percent Composition of Fish Species Guilds Collected in USCGA Trawls from 1992 to 2015

Warm temperate pelagic (WP) species comprised 20% of species sampled in 1992 to 25% in 1998. WP species made up less than 4% of species observed from 2003 to 2008 but increased back to 26% in 2009 and 20% in 2015. The most abundant WP species sampled from 1992 to 1998 was the menhaden. The most abundant WP species sampled from 2009 to 2016 included anchovy (*Engraulidae* sp.) and butterfish (*Peprilus triacanthus*).

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Warm temperate epibenthic (WE) species remained below 3% of species sampled from 1992 to 1998. WE species ranged from 6% in 2003 to 14% in 2015. The most abundant species observed from 1992 to 1998 in this grouping was the banded killifish. The most abundant WE species observed from 2003 to 2015 were the summer flounder (*Paralichthys dentatus*) and the smallmouth flounder (*Etropus microstomus*).

Cold temperate epibenthic (CE) species were 28% of the finfish sampled from 1992 to 1995, with winter flounder being most abundant followed by windowpane flounder (*Scophthalmus aquosus*). This grouping remained under 10% of the guilds detected from 1996 to 2015 with winter flounder and windowpane flounder continuing to be the most abundant species.

Cold temperate pelagic (CP) species consistently represented <1% of species sampled from 1992 to 1998 as well as from 2006 to 2015.

Cold temperate demersal (CD) species stayed consistently under 1% of the species sampled from 1992 to 2015. The most abundant species in this grouping was silver hake (*Merluccius bilinearis*).

Subtropical pelagic (SP) species consistently represented under 1% of the total species composition from 1992 to 2005, while slightly increasing from 4% in 2006 to 5% in 2015. Moonfish accounted for the large majority of species captures in this guild. Subtropical demersal (SD) species were not observed in trawl samples from 1992 to 2007.

3.3.3 SUBASE-NLON Surveys

In addition to the USCGA time series, the SUBASE-NLON recently completed comprehensive surveys to characterize finfish resources near their facility (Tetra Tech 2016). The 2014 and 2015 surveys included trawl samples from channel portions of the Thames River in deep subtidal areas to assess juvenile and adult fish seasonal fluctuations in species composition and abundance. In addition, samples were collected to characterize ichthyoplankton (egg and larval) fish species abundance and composition. The subtidal fisheries data collected as part of the SUBASE-NLON survey provides a representative data set for the aquatic resources that are likely present in the South Yard Project Area given the proximity, industrial history, and similarities with respect to deep subtidal habitat present at the two facilities.

Trawl surveys in the SUBASE-NLON program, targeted at adult and juvenile finfish life stages, were completed in water depths ranging from 30 to 39 ft at a frequency of three times per season (12 surveys total). A total of 29 species were sampled with seasonal variations in juvenile and adult fish composition observed (Table 3). Four species made up over 75 percent of the catch, including bay anchovy (*Anchoa mitchilli*), scup, butterfish, and Atlantic herring (*Clupea harengus*). Summer flounder, winter flounder, and alewife were captured in three out of the four seasons. Trawls in the winter had the lowest diversity and catch per unit effort (CPUE); CPUE was highest in summer and diversity was highest in summer and fall (Tetra Tech 2016).

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Table 3. Seasonal Juvenile and Adult Finfish Relative Abundance and Species Composition at SUBASE-NLON

Common name	Scientific name	Fall 2014	Winter 2015	Spring 2015	Summer 2015	Total Count	Total (%Comp.)
bay anchovy	<i>Anchoa mitchilli</i>	50	--	--	1,073	1,123	31.8%
scup	<i>Stenotomus chrysops</i>	299	--	--	269	568	16.1%
butterfish	<i>Peprilus triacanthus</i>	50	--	--	504	554	15.7%
Atlantic herring	<i>Clupea harengus</i>	--	--	182	228	410	11.6%
Atlantic moonfish	<i>Selene setapinnis</i>	176	--	--	123	299	8.5%
Atlantic silverside	<i>Menidia menidia</i>	--	6	--	169	175	5.0%
juvenile sciaenid	Family Sciaenidae	--	--	--	117	117	3.3%
bluefish	<i>Pomatomus saltatrix</i>	--	--	--	96	96	2.7%
winter flounder	<i>Pseudopleuronectes</i>	1	--	1	39	41	1.2%
alewife	<i>Alosa pseudoharengus</i>	32	1	--	1	34	1.0%
black seabass	<i>Centropristis striata</i>	24	--	--	--	24	0.7%
summer flounder	<i>Paralichthys dentatus</i>	13	--	3	3	19	0.5%
spotted hake	<i>Urophycis regia</i>	--	--	15	1	16	0.5%
Atlantic menhaden	<i>Brevoortia tyrannus</i>	--	--	--	14	14	0.4%
cunner	<i>Tautoglabrus adspersus</i>	--	--	5	1	6	0.2%
juvenile gadid sp.	Family Gadidae	--	--	6	--	6	0.2%
weakfish	<i>Cynoscion regalis</i>	6	--	--	--	6	0.2%
bluestripe lizardfish	<i>Synodus saurus</i>	4	--	--	--	4	0.1%
tautog	<i>Tautoga onitis</i>	3	--	1	--	4	0.1%
shorthorn sculpin	<i>Myoxocephalus Scorpius</i>	--	--	4	--	4	0.1%
northern pipefish	<i>Syngnathus fuscus</i>	4	--	--	--	4	0.1%
longfin squid	<i>Doryteuthis pealeii</i>	3	--	--	--	3	0.1%
Atlantic tomcod	<i>Microgadus tomcod</i>	--	--	1	--	1	T
fourspot flounder	<i>Paralichthys oblongus</i>	--	--	1	--	1	T
silver hake	<i>Merluccius bilinearis</i>	--	--	1	--	1	T
smallmouth	<i>Etropus microstomus</i>	1	--	--	--	1	T
striped anchovy	<i>Anchoa hepsetus</i>	1	--	--	--	1	T
striped searobin	<i>Prionotus evolans</i>	--	--	1	--	1	T
windowpane	<i>Scophthalmus aquosus</i>	--	--	--	1	1	T
Totals		667	7	221	2,639	3,534	

T = Trace (<0.1%)

Ichthyoplankton samples were collected with a net (300 µm mesh) that was towed obliquely throughout the Thames River water column adjacent to the SUBASE-NLON (3). A total of 11 species were collected, with tautog (*Tautoga onitis*), Atlantic tomcod (*Microgadus tomcod*), winter flounder, American sand lance (*Ammodytes americanus*), Atlantic herring, and cunner comprising over 80% of the catch (Table 4). The fall survey had the lowest CPUE and diversity;

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CPUE was generally consistent for the remaining months and diversity was the highest in the spring (Tetra Tech 2016).

Table 4. Ichthyoplankton Relative Abundance and Species Composition at SUBASE-NLON

Common name	Scientific name	Density (per 100 m ³ of river water)					Cumulative %
		Fall 2014	Winter 2015	Spring 2015	Summer 2015	Total	
tautog	<i>Tautoga onitis</i>	-	-	5.5	8.2	13.7	19.7%
Atlantic tomcod	<i>Microgadus tomcod</i>	-	11.2	-	-	11.2	16.1%
winter flounder	<i>Pseudopleuronectes americanus</i>	2.5	1.0	7.2	-	10.7	15.4%
American sand lance	<i>Ammodytes americanus</i>	-	7.5	-	-	7.5	10.7%
Unknown egg	-	-	-	2.0	4.3	6.3	9.0%
Atlantic herring	<i>Clupea harengus</i>	1.7	-	4.3	-	6.0	8.6%
cunner	<i>Tautoglabrus adspersus</i>	-	-	0.7	4.6	5.3	7.6%
northern pipefish	<i>Syngnathus fuscus</i>	-	-	-	2.9	2.9	4.2%
grubby	<i>Myoxocephalus aeneus</i>	-	1.4	0.7	-	2.1	2.9%
rock gunnel	<i>Pholis gunnellus</i>	-	1.9	-	-	1.9	2.8%
searobin sp.	Family Triglidae	-	-	-	1.5	1.5	2.1%
striped bass	<i>Morone saxatilis</i>	-	-	0.8	-	0.7	1.0%
Totals		4.2	23.0	21.2	21.5	69.7	

Species and guilds representing a high proportion of the total number collected as part of recent USCGA surveys are generally consistent with those identified in the 2014 and 2015 monitoring efforts at the SUBASE-NLON. These two recent and comprehensive data sets were collected in Thames River habitats consistent with those present in the South Yard Project Area offer a representative proxy for characterizing potential project impacts to finfish resources.

