Report of Findings

Board of Selectmen
Town of Branford
Branford, CT 06405

# Preliminary Report on the Anticipated Biological Impacts Associated with the Proposed Islander East Pipeline Project, through the Nearshore Area of Long Island Sound - Branford, CT

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# PRELIMINARY REPORT ON THE ANTICIPATED BIOLOGICAL IMPACTS ASSOCIATED WITH THE PROPOSED ISLANDER EAST PIPELINE PROJECT, THROUGH THE NEARSHORE AREA OF LONG ISLAND SOUND - BRANFORD, CONNECTICUT

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## Executive Summary


The Garrett Group, LTD. (TGG) has been retained by the Town of Branford, CT (the Client) to conduct a review of technical environmental materials presented by Islander East Pipeline Company (the proponents) to various regulators for the above-referenced project. TGG accepts the biological data presented by the proponents as valid. However, a future field effort may occur and these data will be provided. TGG's evaluation is limited to the subtidal environment of the Long Island Sound (LIS) project area associated with the project's Connecticut Mainland approach, which includes the dredged Horizontal Directional Drilling (HDD) transition basin beginning at MP 10.1 and extending to MP 10.9; the mechanically dredged pipeline trench (MP 10.9 to MP 12), that extends beyond the limit of town jurisdiction; and a short portion of the seaplow trench from MP 12 to MP 12.5 out to Northwest Reef. The LIS estuary provides extensive natural and physical resources, and suitable shellfish and finfish habitats.

The pipeline project proposes to lay a 24" welded gas pipeline from Branford, CT across the central portion of LIS to Wading River, NY, on Long Island. The Connecticut Mainland approach will directly impact 440± ac of nearshore bottom. Direct Impacts include displacement or disruption from dredging, barge anchor scars and cable sweeps. The proponents proposed to side cast the dredged material into temporary piles around the perimeter of the trench, however they now propose to place dredge material on barges as opposed to side casting onto the nearshore bottom. The proponent reports that the backfilling proposal has been modified from 3.0± ft of cover over the pipeline, to 1.5± ft of cover over the pipeline. This modification creates a bowl depression of 1.5± ft over 0.75 ac and a 1.5± ft x 50± linear depression over 6.67 ac of nearshore bottom. The change in relief should not pose any additional adverse effect to the post construction nearshore bottom.

Recolonization of bottom disturbances can vary dramatically. These periods can range from a few weeks for pioneer species to several years for late successional species, and are extremely dependent on site specific physical, environmental and anthropogenic conditions.

Indirect impacts caused by dredging and disposal operations cannot be quantified at this time, but include increased suspended solids, sedimentation and anoxic episodes. Motile species will move to avoid turbid sediment plumes, while sessile species must survive the event(s). Based on the reported ebb and flood currents for the project area, the plume will migrate to the east-northeast on the ebb current, and west on the flood current. Since the ebb current is slightly faster than the flood current, TGG would expect the extent of the plume to be slightly greater to the east-northeast than to the west. Sedimentation typically smothers benthic species and demersal/benthic eggs. Demersal eggs are subjected to abrasion from coarse sediments.

Worst-case modeled suspended solid concentrations at the Thimble Islands ≤ 3 mg/l. The sub- and intertidal rocky outcrops immediately to the west of the Thimbles are also subjected to nearly absent turbidity, with plume concentrations of 3 - 10 mg/l. Based on reported impact thresholds, it appears that sedimentation in the amounts to cause 50 - 100% mortality to demersal and benthic eggs and species could occur within, and to ≤ 100 ft of the trench footprints. Resuspension of anoxic muds and silts will likely cause an anoxic episode(s) in the overlying water column.

Should side cast storage of material re-emerge as a preferred project alternative, the proposed piles will have heights of 10 - 11 ft and will extend to between 2 - 10 ft of the water surface These piles will present temporary navigational hazards and be exposed to both ambient and storm generated wave action, breaking wave conditions, and deepwater/wave generated water velocities. These piles will likely be eroded and redistributed. The transport of these materials will likely extend to the reaches of the defined sediment plume. In the best scenario and if the piles remain in place, the backfilling of the basin and trench will cause a second plume episode of elevated suspended solids and sedimentation. In either case, the impact of erosion or of the backfilling could be as much as that of the original dredging and would cumulative.

The soft substrate in the project area includes: anoxic mud, soft mud and coarse and silty sand. Evidence of Quahaugs (*Mercenaria mercenaria*), Eastern Oysters (*Crassostrea virginica*) and Surf Clams (*Mulinia* sp.) exist throughout the nearshore project area, indicative of shellfish habitat. Various other benthic species were also evident throughout this habitat (e.g. crabs, whelks, worms and other clams). Rocky subtidal outcrops, functioning as reef-like (fouling) habitat, are interspersed among the dominant soft substrates. Fouling species include the macroalgae (Rockweeds - *Fucus* sp. and *Ascophyllum* sp., and Sea Lettuce - *Ulva* sp.), Blue Mussels (*Mytilus edulis*), Oyster Drills (*Urosalpinx cinera*), Dove Snails (*Mitrella lunata*), Red-beard Sponge (*Microcionia prolifera*), Convex Slipper Shell (*Crepidula plana*) and Slipper Shell (*C. fornacata*).

Approximately twenty-three (23) finfish species may transit or reside in the project area. Egg distribution of ten (10) of these species are laid on, or settle to the bottom. Four (4) species of *Arthropoda* are benthic or demersal species. Lobsters reside along hard bottoms or bottoms with relief and or shelter conditions. At maturity, lobster eggs are hatched when the female agitates them by shaking her body and the offspring are cast off. The young drift as pelagic zooplankton then settle as early benthic forms with a soft carapace and require stable hard substrates with relief and crevices, or with ample sheltering features until maturity.

The proposed actions will cause an estimated direct displacement or damage to 440± ac of nearshore bottom area between MP 10.1 - 12.5. These impacts will be caused by the dredging/trenching, barge anchor scars and anchor cable sweeps. The anticipated bottom damage will alter an existing productive shellfish habitat, and an existing invertebrate community structure inclusive of a late successional/transition structure to a pioneer/opportunistic structure. After all project related activities and secondary conditions associated with the construction have ceased, the bottom will recover after several years and return to the existing condition. In addition to direct bottom damage, indirect impacts caused by elevated suspended solid concentrations at or near the bottom can be irritating to any species that remains/survives within construction locus.

Mechanical clamshell dredging of medium sands with some coarse and silty fractions will generated suspended solids concentrations ranging from 50-700 mg/l, and the plume will decay rapidly. These concentrations are reported within 16.5 ft (5 m) of the centerline of the proposed dredged trench.

Measurable residual concentrations can exist along the bottom up to 3040± ft (920 m). Concentrations of suspended solids are directly related to the speed of the bucket retrieval during the dredging.

The literature reports that sedimentation deposits of 0.5 - 1.0 mm will cause up to 50%, and deposition of up to 2.0 mm will cause 100% mortality to non-encased pelagic fish eggs with diameters of up to 0.9 mm. Deposition between 1.0 - 2.0 mm will limit the settling of shellfish culch. Potentially damaging sedimentation thicknesses generated from the project can occur within 100 ft of the dredged trenches. Sedimentation can cover existing unaffected soft bottom conditions, possibly smothering existing resources; or cover limited hard substrate conditions, reducing both fouling and sheltering hard substrate conditions, and possibly smothering existing resources.

Impacts of primary concern should include the 440± ac of direct displacement or damage. These losses will have a dramatic effect in the short term fishery (commercial and recreational). In addition, secondary concern should include the various turbidity events anticipated, and the deposition of sediments on the hard substrate habitats. TGG recommends that stringent and specific construction supervision and mitigation, and compensatory resource mitigation must be developed to protect nearshore resources and compensate (in- and out of kind) for lost valuable resources.

