MAINTENANCE DREDGING IN A SENSITIVE ENVIRONMENT CASE STUDY: MANCHESTER ENTRANCE CHANNEL

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ABSTRACT

Eelgrass (Zostera marina) is a shallow water plant species common in coastal regions and estuaries throughout the world and along the eastern and western coasts of the United States. Eelgrass provides a natural food source for waterfowl and numerous marine organisms and also provides a habitat for shellfish, crustaceans and fish throughout their life cycles. The existence of eelgrass populations in a coastal region usually indicates a vibrant marine community and related ecosystem.

The onset of environmental awareness and pollution control measures over the last 30 years have improved our coastal regions and in some cases provided for additional habitat areas for eelgrass populations. Eelgrass expands populations in an area by migrating through a process of rhizome projections underneath the seabed to create new rootstalks in a geometric progression. The new plants can populate areas licensed as navigation waterways, mooring areas and other marine related activities. The federal government, state agencies and local boards protect eelgrass and their habitats. Stringent regulations protect eelgrass habitats from negative impacts from marine related projects. Proposed projects in or near eelgrass habitats must be carefully planned and executed to minimize any negative impacts.

Occasionally a project deemed essential to a community arises, such as the maintenance dredging of the only accessible channel linking a harbor to the ocean. To allow maintenance dredging of a former federal channel at the entrance to Manchester-By-The-Sea in Massachusetts, all parties worked out an agreement for "out-of-kind" mitigation and instituted strict operational and monitoring constraints for the dredging. The Army Corps of Engineers further required the proponent to perform a yearly eelgrass survey to monitor and assess the recovery of populations in the entrance channel for a period of five (5) years following the dredging. The National Marine Fisheries Services (NMFS) conducted an initial eelgrass assessment on November 10, 1999. The dredging work of nearly 10,000 cubic yards of sediment began on December 9, 2001 and was completed by December 27, 2001. Our firm performed the first eelgrass survey on May 1, 2002 and recently completed our third, of the projected five inspections, on September 23, 2004.

This paper will review the basic function and values of eelgrass habitats, outline the permit process for the maintenance dredging project, highlight the special conditions imposed for the dredging work and report the preliminary results of the eelgrass monitoring study to date.

Keywords: maintenance dredging, eelgrass, mitigation, fish habitat study & environmental permitting

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EELGRASS HABITATS

Eelgrass (Zostera marina), one of about thirty species of flowering plants known to occur in the sea (Burkholder & Doheny 1968), is a wide-ranging aquatic plant found along the eastern and western coasts of the United States. The eelgrass habitat is a protected resource under the Wetlands Protection Act (the ACT) and provides shelter and nutrition to a variety of mammals, fish, crustacean, and other marine organisums. The main characteristics of an eelgrass habitat include relatively clean and clear water, a fine muddy sand substrate and a low wave energy environment. The presence of eelgrass beds (Figure 1) is usually an indication of a healthy and vibrant marine community. Seagrass leaves baffle wave energy while roots and rhizomes trap and hold sediments from the scour of tides. Seagrasses act as natural buffers by protecting the benthos from the scouring effects of tide energy (Lerman 1985). As a result, Seagrasses may help prevent erosion along shorelines (NOAA 2001).