3.4 INTERTIDAL AND SHALLOW SUBTIDAL HABITATS

Surveys in intertidal and shallow subtidal habitat were conducted by Stantec on August 29 and 30, 2017, followed by a dedicated eelgrass (*Zostera marina*) survey on September 28, 2017. For the purposes of this document, the intertidal and shallow subtidal area is assumed to be from -10 ft NAVD88 to mean high water (MHW) (Figure 2). The South Yard Project Area encompasses approximately 1,800 lf of shoreline, which supports intertidal and shallow subtidal habitats. Data collected during the intertidal and shallow subtidal surveys were qualitatively assessed to characterize the relative abundance of species and natural communities that occupy these habitats.

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Species presence in the intertidal and shallow subtidal areas were visually assessed in seven discrete survey areas (Figure 2); each survey was approximately 100-ft in length and spaced evenly along the shoreline. The marine flora and fauna inhabiting the upper, middle, and lower tidal zones within each of the survey areas were characterized using a 0.25-m² quadrat, which was placed randomly in each tidal zone. From each survey area, a total of three quadrats were characterized within each of the three tidal zones (i.e., 9 quadrats per survey area, 63 quadrats total). In addition to the quadrats, a meander survey was conducted in each survey area and tidal zone to record other habitat and species observations. Surveys were focused during low tide conditions so the maximum extent of the intertidal area could be observed. The shallow subtidal was characterized by completing underwater video footage along the length of the transect. The video survey included searching for eelgrass and other habitat features along the established transects.

Substrate type (e.g., ledge, rocky, cobble, rip rap), representative algae, and macroinvertebrates were recorded at each quadrat location. The species observed within each quadrat were identified and qualitatively categorized as to relative abundance (i.e., occasional, common, abundant). Any organisms not identifiable in the field were collected, preserved with formalin, and taken back to Stantec's lab for identification. Organisms were identified to the lowest taxonomic level practicable. Where possible, the level of classification was taken to species.

The intertidal areas in the South Yard Project Area consists of two main habitat types. South of survey area TR-3 the intertidal zone is "rocky shorefront" as defined in Connecticut CGS Chapter 444 and is composed of natural ledge with scattered boulders and cobble (Figure 6). North of TR-3 the intertidal habitat is "developed shorefront" as defined in Connecticut CGS Chapter 444 and is characterized by installed rip-rap consisting of boulders and cobble (Figure 6). Both the rocky shorefront and developed shorefront portions have relatively narrow intertidal zones (~3 ft vertical) and moderate slopes that support similar intertidal species. Both coastal resource habitat types also grade into silty soft bottom habitats in the subtidal at approximately -5 ft NAVD88.

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Figure 6. Rocky shorefront south of Survey Area TR-3 (left photo, looking south) and developed shorefront north of Survey Area TR-3 (right photo, looking south)

The species documented during the intertidal survey along the seven survey areas were all commonly found species in the region (Table 5). The two southern most survey areas, TR-1 and TR-2, were located on the rocky shorefront habitat while the remaining five survey areas were located on developed shorefront (Figure 2). Representative photos of the quadrats from each tidal zone are presented in Attachment 2. Individual photos and/or videos of each survey area/quadrat are available upon request.

High Intertidal

Abundant species in high intertidal included blue green algae/cyanobacteria (*Calothrix* sp), which formed a film on the rocky substrate, and green algae (*Prasiola stipitata*). Other species were occasional and included spiral rockweed (*Fucus spiralis*), little gray barnacle (*Chthamalus fragilis*), common periwinkle (*Littorina littorea*), Asian shore crab (*Hemigrapsus sanguineus*), green crab (*Carcinus maenas*), amphipods (*Amphipoda* sp.), ribbed mussel (*Geukensia demissa*) and earwig (*Anisolabis* sp.).

Mid Intertidal

Abundant species in the mid intertidal zone included green algae, rockweed (*Fucus vesiculosus*), blue mussels (*Mytilus edulis*), and northern rock barnacle (*Semibalanus balanoides*). Other species were common to occasional and included hollow green algae (*Enteromorpha intestinalis*), spiral rockweed, common periwinkle, Eastern mud snail (*Ilyanassa obsoleta*), oyster drill (*Urosalpinx cinerea*), ribbed mussel, polychaete worms, Asian shore crab, green crab, and amphipods.

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Low Intertidal

The low intertidal zone demonstrated the greatest species diversity. Abundant species included rockweed, northern rock barnacle, and blue mussel. Other species were common to occasional and included hollow green algae, sea lettuce (*Ulva lactuca*), green algae (*Enteromorpha clathrata*), knotted wrack (*Ascophyllum nodosum*), dulse (*Palmaria palmata*), crustose coralline algae (Corallinales), yellow encrusting sponge (Porifera), hydroid (Hydrozoa), sea lace (Bryozoa), common periwinkle, Eastern mud snail, oyster drill, tortoise shell limpet (*Testudinalia testudinalis*), spiral tube worm (*Spirorbis borealis*), Isopod (Isopoda sp.), ribbed mussel, Asian shore crab, green crab, and amphipods.

Shallow subtidal

The shallow subtidal zone consisted of the rocky habitats associated with the submerged ledge and rip-rap and the silty substrate at the toe of the rocky slope. The hard substrates were covered by a dense and diverse assemblage of green and red algae including sea lettuce, green algae, dulse, Irish moss (*Chondrus crispus*), laver (*Porphyra* sp.), crustose coralline algae and other unidentified algae species. Macroinvertebrates observed on the underwater video included hydroids, sea lice, and slipper snail (*Crepidula adunca*). The silty substrate also had some areas with algae (including dense mats of green algae) in places.

During the initial shallow subtidal surveys in August, Stantec detected the presence of eelgrass in underwater video collected between TR-1 and TR-2. Though these eelgrass areas appeared to be limited in size, Stantec believed that a more thorough survey would be required to determine the limits of this resource in the South Yard Project Area.

For the dedicated eelgrass survey, Stantec followed the Tier 1 methodology outlined in the *Joint Federal Agency Submerged Aquatic Vegetation Survey Guidance for the New England Region* (August 2016 update), which is an interagency guidance document developed by the National Oceanic and Atmospheric Administration Fisheries Service Habitat Conservation Division, U.S. Environmental Protection Agency (EPA) Region 1 and the U.S. Army Corps of Engineers (New England District) (USACE). Tier 1 field methodology determines presence/absence of submerged aquatic vegetation (SAV) and delineates the spatial extent of SAV beds.

Stantec divers swam multiple reconnaissance transects oriented parallel to the shoreline in the subtidal waters between TR-1 and TR-4. Transects encompassed the area extending out to approximately -20 ft NAVD88. The inshore, offshore, and lateral extent of eelgrass detected was marked with a buoy during the reconnaissance surveys. The location of the buoys was recorded using a mapping-grade GPS receiver. As depicted in Figure 2, eelgrass was identified between TR-1 and TR-2 and included a bed that measured approximately 160 ft by 25 ft and a much smaller isolated patch (not drawn to scale on Figure 2) located to the north that measured approximately 8 ft by 8 ft.

A series of transects oriented perpendicular to the shoreline were established every 10 ft within the larger eelgrass bed (17 transects total). Eelgrass observations within a pair of 0.25 m quadrats

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along each transect (34 quadrats) included total percent cover, shoot length, eelgrass condition, signs of herbivory, and evidence of seed production.