# *REPORT OF FINDINGS*

# PRELIMINARY REPORT ON THE ANTICIPATED BIOLOGICAL IMPACTS ASSOCIATED WITH THE PROPOSED ISLANDER EAST PIPELINE PROJECT, THROUGH THE NEARSHORE AREA OF LONG ISLAND SOUND - BRANFORD, CONNECTICUT

## *SECTION ONE: INTRODUCTION*

The Garrett Group, LTD. (TGG) has been retained by the Town of Branford, CT (the Client) to conduct a review of technical environmental materials presented by Islander East Pipeline Company (the proponents) to various regulators for the above-referenced project. Included in our review is the Final Environmental Impact Statement (FEIS)[1] and various technical reports prepared in support of, or to augment the FEIS presentation. TGG has also reviewed a study prepared for the Client, by Roberge (2003)[2]; a benthic study prepared for the proponent, by TRC (2003)[3], and various other literature resources available to TGG. TGG accepts the biological data presented by the proponents as valid. However, we have also been requested by the Client to verify the biological information presented by the proponents. Therefore, TGG will conduct field sampling during the upcoming months. Any additional findings will be presented as an addendum to this report.

TGG's evaluation is limited to the subtidal environment of the project area associated with the project's Connecticut Mainland approach, which includes the dredged Horizontal Directional Drilling (HDD) transition basin beginning at MP 10.1 and extending to MP 10.9; the mechanically dredged pipeline trench (MP 10.9 to MP 12), that extends beyond the limit of town jurisdiction; and a short portion of the seaplow trench from MP 12 to MP 12.5 out to Northwest Reef.

The FEIS accurately describes Long Island Sound (LIS) as one of the largest estuaries along the Atlantic coast of the United States. LIS is a semi-enclosed northeast-southwest trending basin that is approximately 113 mi long and 20 mi wide. Its eastern end opens to the Atlantic Ocean through several large passages between islands. The western end is connected to New York Harbor through a narrow tidal strait. According to the Eldridge Tide and Pilot Book 2003[4], ebb currents in the project area trend to the east-northeast, or 82° as reported by Roberge 2003. Flood currents trend to the west or 265°, as reported by

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1 FERC. 2002. Islander East Pipeline Project - Final Environmental Impact Statement. Islander East Co. LLC. - Docket No. CP01-384.000 and Algonquin Gas Transmission Co. - Docket No. CP01-387-000. FERC/EIS - 0143F.

2 Roberge, J.C. 2003. Potential sedimentation impacts which could result from dredging, MP 10.9 - MP 12.0 Proposed Construction of the Islander East Gas Transmission Pipeline. Prepared for the Town of Branford, CT, by John C. Roberge, PE, LLC.

3 TRC Environmental Corporation. 2003. Evaluation of Benthic Impacts Associated with Islander East's Modified Offshore Construction Techniques - Islander East Pipeline Project. Prepared for: Islander East Pipeline Company, LLC, Branford, CT. Prepared by: TRC Environmental Corporation, Lowell, MA. pp 1-7.

4 White, M.J., R.E. White, Jr. and L.F. White. 2003. Eldridge Tide and Pilot Book - 2003. Boston, MA. pgs. 78-83.

Roberge (2003). Roberge (2003) also reports that maximum current velocities on the ebb current run at 72 cm/s, and on the flood run at 57 cm/s.

The proposed pipeline will cross the central portion of LIS. The major water quality issue associated with LIS is extremely low dissolved oxygen (DO) concentrations (anoxia or hypoxia) in, or near the bottom waters. This condition is typically encountered in the western portion of LIS; however, concerns include the entire Connecticut shoreline during the summer months or during specific events throughout the year (i.e marine construction activities). LaSalle et al (1991)[5] reports that dredging or disposal induced dissolved oxygen (DO) reduction in the water column around the construction activity is a direct consequence of the suspension of anoxic sediment material causing an episodic chemical or biological oxygen demand. DO reductions of 2 - 4 mg/l can be catastrophic to the nearshore community, especially during slack water. Please review any one of the annual CTDEP-OLISP Sound Hypoxia Reports as published in hard copy or on the CTDEP web page, for both short - and long term trends.

Estuarine embayments typically provide extensive natural and physical resources, and suitable shellfish and finfish habitats. National Marine Fisheries Service (NMFS) personnel (Milford, CT) are typically concerned with adverse effects to Winter Flounder *(Pleuronectes americanus)* breeding habitat and American Lobster (*Homarus americanus*) habitat relative to dredging projects proposed for the Connecticut nearshore area.

## *SECTION TWO: PROPOSED PROJECT ACTIVITIES AND ANTICIPATED EFFECTS WITHIN THE STUDY AREA*

### Nearshore Bottom Involvement

The pipeline project proposes to lay a 24" welded gas pipeline from Branford, CT across the central portion of LIS to Wading River, NY, on Long Island.

The Connecticut Mainland approach includes a transition from a subsurface onshore to subsurface offshore pipeline. The passing from the onshore to offshore portion of the pipeline will be constructed using the HDD method. A borehole will be set below the sea floor at the Tilcon Crossing Channel. The HDD portion of the pipeline will extend 0.60 mi into the nearshore area of LIS to MP 10.9. At this location, the pipeline alignment will transition to a mechanically dredged channel. The dredged channel will continue offshore for an additional 1.1 mi from MP 10.9 to MP 12. At MP 12, the pipeline will lay in a plow trench using a seaplow methodology.

The HDD borehole will be a subsurface feature and will have no direct effect on the nearshore sea floor. The borehole will be drilled from a land-based drilling platform on the Connecticut Mainland. To assist the drill over the 0.60 mi length of proposed borehole, the borehole will be lubricated using a bentonite slurry that will be pumped into the borehole as the drill advances. The slurry will be mixed on, and be pumped from the land-based drilling platform. The borehole will pierce the sidewall (landside) of the HDD

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5 LaSalle, M.W., D.G. Clarke, J. Homziak, J.D. Lunz and T.J. Fredette. 1991. *"A Framework for Assessing the Need for Seasonal Restrictions on Dredging and Disposal Operations"*. Tech Rep D-91-1, US Army Engineer Waterways Exp Stn, Vicksburg, MS.

transition trench. The dimensions of this trench are 250' long by 130' wide (32,500 sf or 0.75 ac), and approximately 20' deep. This surface area allows for working room to insert the 24" welded pipeline into the borehole. The welded pipe will be pulled back through the borehole as the drill is extracted back toward land. The 250' trench length also allows for the pipe's elevation transition from the deep borehole to the shallow dredge trench (5' ft below the seabed). Anchored surface and lay barges will provide over water working and storage platforms to fabricate and lay the welded pipeline. The dredging of the transition trench will generate approximately 6500 cy of material.

In their initial submittals, the proponents proposed to side cast the dredged material into temporary piles around the perimeter of the trench. The toe width of the side cast piles is 65± ft. Side casting of trench material would add 49,400 sf or 1.13 ac of surface area impact[6]. A later submittal (TRC 2003) indicates that the proponents propose to place dredge material on barges as opposed to side casting onto the nearshore bottom, therefore eliminating the predicted 1.13 ac of temporary bottom displacement. The dredged transition trench will be backfilled with a portion of the dredge material stored on the barges, or engineered fill (cut stone and/or graded sand) barged out to the site, to cover the laid pipeline with 1.5' of cover material.

Since there will be several barging events (e.g. dredging, pipeline construction and backfilling), anticipated surface area disruption from anchor scars and anchor cable sweeps will occur during each event, and will overlay each other. Based on numbers reported in the FEIS, TGG estimates surface area impacts (temporary disruptions) from both anchor scars and anchor cable sweeps to be up to 18 ac in association with the HDD construction method[7].