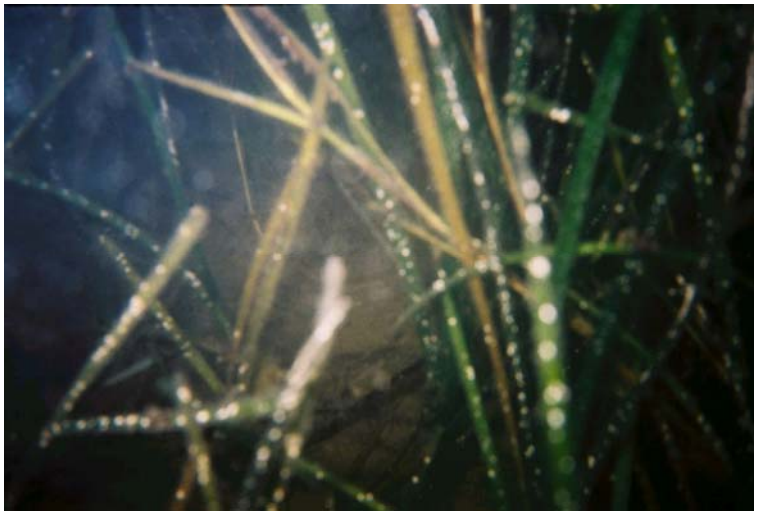

Figure 1: Typical Eelgrass Bed in New England

In New England an eel grass habitat is usually found along protected bays and harbors in water depths ranging from –1.0' below Mean Low Water to a depth exceeding 18' in the coastal regions in Manchester Harbor. According to Burkholder and Doheny (1968) eelgrass flourish when water temperatures range from 10°C to 20°C and a salinity range from 26 ppt to 42 ppt. Eelgrass is a deciduous marine plant commonly referred to seagrass, crabgrass and grass wrack. The plant produces roots, stems, leaves, flowers and seeds. The leaves typically grow from 12" to 48" depending on the habitat characteristics and photosynthesize carbon dioxide in seawater into oxygen. Eelgrass populations grow by reproduction and vegetation. Reproduction growth includes the maturation of pollen grains and ovaries, shedding of pollen into the water, pollination, fertilization and the formation of mature fruits with seeds (Burkholder & Doheny 1968). The vegetative growth includes the development from seed, turion and lateral bud formation, up to and including the production of flowering shoots with buds (Burkholder & Doheny 1968). The development cycle of a plant is typically three (3) years, beginning with the seedling and the formation of a terminal bud the first year, the growth of a flowering shoots and the lateral vegetative shoots the second year and the sprouting of rhizomes and geometrically expansion the third year. The plant is perennial and lives for many years.

A typical eelgrass community includes the following:

- Eelgrass (Potamogetonaceae)
- Algae & Mosses (Bryozoa)
- Worms & Leaches (Annelida)
- Larva & Juvenile Fin Fish
- Clams & Shells (Mollusca)
- Crabs & Lobsters (Crustacea)
- Marine Mammals

MANCHESTER ENTRANCE HARBOR CHANNEL

The Department of Environmental Management (DEM) now known as the Department of Conservation and Recreation (DCR) and the Town of Manchester-By-The-Sea, located on the Cape Ann peninsula, proposed performing maintenance dredging of the entrance channel into Manchester Harbor. The harbor supports marinas, yacht clubs, moorings, waterfront access, a municipal wastewater plant, railroad facility and other commercial, municipal, public and private interests. The former 200' wide federal channel was last dredged in the 1970's and a sewer outfall line was constructed within the channel footprint in the 1980's. The present channel is 2,825 feet in length, 100' wide and maintained to a depth of 10' + 1' over-dredge relative to Mean Low Water (MLW).

ENVIRONMENTAL PERMITTING

The Magnuson-Stevens ACT requires proponents of marine projects to eliminate, minimize or mitigate any negative impacts from a proposed project activity. A project proponent may not be allowed to proceed with a proposed activity or is required to adhere to strict local, state and federal permit conditions restricting any negative impacts to resource areas. As part of the permitting process the proponents of the project were required to perform and Essential Fish Habitat (EFH) Study under the Army Corps of Engineers and National Marine Fisheries Service (NMFS) permit process. The document addressed the following issues:

- Define wetland resource areas.
- Document existing conditions.
- Propose mitigation measure to minimize impact.
- Provide long-term monitoring of affected resource habitats.

As a result to the permit process the project constraints included:

- Reduced dredging footprint limited to shoal areas and no side slopes.
- Limited over-dredge quantities.
- Dredging in quiescence winter season.
- Performance of a five (5) year eelgrass study to document the recovery of the eelgrass habitats.