Within the larger bed there was a fairly even distribution of low density and high density patches. Eelgrass shoots throughout the bed appeared healthy (non-chlorotic) even though many shoots were encrusted with biological growth (algae and encrusting macroinvertebrates). No herbivory or evidence of eelgrass seed production was observed. Lower density areas within the larger eelgrass bed were intermingled among high density patches but appeared to be focused along the offshore boundary where water depth increased. Shoots ranging from 12 to 24 inches were observed in the low density areas with average percent cover of 20 to 30%. High density eelgrass areas in the larger bed demonstrated shoot lengths from 18 to 36 inches with an average percent cover of 30 to 60%. The total eelgrass percent cover in the larger bed was 40%.

The small isolated eelgrass patch north of the larger bed exhibited 25% cover with shoot lengths ranging from 12 to 30 inches. As depicted in Figure 2, the extent of in-water activities anticipated to occur in the South Yard Project Area do not overlap with established eelgrass resource areas.

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Table 5. Species Occurrence Within Upper, Middle, and Lower Intertidal Areas in the South Yard Project Area

Survey Area	Quadrat	Intertidal	Blue-green algae (cyanobacteria) (<i>Calothrix</i> sp)	Green algae (<i>Prasiola stipitata</i>)	Green algae (<i>Enteromorpha clathrata</i>)	Hollow green algae (<i>Enteromorpha intestinalis</i>)	Sea lettuce (<i>Ulva lactuca</i>)	Spiral rockweed (<i>Fucus spiralis</i>)	Rockweed (<i>Fucus vesiculosus</i>)	Knotted wrack (<i>Ascophyllum nodosum</i>)	Dulse (<i>Palmaria palmata</i>)	Irish moss (<i>Chondrus crispus</i>)	Laver (<i>Porphyra</i> sp.)	Crustose coralline algae (Corallinales)	Yellow encrusting sponge (Porifera)	Hydroid (Hydrozoa)	Sea lace (Bryozoa)	Tortoise shell limpet (<i>Testudinaria testudinalis</i>)	Common periwinkle (<i>Littorina littorea</i>)	Oyster drill (<i>Urosalpinx cinerea</i>)	Eastern mud snail (<i>Ilyanassa obsoleta</i>)	Ribbed mussel (<i>Geukensia demissa</i>)	Blue mussel (<i>Mytilus edulis</i>)	Polychaete worm (<i>Polychaeta</i> sp.)	Spiral tube worm (<i>Spirorbis borealis</i>)	Northern rock barnacle (<i>Semibalanus balanoides</i>)	Little gray barnacle (<i>Chthamalus fragilis</i>)	Asian shore crab (<i>Hemigrapsus sanguineus</i>)	Green crab (<i>Carcinus maenas</i>)	Grass shrimp (<i>Palaemonetes</i> sp.)	Isopod (<i>Isopoda</i> sp.)	Amphipods (<i>Amphipoda</i> sp.)	Earwig (<i>Anisolabis</i> sp.)				
1	1	High	A																																		
1	2	High	A																																		
1	3	High		C																																	
1	4	Mid							A										O				O	O										O	O		
1	5	Mid			C			O	A										C				C				A								O		
1	6	Mid							A										O				A				O									C	
1	7	Low					C		O	C											O		C				O									C	
1	8	Low			O		C		A										O		O	O	A				O									C	
1	9	Low				O	C		A		O								O	O	O		A				A									C	
2	1	High	A	C																																	
2	2	High		O																								O									
2	3	High	A	O																																	
2	4	Mid				C	O		A														O													C	
2	5	Mid		C					A																		C									C	
2	6	Mid							A								O		O			O	C				A									C	
2	7	Low			O		C		A														O				C									O	
2	8	Low					O		A								O						C				A									O	
2	9	Low					C		A														C				A									C	
3	1	High	A																																		
3	2	High	A																																		O
3	3	High	A																									O									
3	4	Mid		C					C																		C										C
3	5	Mid		C					A																		C										C

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Survey Area	Quadrat	Intertidal	Blue-green algae (cyanobacteria) (<i>Calothrix</i> sp)	Green algae (<i>Prasiola stipitata</i>)	Green algae (<i>Enteromorpha clathrata</i>)	Hollow green algae (<i>Enteromorpha intestinalis</i>)	Sea lettuce (<i>Ulva lactuca</i>)	Spiral rockweed (<i>Fucus spiralis</i>)	Rockweed (<i>Fucus vesiculosus</i>)	Knotted wrack (<i>Ascophyllum nodosum</i>)	Dulse (<i>Palmaria palmata</i>)	Irish moss (<i>Chondrus crispus</i>)	Laver (<i>Porphyra</i> sp.)	Crustose coralline algae (Corallinales)	Yellow encrusting sponge (Porifera)	Hydroid (Hydrozoa)	Sea lace (Bryozoa)	Tortoise shell limpet (<i>Testudinaria testudinalis</i>)	Common periwinkle (<i>Littorina littorea</i>)	Oyster drill (<i>Urosalpinx cinerea</i>)	Eastern mud snail (<i>Ilyanassa obsoleta</i>)	Ribbed mussel (<i>Geukensia demissa</i>)	Blue mussel (<i>Mytilus edulis</i>)	Polychaete worm (<i>Polychaeta</i> sp.)	Spiral tube worm (<i>Spirorbis borealis</i>)	Northern rock barnacle (<i>Semibalanus balanoides</i>)	Little gray barnacle (<i>Chthamalus fragilis</i>)	Asian shore crab (<i>Hemigrapsus sanguineus</i>)	Green crab (<i>Carcinus maenas</i>)	Grass shrimp (<i>Palaemonetes</i> sp.)	Isopod (<i>Isopoda</i> sp.)	Amphipods (<i>Amphipoda</i> sp.)	Earwig (<i>Anisolabis</i> sp.)			
3	6	Mid		C					A										O								C								C	
3	7	Low				O	O		A								O	O	O					O				C								
3	8	Low				C	O		A								O						O				C								O	
3	9	Low					O		A		O						C			C				C			C								C	
4	1	High	C					O															C					C	C						C	
4	2	High	C																																C	
4	3	High	A																				C												C	
4	4	Mid				C			A														O				A		O						C	
4	5	Mid		C					A														O	C			C								C	
4	6	Mid		C					A								O										C								C	
4	7	Low				C	C		A						O					O							C							O	C	
4	8	Low			O	C			A								C			O			O		O		C								C	
4	9	Low				C	O		A								C			O		O	C						O						C	
5	1	High	O	O				O																					A						O	
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5	3	High	A																O									O	C						C	
5	4	Mid		C					A														C				C								O	
5	5	Mid		C					A								O		O								C								O	
5	6	Mid		A					A																		C								O	
5	7	Low				O	C		A								C			O			O				C								C	
5	8	Low				O	O		A								O					O	O						O						C	
5	9	Low				O			A								C			O			O				A		O	O					C	
6	1	High	C																									C								
6	2	High	O																																	

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3.5 WETLANDS AND WATERCOURSES

On August 28, 2017, a Certified Professional Soil Scientist from Stantec conducted an inland and tidal wetland and watercourse delineation upland of the Coastal Jurisdiction Line (CJL) in the South Yard Project Area (Figure 2). The objective of the delineation was to identify wetlands and watercourses regulated under local, state, and federal statutes and regulations as described below. The delineation area encompassed approximately 35 acres and includes approximately 2,500 lf of Thames River shoreline, including the 1,800 lf of shoreline in the South Yard Project Area (Figure 2). The majority of the shoreline in the delineation area is developed shorefront characterized by bulkheads, assembly buildings, berthing areas, piers, and shoreline armoring. The shoreline in the southernmost portions of the delineation area includes approximately 500 linear ft of rocky shorefront coastal resource characterized by natural, gently sloping, exposed bedrock with scattered boulders and cobble.