Previously, the mechanical dredge trench construction included side casting of dredge material. However, the proponent now proposes to place the dredge material from the trench between MP - 10.9 and 12 (1.1 mi) on barges, causing 6.67 ac of disruption to the nearshore bottom[8]. This reduces direct bootom displacement by 8.0± ac. The dredging of the dredge trench will generate approximately 45,000 cy of material. As with the transition trench dredging, the dredged trench will be backfilled with a portion of the dredge material stored on the barges, or engineered fill barged out to the site, to cover the laid pipeline with 1.5' of cover material. Anticipated surface area disruption from barge anchor scars and anchor cable sweeps will occur during each event, will overlay each other, and are estimated to be up to 280 ac in association with the mechanical dredge trench[9].

From MP 12 to where the depth of LIS is < 20' along the nearshore area of Long Island, the pipeline will be laid in a proposed seaplow trench. The seaplow trench and spoil mounds will temporarily displace 4.5± ac

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6 ([250' x 65'] x 2) + ([130' x 65'] x2) = 49,400 sf / 43560 sf / ac = 1.13 ac.

7 The FEIS appears to have calculated impacts over a 22.5 mi project distance, and TGG interpolated these numbers to a 0.07 mi project distance.

8 (5280'/mi x mi) x 50' = 290,400 sf / 43560 sf / ac = 6.67 ac.

9 The FEIS appears to have calculated these impacts over a 22.5 mi project distance, and TGG interpolated these numbers to a 1.1 mi project distance.

of nearshore bottom[10] between MP 12 and MP 12.5. Anticipated surface area impacts from both anchor scars and anchor cable sweeps are estimated to be up to 130 ac in association with the short run of the seaplow trench (MP 12 - 12.5)[11].

Table 1 presents a summary of TGG's estimated direct surface area displacement or effects to the Connecticut nearshore bottom area of LIS.

**TABLE 1: ANTICIPATED SURFACE AREA EFFECTED IN THE BRANFORD, CT NEARSHORE BOTTOM (MP 10.1 - 12.5)**

| Construction Operations | | Location | Effected Surface Area | |
|---|---|---|---|---|
| Method | Action | | Square Footage | Acreage |
| HDD | Borehole | MP 10.1 - 10.9 | N/A | N/A |
| | Transition Trench | | 32,500± | 0.75 |
| | Anchor Scars & Cable Sweeps | | 784,100± | 18 |
| Dredge Trench | Dredged Trench | MP 10.9 - 12 | 290,400± | 6.67 |
| | Anchor Scars & Cable Sweeps | | $1.2 \times 10^7$± | up to 280± |
| Sea Plow | Trench & Side Cast Piles | MP 12 - 12.5 | 196,000± | 4.5 |
| | Anchor Scars & Cable Sweeps | | $5.7 \times 10^6$± | up to 130± |
| ESTIMATED TOTAL SURFACE AREA EFFECTED | | | | 440± ac |

The proponent's impact estimates for both the transition trench and dredge trench do not appear to take into account the anchor scars or cable sweeps as bottom impacts. In TGG's best professional judgement, anchor scars and cable sweeps change bottom relief, and disrupt bottom conditions. While these impacted areas will recolonize, there will be a short-termed adverse effects and therefore should be part of the direct impact calculation.

For the transition trench, the FEIS reports direct bottom impacts to be 24± ac including side cast piles; and TRC (2003) reports impacts to be 8± ac without side cast piles. For the dredge trench, the FEIS reports direct bottom impacts to be 115± ac including side cast piles; and TRC (2003) reports impacts to be 5.6± ac without side cast piles.

10 75' x 2640' / ½ mi = 198,000 sf / 43560 sf / ac = 4.5 ac

11 The FEIS appears to have calculated these impacts over a 22.5 mi project distance, and TGG interpolated these numbers to a 0.5 mi project distance.

TRC (2003) also reports that the backfilling proposal has been modified from 3.0± ft of cover over the pipeline, to 1.5± ft of cover over the pipeline. This modification reduces the direct surface area impacts as reported by TRC (2003). It also creates a bowl depression of 1.5± ft over 0.75 ac of the bottom, and a 1.5± ft x 50± linear depression over 6.67 ac of nearshore bottom. The change in relief should not pose any additional adverse effect to the post construction nearshore bottom.

Dredging is proposed to create the HDD transition trench and the dredging trench. Environmental concerns relative to dredging include: temporary loss of existing benthic habitat; increased suspended solids; resuspension of sediment bound pollutants; anoxic episodes, and sedimentation. During the dredging, the benthic habitat will undergo disturbance, and may eventually recover at the completion of the project. Based on professional experience, TGG reports that bottom recoveries typically require several years in the absence of additional activity.

The project area, prior to the implementation of the proposed pipeline project, is an area that is affected by several planned activities that include, at a minimum:

> The maintenance of the mooring basin around, and the navigation channel into the Tilcon Terminal, and
>
> Historical and on-going aquacultural activities on designated grants.

These activities, the effects of storms on the fine to moderate soft bottom environments in the nearshore area; and as reported by USDOC (1972)[12], the "unstable muddy bottom" support limited numbers of benthic species; have long contributed to limiting the project area's ability to succeed beyond a late successional and transitional stage species community.

LaSalle et al (1991) reports that periods for recolonization of bottom disturbances can vary dramatically. These periods can range from a few weeks for pioneer species to several years for late successional species, and are extremely dependent on site specific physical, environmental and anthropogenic conditions. These findings are supported by the database of monitoring data compiled by the Army Corps of Engineers - Disposal Area Monitoring Studies (the DAMOS Program).

LaSalle et al (1991) also summarizes the environmental effects of dredging and disposal operations on several types of marine organisms including finfish. Those effects include:

> **Increased Suspended Solids:** The life stages of all estuarine fish species are fairly tolerant of elevated suspended sediments levels. Fish that utilize naturally turbid waters for spawning and nursery grounds (e.g. estuaries) are typically adapted to elevated suspended solid levels. Channel dredging is typically a short termed event. Various investigators suggest that short termed elevated turbidity levels ranging from 500 - 1000 mg/l are considered safe for estuarine dependent finfish. However, elevated suspended solid levels around dredging operations typically cause short term and localized reductions in dissolved oxygen concentrations. Resuspension of contaminated bottom materials into the water column can strip chemically bound pollutants and redistribute them. Seasonal restrictions may need to address any adverse effects caused by such a redistribution.

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12 USDOC. 1972. Long Island Sound: An Atlas of Natural Resources. NOAA. pp. 52

**Sedimentation:** Demersal eggs are typically adhesive and typically remain in place along the bottom until larval hatching. Benthic species attach themselves or burrow into the bottom. Sedimentation typically smothers these species and benthic eggs. Also, demersal eggs are subjected to abrasion from coarse sediments. Fine grain materials tend to disperse over a greater bottom area than larger grained sands. Sediment deposition depths of 0.5 mm to 1.0 mm of material are reported to cause 50% mortality to non-encased pelagic fish eggs (White Perch - *Morone americana*) with egg diameters of 0.9 mm. Deposition depths of 2.0 mm cause 100% mortality. Also, deposition depths of 1.0 mm - 2.0 mm limit the settling of shellfish culch. Demersal and pelagic fish are sufficiently mobile to avoid burial during a sedimentation event, and will typically return to areas of disturbance following the cessation of activity. Sessile food resources are also subject to burial during sedimentation. Pre-existing hard bottom substrate and the associated sessile species are also subject to burial. Therefore, changes in the overall habitat conditions will occur.