DREDGING PROJECT

The dredging project was completed in the winter of 2001 by the contractor Jay Cashman, Inc. utilizing an eight (8) yard clamshell dredge and a 2000 cy dump scow (Figure 2) with offshore disposal. The dredge area was limited to only specific areas and no dredging of the channel side-slopes. Additional restrictions included a no-spud zone within 25' of the buried sewer outfall line. The specifications also include the contractor to use a DGPS system with HYPACK software to provide positioning for the dredge and log dredge production activities. The contractor completed the work ahead of schedule and was very diligent in abiding by the permit conditions for the project.

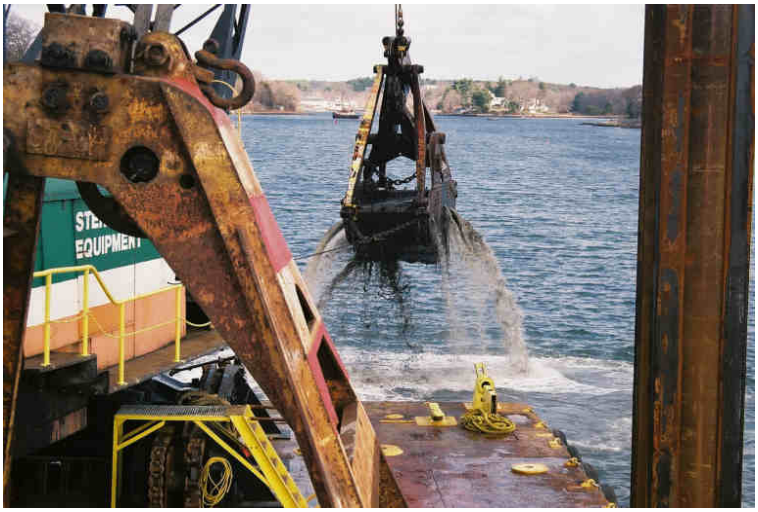

Figure 2: Clamshell dredge in the channel

FIVE (5) YEAR EELGRASS STUDY

At the completion of the dredging project, the NMFS required the Town to perform yearly eelgrass habitat inspections (see Plan 1) for a period of five (5) years. CLE Engineering, Inc. (CLE) is performing the studies under the supervision of our habitat specialist Jeffrey W. Oakes, P.E. The NMFS office conducted the initial pre-dredge evaluation of the project area and typically every fall during the middle of September and after the recreational boating seasons CLE's staff performs subsequent studies, prepares reports and submits them to the Town of Manchester-By-The-Sea.

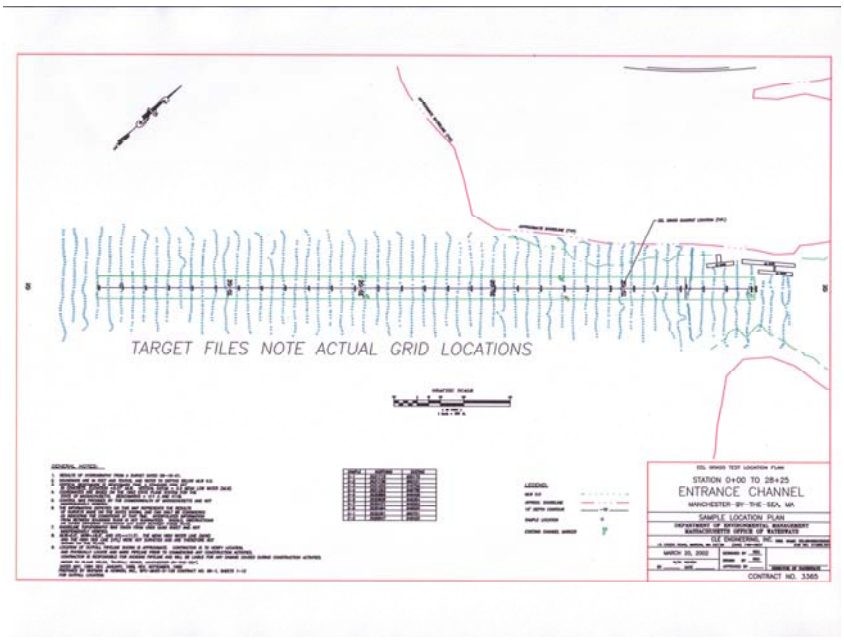

Figure 3: Eelgrass Study Locations

Assessment History

The National Marine Fisheries Service (NMFS) conducted an initial eelgrass assessment on November 10, 1999.