City of Groton

Municipalities in Connecticut are responsible for the regulation of inland wetlands and watercourses. The City of Groton (City) regulates inland wetlands and watercourses in accordance with the *Regulations for the Preservation of Inland Wetlands and Watercourses, City of Groton, Connecticut* (as amended May 6, 2014) and Sections 22a-36 through 22a-45 of the Connecticut General Statutes (i.e., the Inland Wetlands and Watercourses Act). Under these regulations, the City defines watercourses and wetlands as:

- *Watercourses means rivers, streams, brooks, waterways, lakes, ponds, marshes, swamps, bogs, and all other bodies of water, natural or artificial, vernal or intermittent, public or private, which are contained within, flow through or border upon the City or any portion thereof not regulated pursuant to Sections 22a-28 through 22a-35, inclusive, of the Connecticut General Statutes. Intermittent watercourses shall be delineated by a defined permanent channel and bank and the occurrence of two (2) or more of the following characteristics: 1. evidence of scour or deposits of recent alluvium or detritus, 2. the presence of standing or flowing water for a duration longer than a particular storm incident, and 3. the presence of hydrophytic vegetation.*
- *Wetlands means land, including submerged land as defined in this section, not regulated pursuant to Sections 22a-28 through 22a-35, inclusive, of the Connecticut General Statutes, which consists of any of the soil types designated as poorly drained, very poorly drained, alluvial and floodplain by the National Cooperative Soils Survey, as it may be amended from time to time, of the Natural Resources Conservation Service of the U.S. Department of Agriculture (USDA). Such areas may include filled, graded, or excavated sites which possess an aquatic (saturated) soil moisture regime as defined by the USDA Cooperative Soil Survey.*

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The City also regulates coastal resources (e.g., tidal wetlands and tidal waters) as part of the Coastal Site Plan Review pursuant to Section 22a-90 through 22a-112 of the Connecticut General Statutes (i.e., the Coastal Management Act).

Unavoidable impacts to inland wetlands and watercourses as well as upland areas within 200 ft from the edge of an inland wetland or watercourse require a permit issued by the City's Conservation Commission. Furthermore, activities within the identified coastal zone (typically 1,000 ft or greater from coastal shorelines) require a Coastal Site Plan Review by the City's Planning and Zoning Commission.

Connecticut Department of Energy and Environmental Protection

The CTDEEP regulates coastal resources including tidal wetlands and tidal (e.g., nearshore, offshore, and intertidal) waters in accordance with Connecticut General Statutes Sections 22a-28 through 22a-35 (i.e., the Tidal Wetlands Act) and Sections 22a-359 through 22a-363f (i.e., the Structures, Dredging, and Fill Statutes), respectively. Unlike inland wetlands, tidal wetlands include areas *which border on or lie beneath tidal waters, such as, but not limited to banks, bogs, salt marsh, swamps, meadows, flats, or other low lands subject to tidal action, including those areas now or formerly connected to tidal waters, and whose surface is at or below an elevation of one foot above local extreme high water (Section 22a-29(2))* that support vegetation tolerant of saline environments.

Unavoidable impacts including the placement of structures, dredging, and fill activities require a permit from the CTDEEP. The CTDEEP has established streamlined permitting for certain minor activities through the issuance of General Permits or Certificates of Permission. Activities with more substantial impacts in tidal wetlands and waters that do not meet the criteria for a General Permit or a Certificate of Permission require an Individual Permit from CTDEEP.

The U.S. Army Corps of Engineers

The USACE regulates the discharge of dredged or fill material into Waters of the United States under Section 404 of the Clean Water Act. Waters of the United States include navigable waters and all their tributaries, adjacent wetlands, and other waters or wetlands with a significant nexus to navigable waters. The USACE also regulates activities in navigable waters under Section 10 of the Rivers and Harbor Act.

The USACE defines wetlands as *areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.* Unlike inland wetlands defined under Connecticut statutes and regulations, which are identified by their soil drainage classification, USACE-regulated wetlands need to meet hydric soil and hydrophytic vegetation criteria and exhibit evidence of wetland hydrology.

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Activities that involve placement of dredged material or fill in Waters of the United States require a permit from the USACE under Section 404 of the Clean Water Act. The USACE has issued a General Permit for Connecticut, which authorizes many activities in Waters of the United States. Activities that do not meet the conditions of the General Permit require an Individual Permit.

The August 28, 2017, delineation was performed in accordance with the *Army Corps of Engineers Wetlands Delineation Manual* and the *Regional Supplement to the Army Corps of Engineers Wetland Delineation Manual: Northcentral and Northeast Region (Version 2.0)*. Hydric soil determinations were based on the *Field Indicators of Hydric Soils in the United States, Version 8.0 (2016)*. In addition, delineations for inland wetlands and watercourses regulated by the CTDEEP were performed in accordance with the Connecticut Inland Wetlands and Watercourse Act and the City of Groton's *Regulations for the Preservation of Inland Wetlands and Watercourses* (amended May 6, 2014). The process included a general assessment of site vegetation, topography, and landscape position/location that would indicate presence of a wetland or watercourse. In areas where wetlands and watercourses appeared likely, the hydrology and soil data were observed to confirm the presence or absence of wetlands or watercourses.

Wetland boundaries and watercourse centerlines were marked with pink flags tied to vegetation, where feasible. The delineated wetland boundaries and the watercourse centerlines were located using a mapping-grade GPS receiver. Representative photographs were taken as appropriate and are included as Attachment 3. Copies of the original field notes and USACE wetland delineation data forms are available upon request.

The weather on August 28, 2017, was sunny with a light wind and temperatures ranged from 65 to almost 80 degrees Fahrenheit. There was light rain overnight on August 27.

As depicted in Figure 2, three wetlands (A, B, and C) and two watercourses (1 and 2) were delineated in the South Yard Project Area

Wetland A is an approximately 364-sq ft feature located along the southern site boundary that meets both the USACE and City definition of a wetland. Wetland A is a man-made feature created as a transition between an underground stormwater pipe outlet and a culvert under an existing railroad line. Wetland A is located in a nearly level area, between the base of a steep slope to the east and the base of railroad fill to the west. The vegetation is predominantly hydrophytic emergent marsh species with sparse shrubs along the periphery. The dominant herbaceous vegetative species are common reed (*Phragmites australis*), spotted touch-me-not (*Impatiens capensis*), slender-leaved goldenrod (*Euthamia caroliniana*), river-bank grape (*Vitis riparia*), climbing nightshade (*Solanum dulcamara*), eastern poison ivy (*Toxicodendron radicans*), and dock-leaf smartweed (*Persicaria lapathifolia*). The dominant shrubs species on the wetland periphery are gray willow (*Salix bebbiana*) and black elder (*Sambucus nigra*). Soils are poorly drained and comprise mucky sand overlying coarse loamy sand. The underlying mineral soil component directly below the dark, mucky surface exhibits a depleted matrix with redoximorphic concentrations, which classify it as a hydric soil (Depleted Below Dark Surface) according to the USACE delineation manual. At the time of the delineation, evidence of

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wetland hydrology included surface water/saturation, sparsely vegetated concave surface, water-stained leaves, oxidized rhizospheres, the presence of iron reduction, and several other secondary hydrologic indicators.

Wetland B is an approximately 864-sq ft isolated depression located at the base of the steep slope to the east and the railroad fill to the west that meets both the USACE and City definitions of a wetland. The sources of hydrology are apparently a stormwater outlet pipe upslope to the east and the seasonal high water table. This is a mowed/maintained man-made feature that is functioning as a wetland. It is primarily devoid of vegetation; however, there are sedge species (*Carex* sp.) along the periphery. Stantec was unable to identify the sedge species because they were mowed at the time of the field delineation. Soils are a poorly drained, thin, mucky, sandy surface overlying a horizon of loamy sand and silt loam. Deeper horizons appeared to be natural, buried soil so the uppermost horizons appeared to be fill that has developed hydric soil characteristics over time. The underlying mineral soil component directly below the mucky surface exhibits a depleted matrix with redoximorphic concentrations, which classify it as a hydric soil (Redox Depressions). At the time of the delineation, evidence of wetland hydrology included saturation, sparsely vegetated concave surface, water-stained leaves, oxidized rhizospheres, the presence of iron reduction, and several other secondary hydrologic indicators.