The FEIS reports that the pipeline will cross the central fine-grained depositional basin of LIS. Also, it reports that a suspended solids plume would extend distances of approximately 360 ft. Based on the reported ebb and flood currents for the project area, the plume will migrate to the east-northeast on the ebb current, and west on the flood current. Since the ebb current is slightly faster than the flood current, TGG would expect the extent of the plume to be slightly greater to the east-northeast than to the west. TGG did not find any discussion on either short- or long termed suspended solids concentrations of this anticipated plume. Near field deposition is estimated to be 1.9 cm, and far field deposition is estimated to be 1.2 mm in thickness.

Bohlen (2001)[13] reports ambient suspended material concentrations within the Connecticut nearshore ranges between 10 -20 mg/l, and display a regular diurnal periodicity in response to tidal forces. In addition, episodic perturbations increase suspended material concentrations to 100 mg/l. These reported perturbations are also subject to episodic diurnal periodicity.

In their "Results and Conclusions" and "Summary" sections, Bohlen et al (2002a)[14] does not speak to suspended solids concentrations within their predicted impact zone. They make a singular statement that states, "The bulk of the remaining mass of resuspended sediments will settle within 300 ft (~100 m)" of its origin "producing a cover of approximately 1.2 mm in thickness in this area. Beyond this secondary impact zone any remaining entrained materials will merge with the background suspended material concentrations...100 mg/l.". They also report, "Despite the finer grained composition of the sediments, this characteristic favors the...rapid settlement of suspended sediments." Additionally, "...for the offshore region beyond MP 12 the impact zone will be confined to the immediate vicinity of the trench and some ancillary scars remaining from anchoring operations."

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13 Bohlen, W.F. 2001. A investigation of sediment transport and circulation in the vicinity of the Thimble Islands, Central Long Island Sound - Project Status Report - November, 2001. UCONN - Dept of Mar Sci, Groton.

14 Bohlen, W.F., M.M.W. Stroebel, M.L. Thatcher. 2002a. An initial evaluation of marine sediment dispersion associated with the installation of the Islander East Natural Gas Pipeline. Prepared for: Natural Resources Group, Inc. Minneapolis, MN.

Roberge (2003) reports that previous work conducted by Bohlen in Milford, CT determined that mechanical clamshell dredging of medium sands with some coarser materials, and some silts generated suspended sediment concentrations of 50 to 250 mg/l. Plume decay occurs rapidly, typically within 60 m downrange of the dredging operation. However, measurable residual concentrations can exist along the bottom up to 920 m downrange. Typical values of depth-averaged suspended sediment concentrations along the centerline of dredge buckets during water entry and withdrawal operations range between 50 - 500 mg/l, during rapid retrieval (Source Strength 1,684 g/s). Roberge (2003) also reports potential suspended concentrations ranges from the dredge trench centerline for this project as summarized in Table 2.

Modeled suspended solid concentrations generated by dredging ranged from a maximum of 671 mg/l at 5 m (16.5 ft) from the trench centerline; to a minimum of 1 mg/l 1000 m (3300 ft) from the trench centerline. At a Source Strength of 1,684 g/s all modeled suspended concentrations at 5 m (16.5 ft) from the centerline were at magnitude concentrations of $10^2$ mg/l; at 100 m (330 ft), were at magnitude concentrations of $10^1$ mg/l; and at ≥ 400 m (1300 ft) were at magnitude concentrations of < 10 mg/l. At a Source Strength of 454 g/s all modeled suspended concentrations at 5 m (16.5 ft) from the centerline ranged between 50 - 200 mg/l, and at distances ≥100 m (330 ft) were at magnitude concentrations of < 10 mg/l. At a Source Strength of 243 g/s all modeled suspended concentrations at 5 m (16.5 ft) from the centerline were < 100 mg/l, and at distances ≥100 m (330 ft) were at magnitude concentrations of < 10 mg/l.

Please refer to Figures 2 - 4 in Appendix A of Roberge (2003) for a graphic depiction of plume extent. At the source strength rate of 1684 g/s, suspended solids concentrations at the Thimble Islands equal ≤ 3 mg/l. The sub- and intertidal rocky outcrops immediately to the west of the Thimbles are also subjected to nearly absent turbidity, with plume concentrations of 3 - 10 mg/l.

Roberge (2003) also reports potential sediment deposition resulting from the anticipated turbidity plume, from the dredge trench centerline as summarized in Table 3. Modeled sedimentation from the anticipated turbidity plume ranged from a maximum of 2.7 mm at a distance of 5 m from the trench centerline; to a minimum of 0.0 mm at a distance of 200 m from the trench centerline. At a Source Strength of 1,684 g/s, all modeled sedimentation 5 m from the centerline ranged 1.4 mm to 2.7 mm, and at ≤ 100 m (330 ft) sediment thicknesses were estimated to be 0.1 mm. No measurable deposition is predicted beyond 100 m (330 ft). At a Source Strength of 454 g/s, the only modeled measurable deposition ranged from 0.4 mm to 0.7 mm; and at Source Strength of 243 g/s, the only modeled measurable deposition ranged from 0.2 mm to 0.4 mm. ASA (2002)[15] reports deposition patterns > 0.05 ft (1.5 cm) caused by the erosion of the spoil mounds during a modeled 90-day (long-term) period to occur 170± ft west of the trench and 460± ft to the east of the trench; and as expected is offset to the east, based on mean LIS current direction. In the short-term (20-day model period), deposition patterns > 0.05 ft (1.5 cm) extend 50 ft to the east and west of the trench.

Therefore based on LaSalle et al (1991) and these data developed by Roberge and ASA, it appears that sedimentation in the amounts to cause 50 - 100% mortality to demersal and benthic eggs and species could occur within, and to ≤ 100 ft of the trench footprints.

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15 Swanson, C., C. Galagan and C. Dalton. 2002. Dredged material mound dispersion analysis using LTFATE. Applied Science Associates, Inc., Narragansett, RI. Prepared for Natural Resources Group, Inc., Minneapolis, MN.

**Table 2: Summary Data Potential Suspended Sediment Concentrations (mg/l)**

| Station | Tidal Current | Normal Distance From Trench Centerline in Meters | | | |
|---|---|---|---|---|---|
| | | 5 | 100 | 400 | 1000 |
| Source Strength (R) = 1,684 g/s | | | | | |
| MP 10.9 | Flood | 671 | 34 | 8 | 3 |
| | Ebb | 354 | 18 | 4 | 2 |
| MP 11.5 | Flood | 527 | 26 | 7 | 3 |
| | Ebb | 299 | 15 | 4 | 1 |
| MP 12 | Flood | 420 | 21 | 5 | 2 |
| | Ebb | 253 | 13 | 3 | 1 |
| Source Strength (R) = 454 g/s | | | | | |
| MP 10.9 | Flood | 177 | 9 | 2 | 1 |
| | Ebb | 94 | 5 | 1 | 0 |
| MP 11.5 | Flood | 139 | 7 | 2 | 1 |
| | Ebb | 79 | 4 | 1 | 0 |
| MP 12 | Flood | 111 | 6 | 1 | 1 |
| | Ebb | 67 | 3 | 1 | 0 |
| Source Strength (R) = 243 g/s | | | | | |
| MP 10.9 | Flood | 97 | 5 | 1 | 0 |
| | Ebb | 51 | 3 | 1 | 1 |
| MP 11.5 | Flood | 76 | 4 | 1 | 0 |
| | Ebb | 43 | 2 | 1 | 0 |
| MP 12 | Flood | 61 | 3 | 1 | 0 |
| | Ebb | 37 | 2 | 0 | 0 |