On August 16, 2001 CLE performed the pre-dredge survey for the entrance channel and confirmed the location of the eelgrass habitats.

On May 1, 2002, Carlos G. Peña, P.E., Jeffrey W. Oakes, P.E. and Robert Hollins, all of CLE, visited the site to perform a visual underwater site assessment of the eelgrass populations in the Entrance Channel. The assessment locations include eight (8) dredge targets in the channel and two (2) control targets outside the project area as shown on the attached plan by CLE dated March 20, 2002.

On September 24, 2003, Carlos G. Peña, P.E., Roy E. Okurowski, P.E. and Robert Hollins, all of CLE, visited the site to perform a visual underwater site assessment of the eelgrass populations in the Entrance Channel. The assessment locations include eight (8) dredge targets in the channel and two (2) control targets outside the project area as shown on the plan by CLE dated March 20, 2002.

On September 23, 2004, Carlos G. Peña, P.E., Jeffrey W. Oakes, P.E. and Christopher P. Bonn, all of CLE, visited the site to perform a visual underwater site assessment of the eelgrass populations in the Entrance Channel. The assessment locations include eight (8) dredge targets in the channel and two (2) control targets outside the project area as shown on the plan by CLE dated March 20, 2002.

General Discussion

The August 16, 2001 CLE's pre-dredge survey confirmed eelgrass populations at target locations C-1, S-8, S-7, S-6, S-4 and near S-3 & S-1. The underwater eelgrass assessment was conducted by a P.E. diver utilizing scuba equipment with an underwater camera from our survey vessel (Figure 4). The eelgrass studies are performed at ten (10) specific locations ranging in water depths from 10' to 18', eight (8) in the channel and two (2) control locations outside the channel area. The CLE team deploys ten (10) buoys at the locations using the DGPS system and then dives to each site and records the number, length and vitality of each representative eelgrass community. The assessment targets were located using DGPS positioned survey vessel and a buoy was placed at each location prior to diving activities. The diver dove at each assessment location, placed a one (1) meter grid on the seabed, photographed each referenced location and noted the density, length and color of eelgrass populations and a topside engineer recorded all data for this report. Presently we have completed three (3) studies and already trends are developing as the eelgrass community recovers from the dredging activity and repopulates the dredge area. Evidence prior to the dredging activity indicated the channel area made a complete recovery following past dredging projects and the installation of the said sewer outfall pipe. The preliminary results of the data so far show the eelgrass repopulating the channel areas. Equally spaced rhizome shoots sprouting and becoming denser once the initial plants establish themselves in a specific location characterize the migration of eelgrass plants across the channel.

Figure 4: Diver Performing Eelgrass Inspection at Buoyed Location

The results for a 2002, 2003 and 2004 eelgrass studies performed by CLE are as follows:

The results of the 2002 assessment are referenced to the locations in (Figure 3) and as tabulated below:

Table 1: Summary of 2002 Assessment

Target	Card # (photo)	Stem Count	Stem Length	Density (stems/m^2)	Desc.
C-1	1	0	0	0	Barren
S-1	2	0	0	0	Barren
S-2	3	0	0	0	Barren
S-4	4	0	0	0	Barren
S-3	5	0	0	0	Barren
S-6	6	0	0	0	Barren
S-5	7	0	0	0	Barren
S-8	8	8	8"-12"	72	Dense
S-7	9	0	0	0	Barren
C-2	10	20	12"-16"	180	Dense

The 2002 eelgrass assessment (Table 1) found a vibrant eelgrass community at Target C-2 and Target S-8 and surrounding the dredged channel along the banks as previously mapped during the pre-dredge hydrographic surveys performed by CLE and NMFS. The assessment locations within the channel with the exception of Target S-8 and at Target C-2 were barren with no eelgrass or other marine vegetation populations and Targets S-1, S-2, S-3, S-4, S-5, S-6 & S-7 all showed evidence of the recently completed dredging project. Damage to eelgrass populations outside of the dredge area was limited by prohibiting the contractor from dredging beyond the toe-of-slope.