Wetland C is an approximately 500-sq ft isolated depression located between a cut bedrock face and the railroad tracks within the railroad fill, and it meets both the USACE and City definition of a wetland. The source of hydrology is apparently the seasonal high water table. This is a maintained man-made feature that is functionally a wetland. It is primarily devoid of vegetation; however, there are *Carex* species along the periphery. We were unable to identify the sedge species because they were mowed at the time of the field delineation. Soils are poorly drained and classified as a hydric soil (Histic Epipedon), with approximately 9 inches of muck overlying bedrock. At the time of the delineation, evidence of wetland hydrology included saturation, sparsely vegetated concave surface, water-stained leaves, oxidized rhizospheres, the presence of iron reduction, and several secondary hydrologic indicators.

Watercourse A is located along the southern property boundary whose hydrology is provide for Wetland A discharge via a culvert. The watercourse begins at the culvert outlet on the western side of the railroad and flows westerly to where it discharges to the Thames River. Watercourse A is a narrow feature (1 to 3 ft wide) that functions primarily for stormwater conveyance. It has a defined channel created by the action of flowing water and a mineral substrate consisting of cobbles, sand, and gravel that is primarily devoid of upland vegetation.

Watercourse B was previously delineated by Stantec on September 19, 2016. It is a manmade ditch that receives stormwater runoff from adjacent developed areas (i.e., roads, parking areas, and other impervious surfaces) and from a drainage pipe outlet at its northern end. The eastern and southern sides consist of a vertical, blasted, bedrock wall that is over 20 ft in height on the east and tapers to ground elevation to the south. The opposite side is bordered by a paved and concrete staging area. Between the bedrock wall and paved staging area this stormwater drainage ditch is approximately 4 to 5 ft wide and 3 ft in depth with sparse sediment deposition

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from runoff and hydrophytic vegetation. The ditch terminates at and empties into a drainage culvert that passes under the rail line and discharges directly into the Thames River. While the majority of this feature does not meet the City's definition of a watercourse, consultation with City Planning and Zoning Commission representatives in 2016 indicated that Watercourse B is a jurisdictional watercourse under the Regulations for the Preservation of Inland Wetlands and Watercourses. Watercourse B does not meet the USACE definition of a Waters of the United States because the watercourse does not contain an ordinary high water mark as the channel is artificially created by excavation in bedrock and was not established by fluctuations of water and, therefore, will only be jurisdictional by the City.

In summary, Watercourse A and the three wetlands within the delineated area meet the USACE definition of a Waters of the United States and/or the City's definition of and Inland Wetland or Inland Watercourse. Watercourse B does not meet the USACE definition of a Waters of the United States but does meet the City's definition of a watercourse.

No tidal wetlands were identified within the delineation area.

3.6 SHOREBIRD, WATERFOWL, AND RAPTOR

A visual survey of shorebird, waterfowl, and raptor activity was completed on August 28 and 29, 2017, within the visual viewshed depicted on Figure 7. The survey goals were to: (1) inventory the species and approximate numbers of birds using the shoreline areas and nearshore river areas at the project site as well as other shoreline areas in the vicinity; (2) assess the late-summer shorebird species composition in this area; and (3) assess the availability of representative shorebird habitats present in the shoreline zone of the South Yard Project Area.

Prior to the survey, one representative, centralized observation point was identified to allow for maximum views of the project site, the different shoreline habitats, and the Thames River in the vicinity of the South Yard Project Area (Figure 7). The observation point was established to track shorebird activity and was located in the transition zone between the developed shorefront to the north and the rocky shorefront to the south.

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Figure 7. Shorebird Survey Viewshed Area in the South Yard

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The survey protocol was based on US Geological Survey Breeding Bird Survey methodologies. The planned survey procedure was to conduct 4-hour point surveys on 3 consecutive days for a total of 12 hours. Due to logistical constraints relating to security and boat access, the methodology was modified so that surveys were performed for 2 consecutive days; 6 hours and 44 minutes on the first day and 4 hours and 30 minutes the second day, resulting in 11 hours and 14 minutes of total survey time.

Surveys were conducted in the morning (beginning before 0800 hours), when bird activity and vocalizations are greatest, and extended into early afternoon. The surveys were also scheduled around low tide where the highest areal extent of shoreline habitat is available. Sky conditions during surveys generally consisted of high clouds. Wind speeds ranged from 0 to 12 miles per hour, and average temperatures ranged from 60 to 75 degrees Fahrenheit. Tidal periods sampled were falling, low, and rising.

Data gathered for observed birds included sex, age, time of observation, number of individuals, distance from survey point when observed, closest distance to survey point, height during first observation, minimum and maximum heights, travel direction, and activity. The location and flight path were also sketched and described on data sheets. A recorded observation included the period from when a bird was first detected in the viewshed until it was no longer visible in the viewshed. If the same birds were observed exiting/entering the viewshed multiple times they would be recorded as multiple observations. Data sheets recording bird observations throughout the survey period are available upon request.

A total of eight taxonomic bird family groups were observed: Haematopodidae (oystercatchers), Scolopacidae (sandpipers), Ardeidae (egrets), Anatidae (swans, geese and ducks), Phalacrocoracidae (cormorants), Laridae (gulls), Accipitridae (raptors), and Cathartidae (vultures) (Table 6).

Stantec observed and recorded data on 16 separate bird species, 59 observations, and 163 individuals (Table 6). We also tallied an additional 174 gulls and cormorants that were not recorded observations for a total of 337 birds observed. Gulls and cormorants were difficult to record as an observation because of the way they utilized the viewshed area. Flocks of these birds (Laridae and Phalacrocoracidae) routinely separated and flew in multiple directions, which would require that sightings be separated and recorded as multiple observations. Individuals from these family groups also flew through the viewshed at great distances from the observation point and did not utilize the South Yard Project Area or its shoreline habitats. To reduce confusion when collecting data for these activities, while still accounting for the birds within the viewshed, we recorded the standard observation data for gulls and cormorants that utilized the South Yard Project Area when foraging, staging, swimming, or floating.

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Table 6. Bird Observations in the Vicinity of the South Yard Project Area

Family	Common name	Scientific name	Number of Individuals
<i>Anatidae</i>	American black duck	<i>Anas rubripes</i>	12
	Canada goose	<i>Branta canadensis</i>	19
	Mallard duck	<i>Anas platyrhynchos</i>	22
	Mute swan	<i>Cygnus olor</i>	6
	White-winger scoter	<i>Melanitta fusca</i>	22
<i>Accipitridae</i>	Northern harrier	<i>Circus cyaneus</i>	1
	Osprey	<i>Pandion haliaetus</i>	15
<i>Ardeidae</i>	Great egret	<i>Ardea alba</i>	1
<i>Cathartidae</i>	Turkey vulture	<i>Cathartes aura</i>	9
<i>Haematopodidae</i>	American oysercatcher	<i>Haematopus bachmani</i>	1
<i>Phalacrocoracidae</i>	Double-crested cormorant	<i>Phalacrocorax auritus</i>	17
<i>Laridae</i>	Great black-backed gull	<i>Larus marinus</i>	3
	Herring gull	<i>Larus argentatus</i>	31
	Laughing gull	<i>Larus atticilla</i>	1
	Little Gull	<i>Larus minutus</i>	1
<i>Scolopacidae</i>	Spotted sandpiper	<i>Actitis macularia</i>	2
* Total for observations—does not include additionally tallied 141 herring gulls and 33 double crested cormorants		Total:	163

The developed shorefront north of the observation point exhibits steep grading and does not provide relatively flat areas. This topography results in a relative scarcity of habitat for shorebird feeding and staging. While the rocky shorefront habitat to the south of the observation point lacks abundant vegetation in the intertidal zone, the gradually sloping grade does provide ample staging areas. As such, the majority of recorded bird observations and the highest number of species were located in the rocky shorefront south of the observation point. More specifically, there is small rock outcropping in this habitat that is located south of the riparian line and off the EB property (Figure 7) and extends approximately 50 ft into the Thames River at low tide. This outcropping was the habitat most frequently utilized by bird species during the survey.