Table 3: Summary Data - Potential Deposited Sedimentation Thicknesses (mm)

| Station | Tidal Current | Normal Distance From Trench Centerline in Meters | | | |
|---|---|---|---|---|---|
| | | 5 | 100 | 400 | 1000 |
| Source Strength (R) = 1,684 g/s | | | | | |
| MP 10.9 | Flood | 2.7 | 0.1 | 0 | 0 |
| | Ebb | 1.4 | 0.1 | 0 | 0 |
| MP 11.5 | Flood | 2.5 | 0.1 | 0 | 0 |
| | Ebb | 1.4 | 0.1 | 0 | 0 |
| MP 12 | Flood | 2.4 | 0.1 | 0 | 0 |
| | Ebb | 1.4 | 0.1 | 0 | 0 |
| Source Strength (R) = 454 g/s | | | | | |
| MP 10.9 | Flood | 0.7 | 0 | 0 | 0 |
| | Ebb | 0.4 | 0 | 0 | 0 |
| MP 11.5 | Flood | 0.7 | 0 | 0 | 0 |
| | Ebb | 0.4 | 0 | 0 | 0 |
| MP 12 | Flood | 0.6 | 0 | 0 | 0 |
| | Ebb | 0.4 | 0 | 0 | 0 |
| Source Strength (R) = 243 g/s | | | | | |
| MP 10.9 | Flood | 0.4 | 0 | 0 | 0 |
| | Ebb | 0.2 | 0 | 0 | 0 |
| MP 11.5 | Flood | 0.4 | 0 | 0 | 0 |
| | Ebb | 0.6 | 0 | 0 | 0 |
| MP 12 | Flood | 0.3 | 0 | 0 | 0 |
| | Ebb | 0.2 | 0 | 0 | 0 |

Should side cast storage of material re-emerge as a preferred project alternative, Roberge (2003) reports that the proposed piles will have heights of 10 - 11 ft. These pile heights will extend to between 2 - 10 ft of the water surface at various tidal stages, and in several locations. These piles will present temporary navigational hazards and be exposed to both ambient and storm generated wave action, breaking wave conditions, and deepwater/wave generated water velocities. During the period between dredging/trenching and backfilling, the side cast piles may be exposed to short-termed storm effects and will be eroded and be redistributed. The transport of these materials will likely extend to the reaches of the defined sediment plume (Roberge 2003). While the periods appear short between opening the trench and backfilling, nearshore storm and tidal effects can be unpredictable. In the best scenario and if the piles remain in place, the backfilling of the basin and trench will cause a second plume episode of elevated suspended solids and sedimentation. In either case, the impact of erosion or of the backfilling could be as much as that of the original dredging and would cumulative.

A concern was raised regarding the potential "toxicity" of the drill lubricating bentonite slurry. Bentonite is a naturally formed fine-particulate clay material that when moistened, forms a dense cake-like solid, but when saturated forms a smooth creamy-like fluid. As with any material used or consumed in extreme amounts, adverse effects could be realized; however, based on an extensive literature search, its recommended use in various applications by the environmental agencies, and discussions with other professionals; bentonite is not considered as a toxin. It behaves in a water column as any dense, inert and fine particle material will behave. It will flock, forming a dense turbid cloud. When the drill pierces the sidewall of the transition trench, there will be a small release of the slurry into the water column. The turbidity cloud produced will be small and isolated, and should mimic previously described plume characteristics, or rapidly dissipate into any background concentrations.

## *SECTION THREE: BIOLOGICAL COMMUNITY AND ANTICIPATED IMPACTS*

### Summary of the Invertebrate Assessment for the Project Area

The FEIS reports, based on several investigations conducted by Pellegrino (2002a and b)[16], the nearshore subtidal area in the path of the proposed pipeline is predominately soft bottom habitat with interspersed rocky outcrops. The soft bottom habitat serves as valuable commercial and recreational shellfish habitat. The proposed alignment passes through town managed shellfish grants and recreational fishing areas, and through two unlisted state managed shellfish leased area. The soft substrate in the project area includes: anoxic mud, soft mud and coarse and silty sand. Evidence of Quahaugs (*Mercenaria mercenaria*), Eastern Oysters (*Crassostrea virginica*) and Surf Clams (*Mulinia* sp.) exist throughout the nearshore project area, indicative of shellfish habitat. Various other benthic species were also evident throughout this habitat (e.g. crabs, whelks, worms and other clams).

Rocky subtidal outcrops, functioning as reef-like (fouling) habitat, are interspersed among the dominant soft substrates. Fouling species include the macroalgae (Rockweeds - *Fucus* sp. and *Ascophyllum* sp., and Sea

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16 Pellegrino, P.E. 2002a. Bottom characterization surveys of selected subtidal and nearshore environments off Juniper Point (Branford, CT) - Final Report. Prepared for Islander East Pipeline Company, Prepared by Coastal Resource Analysts. 21 p.

and

___________. 2002b. Macrobenthic community structure along the proposed Islander East Gas Pipeline route in Long Island Sound - Final Report. Prepared for Islander East Pipeline Company, Prepared by Coastal Resource Analysts. 14 p. w/Figures.

Lettuce - *Ulva* sp.), Blue Mussels (*Mytilus edulis*), Oyster Drills (*Urosalpinx cinera*), Dove Snails (*Mitrella lunata*), Red-beard Sponge (*Microcionia prolifera*), Convex Slipper Shell (*Crepidula plana*) and Slipper Shell (*C. fornacata*).

TGG agrees with Pellegrino (2002a & b) that the dominant invertebrate community is comprised of late successional and transitional stage species.

## Summary Fishery Assessment for the Project Area

The FEIS reports the following representative marine finfish species, as important species known to occur in the project area.

| Diadromous Species | Marine Species | | |
|---|---|---|---|
| | | Atlantic Mackerel | Sand Eel |
| | | Pollack | Sand Lance |
| | Butterfish | Red Hake | American Lobster |
| Brook Trout* | Summer Founder | Windowpane | Crab |
| Brown Trout* | Silver Hake | Striped Bass | Oyster Clam |
| Atlantic Salmon* | Weakfish | Sturgeon | Conch |
| Eels | Winter Flounder | Tautog | Scallop |
| Menhadens | Scup | Cunner | Squid |
| Smelt | Black Sea Bass | Sandbar Shark | |
| Shad | Bluefish | Sand Tiger Shark | |

* sea run species

Table 4, as reproduced from the FEIS, reports the Essential Fish Habitat (EFH) - Designated Species for the project area. EFH is defined as "those waters, aquatic areas, and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity...and to fulfill their associated physical, chemical and biological requirements. EFH provides a suite of indicator species that assist in evaluating status and/or changes in environmental conditions, and any alterations to those conditions.

While designated EFH species may address regulatory requirements, given the extent and complexity of the proposed pipeline project and the sensitive commercial and recreational nearshore resources within the Connecticut Mainland approach, TGG would recommend the applicant should expand the indicator species database to include other species that are documented to utilize the project area (e.g. Stone et al 1994[17]). As reported, the designated Estuarine Living Marine Resources (ELMR) program species were selected based on four (4) selection criteria that include: Commercial Value, Recreational Value, Ecological Value and indicators of environmental stress.

Appendix A presents a comprehensive list of ELMR fisheries resources expected to be found in the LIS estuary. This list includes 50 species. Variables such as water quality, salinity regime, substrate types will govern potential resource and habitat usage in the project area. TGG has short-listed those species which would be more than likely present in the project area. Criteria for short-listing included distribution within the mixing tidal regime, vertical distribution within the lower portion of the water column (benthic and

17 Stone, S.L, T.A. Lowery, J.D. Field, C.D. Williams, D.M. Nelson, S.H. Jury, M.E. Monaco and L. Andrease. 1994. Distribution and abundance of fishes and invertebrates in Mid-Atlantic estuaries. ELMR Rep No 12. NOAA/NOS Strategic Environmental Assessments Division, Silver Spring, MD. 280 p.

demersal types), and benthic residential and breeding habits. Species may fit all or a portion of these criteria. Many of which are transient or migratory.