The results of the 2003 assessment are referenced to the locations in (Figure 3) and as tabulated below:

Table 2: Summary of 2003 Assessment

Target	Card # (photo)	Stem Count	Stem Length	Density (stems/m^2)	Desc.
C-1	1	0	0	0	Barren
S-1	3	0	0	0	Barren
S-2	2	0	0	0	Barren
S-4	4	0	0	0	Barren
S-3	5	0	0	0	Barren
S-6	6	6	18”	54	Moderate
S-5	7	0	0	0	Barren
S-8	8	2	8”-12”	18	Sparse
S-7	9	2	12”	18	Sparse
C-2	10	15	18”	135	Dense

The 2003 eelgrass assessment (Table 2) found the eelgrass community beginning to re-establish itself within the dredge footprint. A vibrant eelgrass community continues to populate the seabed at Target C-2. New eelgrass populations appear to be re-establishing themselves at Targets S-6 & S-7, while slightly decreasing last year’s reported density at Target S-8. The remaining assessment locations within the channel were barren with no eelgrass or other marine vegetation populations at Targets C-1, S-1, S-2, S-3, S-4, S-5 & S-6.

The results of the 2004 assessment are referenced to the locations in (Figure 3) and as tabulated below:

Table 3: Summary of 2004 Assessment

Target	Card # (photo)	Stem Count	Stem Length	Density (stems/m^2)	Desc.
C-1	1	0	0	0	Barren
S-1	3	0-1	12”	0-9	Sparse
S-2	2	0-1	12”	0-9	Sparse
S-4	4	0-1	18”	0-9	Sparse
S-3	5	0-1	18”	0-9	Sparse
S-6	6	5-10	12”	45-90	Moderate
S-5	7	5-10	18”	45-90	Moderate
S-8	8	10-15	18”	90-135	Dense
S-7	9	1-2	18”	9-18	Sparse
C-2	10	10-15	24”	90-135	Dense

The 2004 eelgrass assessment (Table 3) found the eelgrass community beginning to re-establish itself within the dredge footprint. A vibrant eelgrass community continues to populate the seabed at Target C-2. New eelgrass populations appear to be re-establishing themselves at Targets S-4 & S-5, while slightly decreasing last year’s reported density at Target S-7. The remaining assessment locations within the channel remained barren at Target C-1 and are becoming sparse with limited eelgrass or other marine vegetation populations at Targets S-1, S-2, S-3 & S-4.

CONCLUSIONS

The continuing eelgrass study at the Manchester-by-the-Sea entrance channel for the next two (2) years will provide additional data to study the repopulation of the site by the said eelgrass and to collaborate the stated growth and reproductive phases of the eelgrass lifecycle. Future studies will also document the temperature of the water during the study due to its stated importance in the development of eelgrass. As of 2004 the eelgrass habitat, as previously mentioned, is continuing to repopulate the dredged channel area and will hopefully attain and surpass its pre-dredge condition.

Observations during the dredging project and the subsequent eelgrass studies suggest the following:

- Dredging: Maintenance dredging of navigation channels in eelgrass habitats can be accomplished by minimizing the duration of the project, the limits of excavation and by maintaining the composition of the pre-dredge marine sediments.
- Eelgrass Repopulation: Eelgrass habitats can recover from limited maintenance dredging operations as described above under optimum site conditions. The repopulation of the eelgrass colony progress according to the documented studies mentioned in this paper by Burkholder and Doheny.

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