At low tide, various species of seaweed are exposed in the vicinity of the rock outcropping and multiple shorebird and waterfowl species, including the American oystercatcher (*Haematopus bachmani*), several duck species, gulls, and cormorants were observed staging at this location. On the falling tides ducks swam upriver from beyond the large pier in the southernmost extent of the viewshed area, staged and fed around the rock outcropping at low tide, and then returned south again as the tide rose. The spotted sandpipers (*Actitis macularia*) were observed foraging in the rock crevices of the rocky shorefront habitat at low tide.

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Herring gulls (*Larus argentatus*) were observed perched on multiple structures in the river including piers, bulkheads and towers, along the shoreline on the rock outcrops, and onshore on guard towers and other buildings.

Gulls, cormorants, and mute swans (*Cygnus olor*) were observed swimming up and down river and along the immediate shoreline. Cormorants were observed fishing several hundred feet offshore, and the other swimming birds appeared to be making transient movements between habitats.

Osprey (*Pandion haliaetus*) were observed to be fishing mostly in the vicinity of the Thames River navigational channel and on western shoreline of the river. One osprey was observed perched on the degaussing tower located between the observation point and the Thames River navigational channel to the west of the observation point. Osprey were also observed successfully catching fish multiple times and at least three individuals flew directly over the observation point then out of view to the east.

The northern harrier (*Circus cyaneus*) was observed flying in the southernmost extent of the viewshed before moving out of view to the west.

There are many existing and potentially disruptive sources for bird activity on and adjacent to the river in the vicinity of the South Yard Project Area, including on land traffic noise, boat traffic and ambient light. Since these sources appear to be relatively constant we did not observe that they have a large effect on birds changing their activity in response.

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Attachments
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**ATTACHMENT 1 Benthic Macroinvertebrate Taxonomy
Results**



Brent Courchene
Stantec Consulting Services, Inc.
400 Crown Colony Drive, Suite 200
Quincy, MA 02169-0982

October 13, 2017

Re: Connecticut Benthic Macroinvertebrate Results

Dear Mr. Courchene,

Ecological Associates, Inc. (EAI) was tasked with processing and analyzing eleven benthic macroinvertebrate samples collected in August 2017 from a coastal area near Groton, Connecticut.

Methods

Benthic Macroinvertebrate Processing

Eleven samples were collected at designated sites using a Ponar grab targeting two liters of sediment per grab. Contents of the grabs were passed through a 0.5 mm sieve, and all material retained by the sieve were field preserved with a 10% buffered formalin solution and sent to the EAI laboratory for analysis. Once received, samples were rinsed, sorted under a dissecting microscope to separate target organisms from organic and inorganic debris, and all macroinvertebrates enumerated and identified to the lowest practicable taxonomic level. Meiofauna, such as nematodes and ostracods, were not removed from the samples. Resulting taxonomic data was used to characterize each site for total abundance (total number of individuals collected), species richness (number of taxa collected), percent dominant taxon, true diversity, and Simpson's Index of Diversity.

Percent dominant taxon was calculated by dividing the number of individuals from the most abundant taxon in each sample by the total number of individuals in the sample. Shannon-Weiner diversity index was computed using logarithmic base e and used to produce true diversity. True diversity was calculated by using a conversion of the Shannon-Weiner diversity index to produce the effective number of species (i.e., true diversity). The effective number of species is the number of species at equal frequency found in a community required to produce a given value of a diversity index (Jost 2006). Simpson's Index of Diversity (1-D) is a measure of diversity that accounts for both the number of species and the relative abundance of each. For example, two communities with an equal number of species would produce unequal diversity index scores if the population distribution in one community was skewed by one or two abundant organisms while the other community had an even distribution of all organisms. The Simpson's Index of Diversity mathematically represents the probability that two organisms selected randomly from a sample will be different species. Values range from 0 to 1, with higher

scores representing communities with higher diversity and lower scores indicating communities with lower diversity.

Quality Assurance/Quality Control

EAI maintains Quality Assurance (QA) and Quality Control (QC) measures over the sorting, taxonomic, and data transfer portions of its laboratory operations. All sorters undergo a training and certification process in which they must achieve and maintain a high degree of sorting efficiency. For this project, 10% of each sample was resorted by the laboratory manager or a qualified designee. Ten percent (10%) of the sorted residue was examined, any missed organisms removed and counted, and a calculation made based on the number of organisms missed divided by the total number of organisms in the sample (missed plus previously removed). To remain certified, each sorter must maintain at least 90% sorting efficiency. All QA/QC results for this project had a passing sorting efficiency rate of greater than 90%. EAI taxonomists maintained a reference collection for this project consisting of approximately five specimens of each taxon present in the samples. All laboratory data was entered into a database and verified by a second technician to ensure accuracy.

Results

One hundred taxa totaling 2,714 individuals were identified from the eleven sites during the August 2017 sampling event (Table 1). Site MB-8 had the highest abundance (565 individuals), while MB-7 had the lowest (99 individuals). Species richness ranged from a high of 40 taxa at MB-1 to a low of 20 taxa at MB-6. Site MB-3 had the lowest percent dominant taxon (18.6%) and Site MB-9 the highest (40.4%). The polychaete *Mediomastus* spp. was the most abundant invertebrate at Sites MB-2 and MB-6. The polychaete *Cossura* spp. was the most abundant taxon at Sites MB-4, MB-8, and MB-11. The American slipper limpet, *Crepidula fornicata*, was the most abundant invertebrate at Sites MB-3 and MB-7. The Atlantic nut clam, *Nucula proxima*, was the dominant taxon at Sites MB-5, MB-9, and MB-10. Site MB-1 was unique from all the other sampling sites in that an amphipod crustacean, *Microdeutopus anomalus*, was the most abundant taxon.

True diversity ranged from a high of 18.59 at Site MB-3 to a low of 9.45 at MB-9. Sites MB-8, MB-9, and MB-11 had similar true diversity scores within 0.2 of each other at the low end of the diversity range. The second highest true diversity score was at Site MB-1, where the taxa count was also the highest. Simpson's Index of Diversity had a small range of values for the sites surveyed. The lowest diversity score (0.80) was found at Site MB-9, but Sites MB-4 and MB-8 were similarly low (i.e., within 0.03). The highest Simpson's index score (0.93) was from Site MB-3. The range of Simpson's index values is small with five sites scoring within ± 0.01 of each other, and these sites include both the highest (40) and lowest (20) numbers of taxa.

Summary

The benthic sites analyzed for this study are reasonably diverse in composition, but are typically dominated by a single species. Polychaetes and molluscs were the most abundant major taxonomic group at five sites each, while an amphipod crustacean dominated a single site. Domination was not complete as the percent composition of the most abundant taxon ranged from 18.6-40.4%, but this skewed distribution affected the diversity measures. Site MB-3 had the second lowest number of individuals (113), but the highest true diversity (18.6). The reason for this is the relatively high number of taxa (32), combined with the lowest proportion of the dominant organism (18.6%) than any other site. Conversely, Site MB-9 had the lowest true diversity and Simpson's index scores due to the abundance of the Atlantic nut clam (40.4% of the total). Sites MB-4, MB-8, and MB-9 had high populations dominated by one or two species, and the nearly identical low values can be considered indistinguishable from a true diversity perspective. True diversity and Simpson's index scores are influenced by evenness of the population distribution, with populations dominated by a single species scoring a lower true diversity score than smaller populations with an even distribution of taxa.

Highly-abundant taxa at these sites are considered pollution-tolerant. Opportunistic polychaete species considered tolerant to pollution were found at these sites. The *Capitella* spp. and *Nephtys incisa* are tolerant of trace metals (Chang et al. 1992), and *Mediomastus* spp. are opportunistic species tolerant of impaired waters (Ingole et al. 2009). The Atlantic nut clam (*N. proxima*) is also persistent in contaminated waters (Chang et al. 1992). Atlantic slipper snail (*C. fornicata*) growth is unaffected by heavy metals (Pechenik et al. 2001). Amphipods are considered more sensitive to pollutants than polychaetes or molluscs, but *Microdeutopus* spp. are known to have a clumped abundance that often masks the effects of contamination (Sanz-Lazaro and Marin 2009). The first or second most abundant organism at all sites is a contaminant-insensitive taxon (Change et al. 1992).