**Table 4: Summary of Essential Fish Habitat Designations (reproduced from FEIS Table 3.4.1-4)**

| Fish and Shark Species | Eggs | Larvae | Juveniles | Adults |
|---|---|---|---|---|
| Atlantic Mackerel - *Scomber scombrus* | x | x | x | x |
| Atlantic Salmon - *Salmo salar* | | | x | x |
| Atlantic Sea Herring - *Clupea harengus* | | | x | x |
| American Plaice - *Hippoglossoides* | | | x | x |
| *platessoides* | | | x | x |
| | | | x | x |
| Black Sea Bass - *Centropristus straita* | x | x | x | x |
| Bluefish - *Pomatomus saltatrix* | x | x | x | x |
| Cobia - *Rachycentron canadum* | | | x | x |
| King Mackerel - *Scomberomorus cavalla* | x | x | x | x |
| Pollack - *Pollachius virens* | x | x | x | x |
| Red Hake - *Urophycis chuss* | x | x | x | x |
| Scup - *Stenotomus chrysops* | | | x | |
| | | | | x |
| Spanish Mackerel - *S. maculatus* | x | x | x | |
| Summer Flounder - *Paralicthys dentatus* | x | x | x | x |
| Whiting - *Merluccius bilinearis* | x | | x | x |
| Windowpane - *Scopthalmus aquosus* | | | | x |
| Winter Flounder - *Pseudopleuronectes* | | x | | x |
| *americanus* | | x | | |
| Longfin Inshore Squid - *Loligo pealeii* | | | | |
| Blue Shark - *Prionace glauca* | | | | |
| Sandbar Shark - *Charcharinus plumbeus* | | | | |
| Sand Tiger Shark - *Odontaspis taurus* | | | | |

Table 5 presents this short-list of ELMR species significant to the project area. Twenty three (23) species are demersal or benthic species which are typically distributed at or near the bottom. Also, the egg distribution of ten (10) of the short-listed species are laid on, or settle to the bottom. The four species of *Arthropoda* are benthic or demersal species, and are ovoviviporous (in these cases holding their eggs on specialized body appendages). The shellfish identified are benthic species (attached and burrowing). Several species are either anadromous or catadromous.

### Summary of Winter Flounder and American Lobster Habitat Requirements

Winter flounder habitat extends to the tide mark at specific tidal stages, including extreme high tides. They can also run up into the extreme brackish reaches of coastal rivers. Lower limits have not been specifically determined, but flounder are common down to 100± ft. Offshore (Georges Bank), flounder have been taken as deep 270± ft. Smaller fish typically inhabit shoal water, while larger specimens tend to go deeper. However, large adults have been taken in shallows. Young fry are chiefly found in the shallows.

## TABLE 5: SHORT-LISTED ELMR SPECIES AT THE PROPOSED PROJECT AREA

| COMMON NAME | FISHERY TYPE | VERTICAL DISTRIBUTION | EGG DISTRIBUTION |
|---|---|---|---|
| Blue Mussel | Invertebrate-Shellfish | benthic attached | buoyant pelagic |
| American Oyster | Invertebrate-Shellfish | benthic attached | buoyant pelagic |
| Northern Quahaug | Invertebrate-Shellfish | benthic burrower | buoyant pelagic |
| Softshell Clam | Invertebrate-Shellfish | benthic burrower | buoyant pelagic |
| Daggerblade Grass Shrimp | Invertebrate-Arthropod-Bait | demersal | ovoviviporous-attached |
| Sevenspine Bay Shrimp | Invertebrate-Arthropod-Bait | demersal | ovoviviporous-attached |
| American Lobster | Invertebrate-Arthropod | benthic | ovoviviporous-attached |
| Blue Crab | Invertebrate-Arthropod | benthic | ovoviviporous-attached |
| Skates | Cartilaginous Fish | benthic | oviparous/egg sack attached |
| American Eel | Bony Fish | pelagic | catadromous |
| Blueback Herring | Bony Fish | pelagic | anadromous |
| Alewife | Bony Fish | pelagic | anadromous |
| American Shad | Bony Fish | pelagic | anadromous |
| American Menhaden | Bony Fish | pelagic | spawns at sea |
| Atlantic Herring | Bony Fish | pelagic | sinking, non-bouyant |
| Bay Anchovy | Bony Fish-Baitfish | demersal | demersal |
| Rainbow Smelt | Bony Fish-Baitfish | demersal | sandy beaches |
| Atlantic Tomcod | Bony Fish | demersal | demersal |
| Red Hake | Bony Fish | demersal | demersal |
| Oyster Toadfish | Bony Fish | demersal | demersal |
| Sheepshead Minnow | Bony Fish-Baitfish | pelagic | sinking, non-buoyant |
| Killifish | Bony Fish-Baitfish | pelagic | sinking, non-buoyant |
| Silversides | Bony Fish-Baitfish | pelagic | benthic, sandy bottom |
| Northern Pipefish | Bony Fish-Baitfish | demersal/grasses | benthic grasses |
| Northern Searobin | Bony Fish | demersal | pelagic buoyant |
| White Perch | Bony Fish | pelagic | anadromous/non-buoyant |
| Striped Bass | Bony Fish | pelagic | anadromous/non-buoyant |
| Bluefish | Bony Fish | pelagic | buoyant |
| Scup | Bony Fish | pelagic | buoyant |
| Weakfish | Bony Fish | pelagic | buoyant |
| Tautog | Bony Fish | demersal | buoyant |

## TABLE 5 cont'd: SHORT-LISTED ELMR SPECIES AT THE PROPOSED PROJECT AREA

| | | | |
|---|---|---|---|
| Cunner | Bony Fish | demersal | buoyant |
| American Sand Lance | Bony Fish-Baitfish | benthic | benthic/sandy bottom |
| Gobies | Bony Fish-Baitfish | pelagic | unknown |
| Atlantic Mackerel | Bony Fish | pelagic | buoyant |
| Butterfish | Bony Fish | demersal | buoyant |
| Windowpane Flounder | Bony Flatfish | benthic | buoyant |
| Winter Flounder | Bony Flatfish | benthic | buoyant |
| Hogchoker | Bony Flatfish | benthic | unknown |

Flounder can be commonly found on bottom types varying from soft muddy sand, with and without eelgrass *(Zostera marina)*; clean sand; clay; and pebbly/gravelly bottoms.

As adults, winter flounder migrate into shoal waters in the late autumn when water temperatures fall, and back to deeper waters in the spring when water temperatures rise. Apart from seasonal movements, winter flounder are typically stationary in nature (CTDEP 1977)[18]. The winter flounder is a winter/spring breeder, typically spawning from December - April in LIS.

Lobsters reside along hard bottoms or bottoms with relief and or shelter conditions. Lobsters are scavengers and feeding activities slow in colder waters and increase as water temperatures increase. After breeding, eggs are carried by the female for 11-12 months . At maturity, eggs are hatched when the female agitates them by shaking her body and the offspring are cast off. The young drift as pelagic zooplankton then settle as early benthic forms with a soft carapace and require stable hard substrates with relief and crevices, or with ample sheltering features until maturity.

## *SECTION FOUR: CONCLUSIONS*

The proposed actions will cause an estimated direct displacement or damage to 440± ac of nearshore bottom area between MP 10.1 - 12.5. These impacts will be caused by the dredging/trenching, barge anchor scars and anchor cable sweeps. The anticipated bottom damage will alter an existing productive shellfish habitat, and an existing invertebrate community structure inclusive of a late successional/transition structure to a pioneer/opportunistic structure. After all project related activities and secondary conditions associated with the construction have ceased, the bottom will recover after several years and return to the existing condition.