Ecological Associates, Inc. appreciates this opportunity to serve Stantec Consulting Services, Inc. If you have any questions regarding the laboratory analysis or data, please feel free to contact me at any time.

Thank you,



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EAI Laboratory Manager

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Table 1. Benthic Macroinvertebrate Community Analysis for Eleven Stations Sampled on August 28, 2017 in Groton, Connecticut

Phylum	Class/Order	Family	Taxon	MB-1-082817-1050	MB-2-082817-1120	MB-3-082817-1150	MB-4-082817-1200	MB-5-082817-1215	MB-6-082817-1230	MB-7-082817-1250	MB-8-082817-1315	MB-9-082817-1340	MB-10-082817-1430	MB-11-082817-1500	Taxonomic Notes
Nemertea			Nemertea		1	2	1	8	1	1	3	6	5	9	
Annelida	Polychaeta	Ampharetidae	<i>Ampharete</i> spp.	1	2	5						1	2		Damaged
Annelida	Polychaeta	Capitellidae	<i>Capitella capitata</i>	59			3			1					
Annelida	Polychaeta	Capitellidae	<i>Mediomastus ambiseta</i>			1	11	2	6		6	2		3	
Annelida	Polychaeta	Capitellidae	<i>Mediomastus californiensis</i>				1								
Annelida	Polychaeta	Capitellidae	<i>Mediomastus</i> spp.	7	29	10	45	14	28	3	94	34	6	27	Damaged
Annelida	Polychaeta	Chaetopteridae	<i>Spiochaetopterus costarum</i>		2							2	1		
Annelida	Polychaeta	Cirratulidae	<i>Chaetozone</i> spp.				4				4				
Annelida	Polychaeta	Cirratulidae	<i>Tharyx acutus</i>										1		
Annelida	Polychaeta	Cossuridae	<i>Cossura pygodactylata</i>				1		1		8				
Annelida	Polychaeta	Cossuridae	<i>Cossura</i> spp.	6	8	1	116	8	17		186	37	2	99	Damaged
Annelida	Polychaeta	Flabelligeridae	<i>Pherusa affinis</i>								1	1			
Annelida	Polychaeta	Flabelligeridae	<i>Pherusa</i> spp.					1							
Annelida	Polychaeta	Goniadidae	<i>Glycinde solitaria</i>		2		1							1	
Annelida	Polychaeta	Goniadidae	Goniadidae									1	1		Damaged
Annelida	Polychaeta	Hesionidae	<i>Podarkeopsis</i> spp.		1		1			1					
Annelida	Polychaeta	Lumbrineridae	<i>Scoletoma impatiens</i>	27	20	1	8	16	1		6				
Annelida	Polychaeta	Lumbrineridae	Lumbrineridae							3					Damaged
Annelida	Polychaeta	Maldanidae	<i>Clymenella torquata</i>		2	1			1						
Annelida	Polychaeta	Maldanidae	<i>Sabaco elongatus</i>		2										
Annelida	Polychaeta	Maldanidae	Maldanidae	1	10	1	8	2	7	1	10	14	1	10	Damaged/Juveniles
Annelida	Polychaeta	Nephtyidae	<i>Nephtys incisa</i>		8	10		6	13			7	11	1	
Annelida	Polychaeta	Onuphidae	Onuphidae							1					Juvenile
Annelida	Polychaeta	Orbiniidae	<i>Leitoscoloplos robustus</i>	10			10				3				
Annelida	Polychaeta	Paraonidae	<i>Aricidea (Acmira) catherinae</i>			2		3	2						
Annelida	Polychaeta	Paraonidae	<i>Aricidea</i> sp. A		2										
Annelida	Polychaeta	Paraonidae	<i>Levinsenia gracilis</i>		8	3		6	6	1		13	21	4	
Annelida	Polychaeta	Paraonidae	Paraonidae						1					2	Damaged
Annelida	Polychaeta	Pectinariidae	<i>Pectinaria gouldii</i>				2			1	1	1	1		
Annelida	Polychaeta	Pectinariidae	<i>Pectinaria</i> spp.					1							Damaged
Annelida	Polychaeta	Phyllodocidae	<i>Hypereteone heteropoda</i>				2								
Annelida	Polychaeta	Phyllodocidae	Phyllodocidae	4					1	1	2				Damaged
Annelida	Polychaeta	Pilargidae	<i>Sigambra tentaculata</i>			1						7	3	1	
Annelida	Polychaeta	Polynemidae	<i>Harmothoe</i> sp. B	7		2		1		1	6				
Annelida	Polychaeta	Polynoidae	<i>Lepidonotus sublevis</i>					1							
Annelida	Polychaeta	Sabellariidae	<i>Sabellaria vulgaris</i>					1			1	2		1	
Annelida	Polychaeta	Sabellidae	<i>Parasabella</i> spp.			1									
Annelida	Polychaeta	Sabellidae	Sabellidae					1							
Annelida	Polychaeta	Sigalionidae	Sigalionidae				1								
Annelida	Polychaeta	Sigalionidae	<i>Sthenelais boa</i>								1				
Annelida	Polychaeta	Spionidae	<i>Carazziella hobsonae</i>					1					4		
Annelida	Polychaeta	Spionidae	<i>Dipolydora</i> spp.		1		4				2			2	Damaged/Juveniles
Annelida	Polychaeta	Spionidae	<i>Polydora cornuta</i>	2	1	4	3	5	2	1	2	5		13	
Annelida	Polychaeta	Spionidae	<i>Prionospio heterobranchia</i>	1											
Annelida	Polychaeta	Spionidae	<i>Prionospio</i> spp.									6			Damaged
Annelida	Polychaeta	Spionidae	<i>Streblospio benedicti</i>		3						2			6	
Annelida	Polychaeta	Spionidae	<i>Streblospio</i> spp.		3	4	3	6	5		30	5	2	32	Damaged, Not Brooding
Annelida	Polychaeta	Spionidae	Spionidae		1	1							1		Damaged
Annelida	Polychaeta	Syllidae	<i>Exogone</i> spp.			1	1				1			1	Damaged
Annelida	Polychaeta	Syllidae	<i>Odontosyllis</i> spp.	2											
Annelida	Polychaeta	Syllidae	<i>Salvatoria clavata</i>	6		1								1	
Annelida	Polychaeta	Terebellidae	<i>Neoamphitrite</i> spp.							1					
Annelida	Polychaeta	Terebellidae	<i>Pista quadrilobata</i>							1					
Annelida	Polychaeta	Terebellidae	Terebellidae	27	1	1		2		2	4		1		Damaged/Juveniles
Annelida	Clitellata	Oligochaeta	Oligochaeta	13	3	2	18	4	6	4	65	3		38	
Mollusca	Gastropoda	Calyptraeidae	<i>Crepidula fornicata</i>	21		21	16	27		27	77	2		12	
Mollusca	Gastropoda	Calyptraeidae	<i>Crepidula</i> spp.					1							Damaged
Mollusca	Gastropoda	Columbellidae	<i>Astytis lumata</i>		1										
Mollusca	Gastropoda	Columbellidae	<i>Costoamachis avara</i>	1											
Mollusca	Gastropoda	Columbellidae	Columbellidae										1		Damaged
Mollusca	Gastropoda	Cylichnidae	<i>Acteocina canaliculata</i>			2							3		
Mollusca	Gastropoda	Nassariidae	<i>Nassarius trivittatus</i>	1				1						2	
Mollusca	Gastropoda	Pyramidellidae	<i>Turbonilla</i> spp.		8		3					5	4		Juveniles
Mollusca	Bivalvia	Arcidae	<i>Anadara transversa</i>	2		5	1	2		1	7				

Phylum	Class/Order	Family	Taxon	MB-1-082817-1050	MB-2-082817-1120	MB-3-082817-1150	MB-4-082817-1200	MB-5-082817-1215	MB-6-082817-1230	MB-7-082817-1250	MB-8-082817-1315	MB-9-082817-1340	MB-10-082817-1430	MB-11-082817-1500	Taxonomic Notes
Mollusca	Bivalvia	Nuculanidae	Nuculanidae											7	
Mollusca	Bivalvia	Nuculidae	<i>Nucula proxima</i>	15	27	16	11	47	24		15	116	23	72	
Mollusca	Bivalvia	Solemyidae	<i>Solemya velum</i>	6			6				1				
Mollusca	Bivalvia	Tellinidae	<i>Tellina versicolor</i>	16	4	2	10				13	2		4	
Mollusca	Bivalvia	Tellinidae	Tellinidae					5	2	7					Damaged/Juveniles
Mollusca	Bivalvia	Veneridae	<i>Mercenaria mercenaria</i>							2	1	1			
Mollusca	Bivalvia	Yoldiidae	<i>Yoldia limatula</i>					1	5					1	
Mollusca	Bivalvia	Bivalvia	Bivalvia					2	1						Damaged/Juveniles
Arthropoda	Tanaidacea	Leptocheiliidae	<i>Leptocheilia dubia</i>	3											
Arthropoda	Isopoda	Idoteidae	<i>Erichsonella filiformis</i>	3											
Arthropoda	Isopoda	Janiridae	<i>Jaera albifrons</i>	1											
Arthropoda	Isopoda	Asellota	Asellota	1											
Arthropoda	Amphipoda	Ampeliscidae	<i>Ampelisca</i> spp.				1				2	3	1		
Arthropoda	Amphipoda	Ampeliscidae	<i>Ampelisca verrilli</i>			1							1		
Arthropoda	Amphipoda	Ampithoidae	<i>Ampithoe longimana</i>	2						1					
Arthropoda	Amphipoda	Aoridae	<i>Leptocheirus pinguis</i>			5		3				2	1		
Arthropoda	Amphipoda	Aoridae	<i>Microdeutopus anomalus</i>	118		2	3	1		18	7		4		
Arthropoda	Amphipoda	Aoridae	<i>Unciola serrata</i>	1											
Arthropoda	Amphipoda	Caprellidae	<i>Caprella mutica</i>	3											
Arthropoda	Amphipoda	Caprellidae	<i>Caprella penantis</i>	4											
Arthropoda	Amphipoda	Corophiidae	<i>Apocorophium acutum</i>	9									1		
Arthropoda	Amphipoda	Corophiidae	<i>Monocorophium acherusicum</i>			1					1				
Arthropoda	Amphipoda	Corophiidae	<i>Monocorophium</i> spp.	1											
Arthropoda	Amphipoda	Dexaminidae	<i>Dexamine thea</i>	22						3					
Arthropoda	Amphipoda	Liljeborgiidae	<i>Listriella barnardi</i>				1								
Arthropoda	Amphipoda	Melitidae	<i>Elasmopus levis</i>	10											
Arthropoda	Decapoda	Carcinidae	<i>Carcinus maenas</i>							1					
Arthropoda	Decapoda	Hippolytidae	<i>Hippolyte zostericola</i>	1						1					
Arthropoda	Decapoda	Paguridae	<i>Pagurus politus</i>			1									
Arthropoda	Decapoda	Palaemonidae	<i>Palaemonetes vulgaris</i>	1											
Arthropoda	Decapoda	Panopeidae	<i>Dyspanopeus sayi</i>	5			2			2	1				
Arthropoda	Decapoda	Pisidae	<i>Libinia emarginata</i>	1											
Arthropoda	Maxillopoda	Balanidae	Balanidae										2		
Arthropoda	Maxillopoda	Balanidae	<i>Balanus venustus</i>			2		1			1				
Sipuncula			Sipuncula								1				
Phoronida			Phoronida									1			
Total Abundance				438	150	113	299	179	130	99	565	287	105	349	
Species Richness				40	25	32	32	30	20	27	34	27	27	24	
Percent Dominant Taxa				26.9%	19.3%	18.6%	38.8%	26.3%	21.5%	27.3%	32.9%	40.4%	21.9%	28.4%	
Shannon-Weaver Diversity (H')				2.7950	2.6115	2.9224	2.3772	2.6626	2.4275	2.5340	2.2578	2.2461	2.6540	2.2739	
True Diversity				16.362	13.619	18.585	10.774	14.333	11.330	12.604	9.562	9.451	14.210	9.717	
Simpson's Index of Diversity (1-D)				0.891	0.899	0.925	0.815	0.888	0.886	0.874	0.828	0.800	0.895	0.848	

Calculated using base e log.

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ATTACHMENT 2 Intertidal and Shallow Subtidal Photo Log



High intertidal quadrat at Survey Area TR-1



Middle intertidal quadrat at Survey Area TR-6

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Low intertidal quadrat at Survey Area TR-1



Surficial subtidal habitat at Survey Area TR-7

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Surficial subtidal habitat at Survey Area TR-6



Surficial subtidal habitat at Survey Area TR-1

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Typical sediment composition from Sample MB-6.



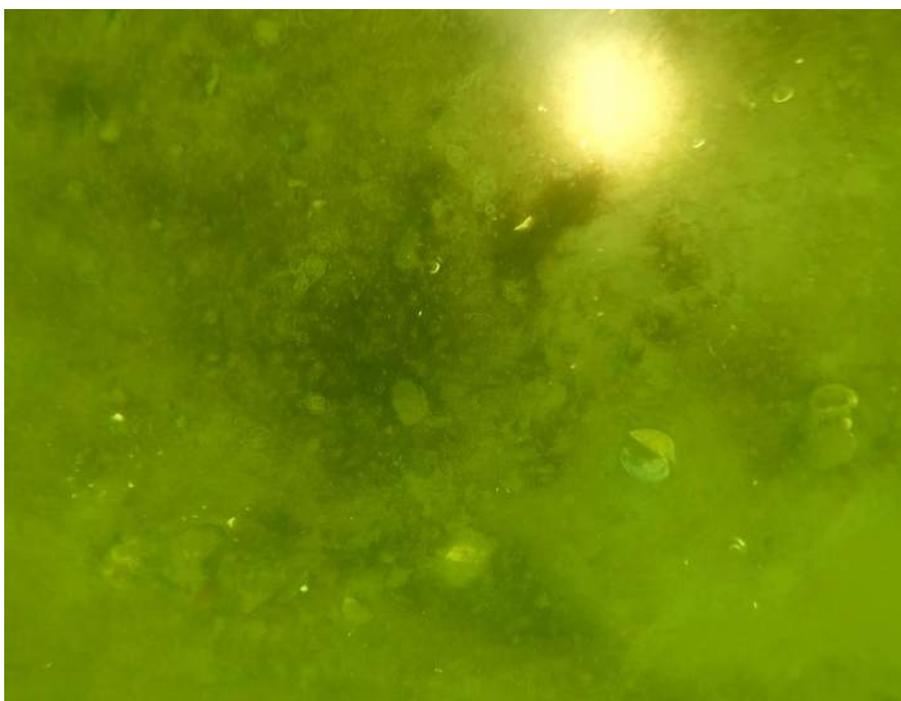
Quahogs collected from Sample MB-7

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Surficial subtidal habitat at Sample MB1.



Surficial subtidal habitat at Sample MB-2.

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Surficial subtidal habitat at Sample MB-6.

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ATTACHMENT 3 WETLAND AND WATERCOURSE PHOTO LOG



Photo 1. Wetland A. Stantec. August 2017.



Photo 2. Inlet structure of Wetland A. Stantec. August 2017.

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Photo 3. Wetland B. Stantec. August 2017.



Photo 4. Wetland C. Stantec. August 2017.

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Photo 5. Watercourse 1. Stantec. August 2017.



Photo 6. Watercourse 1 origin; railroad culvert outlet. Stantec. August 2017.

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Photo 7. Watercourse 2. Stantec. August 2017.



**Photo 8. Vegetation growing in accumulated sediment on the downstream end of
Watercourse 2. Stantec. August 2017.**

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Photo 9. Rocky shorefront in southern portion of project site. Stantec. August 2017.



Photo 10. Typical riprap developed shorefront in the proposed project area. Stantec. August 2017.