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18 CTDEP. 1977. *Long Island Sound: An Atlas of Natural Resources*. CTDEP - Coastal Area Management Program, NOAA/CZM. pp. 52.

This project modification that eliminates the side cast piles reduces the direct surface area impacts. The reduction of cover material from 3.0± ft to 1.5± ft will create a bowl depression of 1.5± ft over 0.75 ac of the bottom, and a 1.5± ft x 50± linear depression over 6.67 ac of nearshore bottom. These changes in relief are gradual and shallow, and will impact the post construction nearshore bottom. The use of engineered fill will create a varied benthic habitat, shelter/relief, and should enhance nearshore bottom conditions.

In addition to direct bottom damage, indirect impacts caused by elevated suspended solid concentrations at or near the bottom may include, a temporal turbidity plume downdrift (tidal/current direction) of the specific construction locus, sedimentation over downdrift bottom (soft and hard substrates), and an anoxic episode(s).

LaSalle et al (1991) indicates that turbidity ranges of up to 500-1000 mg/l are considered safe for estuarine dependent species. Bohlen (2001) estimates that ambient turbidity concentrations range from 10-20 mg/l in the Connecticut nearshore area. Episodic perturbations under ambient conditions may cause a rise in suspended concentrations to ±100 mg/l. Bohlen (2002a) reports that any plume generated (no specific concentration reported) will either merge with background concentrations, or will decay within 300 ft (91 m) of the dredged trench. Roberge (2003) reports that mechanical clamshell dredging of medium sands with some coarse and silty fractions will generated suspended solids concentrations ranging from 50-700 mg/l, and the plume will decay rapidly. These concentrations are reported within 16.5 ft (5 m) of the centerline of the dredged trench. Measurable residual concentrations can exist along the bottom up to 3040± ft (920 m). Concentrations of suspended solids are directly related to the speed of the bucket retrieval during the dredging.

LaSalle et al (1991) reports that sedimentation deposits of 0.5 - 1.0 mm will cause up to 50%, and deposition of up to 2.0 mm will cause 100% mortality to non-encased pelagic fish eggs with diameters of up to 0.9 mm. Deposition between 1.0 - 2.0 mm will limit the settling of shellfish culch. Roberge (2003) reports potentially damaging sedimentation thicknesses within 16.5 ft (5 m) of the trench centerline during various retrieval rates. Near- and far field deposition of suspended solids may cause a measurable cover, or a thin veneer of fine particle cover over proximal hard bottom substrate; and again may adversely effect the fouling capacities of, or sheltering resources on, or within these substrates. Sedimentation will cover existing unaffected soft bottom conditions, possibly smothering existing resources; or cover limited hard substrate conditions, reducing both fouling and sheltering hard substrate conditions, and possibly smothering existing resources. Benthic species are so sensitive (e.g. Eastern Oyster), that thin sedimentation veneers can alter a hard substrates ability to foul. With the presence of anoxic muds and silts temporary anoxic episodes should be anticipated.

The project should consider expanding the scope of species of concern to include not only the EFH designated species, but also those other species identified which utilize the LIS nearshore areas (e.g. those additional ELMR species not included in the EFH list etc.). During the construction period motile pelagic, demersal and benthic species will evacuate the 440± ac direct impact area. Sessile species will be lost when bottom disruptions are experienced. Upon completion, many of the motile species will return. However, the bottom will be barren with little to no relief in the short term, and lacking a benthic invertebrate community. Beyond the immediacy of the construction period, the soft bottom will recruit a limited pioneer/opportunistic structure. Based on both historical and existing project area activities, it could take several years for the soft bottom to return to the existing successional/transition structure.

The EFH species list designated for the project site appears skewed toward pelagic species. Whereas, the ELMR species list includes several demersal and benthic species and appears more representative of those species utilizing the project area. Several of the ELMR species, and some of the EFH species identified are demersal or benthic species which are typically distributed at or near the bottom. Also, the egg distribution of ten (10) of these species are laid on, or settle to the bottom. The identified *Arthropoda* are benthic or demersal species. The shellfish identified are benthic species (attached and burrowing).

The anticipated direct impacts, bottom turbidity and sedimentation will affect portions of the existing benthic environment; therefore, disrupting the habitat conditions for various shellfish and finfish. These disruptions will be temporal, assuming natural recovery, the nearshore area will exhibit noticeable changes.

## Recommendations

Impacts of primary concern should include the 440± ac of direct displacement or damage. These losses will have a dramatic effect in the short term fishery (commercial and recreational). In addition, secondary concern should include the various turbidity events anticipated, and the deposition of sediments on the hard substrate habitats.

TGG recommends that specific construction supervision and mitigation, and compensatory resource mitigation should be considered to protect adjacent resources and compensate (in- and out of kind) for lost valuable resources. Project mitigation should include, but not be limited to:

### Construction Mitigation

1) Require "third party oversight for all construction operations and monitoring, and authorizing said party to shut down operations should operational or permitting thresholds limits be exceeded.

2) The dredging contractor should be required to prepare and implement a project specific "Dredge Management Plan" to establish performance standards to define monitoring protocols, specific protective mitigation actions, and the means to which the contractor will employ to minimize construction impacts (e.g. silt curtains/barriers, acoustic deterrents, bucket retrieval rates etc.).

3) Define the operational limits for sediment plume release and suspended solids concentrations that will cause the termination of dredging/seaplowing, should those limits be exceeded.

4) Limit construction to construction windows that will minimize impacts to areal flora and fauna, including periods of productivity and spawning.

5) No side cast disposal of dredged material should be allowed.

6) Use of sealed environmental buckets to limit turbidity generated by resuspension of materials in the water column during hauling and retrieval.

**Compensatory Resource/Habitat Mitigation -**

1) Recommend the use of engineered fill.

2) The proponent and the Client should agree upon a shellfish protection and restoration plan to protect this vital commercial and environmental resource. This plan should include at a minimum:

   define all productive resources within the pipeline path,
   develop a relay plan to harvest existing individuals, and utilize or replant all, or a portion them in another suitable areal bed,
   once the construction activities are completed and the nearshore bottom has stabilized, a multi-year shellfish seeding plan should be developed and approved by the resource agency(s), and implemented by the proponent, and
   develop and implement a monitoring program to assure that replanted shellfish beds are reasonably successful.

3) Since the bottom will be barren with little to no relief immediately following construction and existing hard substrate bottom, may be altered by sedimentation; the applicant should commit to placing protective structure and relief to provide sheltering habitat for vulnerable benthic species (e.g. BBP lobsters); and

4) develop and implement 5 year monitoring program to define all sensitive resources in the nearshore area and document the recovery of benthic habitats in the project area.

# *APPENDIX A*

# TYPICAL SPATIAL AND TEMPORAL DISTRIBUTION, AND ABUNDANCE FOR THE SPECIES CONSIDERED SIGNIFICANT TO THE LONG ISLAND SOUND ESTUARY

| Common Name | Scientific Name | Spatial Distribution and Abundance | Temporal Distribution |
|---|---|---|---|
| Blue Mussel[(1)] | *Mytilis edulis* | E: common (M) | E: common April-July and October, rare August-September |
| | | L: common (M) | L: common April-July and October, rare August-September |
| | | J: common (M) | J: common all year |
| | | S: common (M) | S: common April-July and October, rare August-September |
| | | A: common (M) | A: common all year |
| Bay Scallop[(1)] | *Argopecten irradians* | E: rare (M) | E: rare June-August |
| | | L: rare (M) | L: rare June-September |
| | | J: rare (M) | J: rare all year |
| | | S: rare (M) | S: rare June-August |
| | | A: rare (M) | A; rare all year |
| American Oyster[(1)] | *Crassostrea virginica* | E: abundant (M) | E: abundant August, common October |
| | | L: abundant (M) | L: abundant August, common March-October-November |
| | | J: abundant (M) | J: abundant all year |
| | | S: abundant (M) | S: abundant August, common October |
| | | A: abundant (M) | A: abundant all year |
| Northern Quahaug[(1)] | *Mercenaria mercenaria* | E: abundant (M) | E: common May and September, abundant June-August |
| | | L: abundant (M) | L: common May and October, abundant June-September |
| | | J: abundant (M) | J: abundant all year |
| | | S: abundant (M) | S: common May and September, abundant June-August |
| | | A: abundant (M) | A: abundant all year |

**TYPICAL SPATIAL AND TEMPORAL DISTRIBUTION, AND ABUNDANCE FOR THE SPECIES CONSIDERED SIGNIFICANT TO THE LONG ISLAND SOUND ESTUARY**

| Common Name | Scientific Name | Spatial Distribution and Abundance | | Temporal Distribution | |
|---|---|---|---|---|---|
| Softshell Clam [1] | *Mya arenaria* | E: | common (M) | E: | rare April, common May to September |
| | | L: | common (M) | L: | rare April, common May to September |
| | | J: | common (M) | J: | common all year |
| | | SA: | common (M) | SA: | rare April, common May to September |
| | | A: | common (M) | A: | common all year |
| Daggerblade Grass [1] Shrimp | *Palaemonetes pugio* | E: | common (M) | E: | rare May and October, common June through September |
| | | L: | common (M) | L: | rare May and October, common June through September |
| | | J: | abundant (M) | J: | rare May and December, common June and November, and abundant July through October |
| | | SA: | common (M) | SA: | rare May and October, common June through September |
| | | A: | abundant (M) | A: | common December through May, abundant July through November |
| Sevenspine Bay Shrimp [3] | *Crangon septemspinosa* | E: | abundant | E: | rare January and February and December, common March through May October and November, and abundant June through September |
| | | L: | abundant | L: | rare January and February and December, common March through May October and November, and abundant June through September |
| | | J: | highly abundant (M) | J: | abundant January through March and December, highly abundant April through November |
| | | SA: | abundant | SA: | rare January and February and December, common March through May October and November, and abundant June through September |
| | | A: | highly abundant (M) | A: | abundant January through March and December, highly abundant April through November |

## TYPICAL SPATIAL AND TEMPORAL DISTRIBUTION, AND ABUNDANCE FOR THE SPECIES CONSIDERED SIGNIFICANT TO THE LONG ISLAND SOUND ESTUARY

| Common Name | Scientific Name | Spatial Distribution and Abundance | | Temporal Distribution | |
|---|---|---|---|---|---|
| American Lobster[(1)] | *Homerus americanus* | E: | abundant (M) | E: | highly abundant all year |
| | | L: | abundant (M) | L: | abundant May and September, highly abundant June through August |
| | | J: | abundant (M) | J: | highly abundant all year |
| | | Mt: | abundant (M) | Mt: | highly abundant June through November |
| | | A: | abundant (M) | A: | highly abundant all year |
| Blue Crab[(3)] | *Callinectes sapidus* | E: | common (M) and (S) | E: | common May through September |
| | | L: | rare (M) | L: | rare May through September |
| | | J: | common (M) and (T) | J: | common all year |
| | | Mt: | common May through October | Mt: | common May through October |
| | | A: | common (M) and (T) | A: | common all year |
| Cownose Ray[(1)] | *Rhinoptera bonansus* | P: | rare (M) | P: | rare June through October |
| | | J: | rare (M) | J: | rare June through October |
| | | Mt: | rare (M) | Mt: | rare June through October |
| | | A: | rare (M) | A: | rare June through October |
| Shortnose Sturgeon[(1)] | *Acipenser brevirostrum* | E: | common (M) | E: | rare April through June |
| | | L: | rare (T) | L: | rare May through August |
| | | J: | rare (M), common (T) | J: | common all year |
| | | SA: | rare (T) | SA: | rare April through June |
| | | A: | rare (M) and (T) | A: | rare all year |

**TYPICAL SPATIAL AND TEMPORAL DISTRIBUTION, AND ABUNDANCE FOR THE SPECIES CONSIDERED SIGNIFICANT TO THE LONG ISLAND SOUND ESTUARY**

| Common Name | Scientific Name | Spatial Distribution and Abundance | | Temporal Distribution | |
|---|---|---|---|---|---|
| American Eel [2] | *Anguilla rostrata* | L: | common (M) and rare (T) | L: | common March through August |
| | | J: | common (M) and (T) | J: | common all year |
| | | A: | common (M) and abundant (T) | A: | abundant September through November |
| Blueback Herring [2] | *Alosa aestivalis* | E: | common (M) and abundant (T) | E: | common May and July through September |
| | | L: | common (M) and abundant (T) | L: | common May and July through September |
| | | J: | common (M) and highly abundant (T) | J: | common January through June and November through December, abundant October, and highly abundant July through September |
| | | SA: | common (M) and abundant (T) | SA: | common May and July through September |
| | | A: | highly abundant (M) and (T) | A: | common January through March and August through December, abundant April and June through August, and highly abundant May |
| Alewife [2] | *A. pseudoharangus* | E: | abundant (T) | E: | common March and July, abundant April through June |
| | | L: | common (M), highly abundant (T) | L: | common April and July, highly abundant May and June |
| | | J: | highly abundant (M) and (T) | J: | common January through May and November and December, highly abundant May through October |
| | | SA: | highly abundant (T) | SA: | common April and July, highly abundant May and June |
| | | A: | abundant (M) and (T) | A: | common January through April and July through December, highly abundant May and June |
| American Shad [2] | *A. sappidissima* | E: | common (M) and (T) | E: | abundant April through July |
| | | L: | abundant (M) and (T) | L: | common May and July through August, abundant June |
| | | J: | abundant (M) and (T) | J: | common January through may and October though December, abundant June through November |
| | | SA: | abundant (T) | SA: | abundant May through July |
| | | A: | abundant (M) and (T) | A: | abundant April through July |

## TYPICAL SPATIAL AND TEMPORAL DISTRIBUTION, AND ABUNDANCE FOR THE SPECIES CONSIDERED SIGNIFICANT TO THE LONG ISLAND SOUND ESTUARY

| Common Name | Scientific Name | Spatial Distribution and Abundance | Temporal Distribution |
|---|---|---|---|
| American Menhaden [1] | *Brevoortia tyrannus* | L: abundant (M) and common (T) | E: common April and August through September, abundant May through July, rare October and November |
| | | | L: common April and August through November, abundant May through July, rare December |
| | | J: highly abundant (M), abundant (T) | J: common April through May and October through November, abundant June through July, highly abundant August |
| | | SA: highly abundant (T) | SA: common August and October, abundant May and September, highly abundant June through August, rare November |
| | | A: highly abundant (M) and common (T) | A: common April and August through November, highly abundant May through July, abundant August |
| Atlantic Herring [1] | *Clupea harengus* | L: rare (M) | L: rare March through May |
| | | J: common (M) | J: common all year |
| | | A: common (M) | A: abundant January through May and November through December, common May through October |
| Channel Catfish [1] | *Ictalurus punctatus* | E: rare (M) and (T) | E: rare June through July |
| | | L: rare (M) and (T) | L: rare June through July |
| | | J: rare (M), common (T) | J: common all year |
| | | SA: rare (M) and (T) | SA: rare June through July |
| | | A: rare (M), common (T) | A: common all year |

## TYPICAL SPATIAL AND TEMPORAL DISTRIBUTION, AND ABUNDANCE FOR THE SPECIES CONSIDERED SIGNIFICANT TO THE LONG ISLAND SOUND ESTUARY

| Common Name | Scientific Name | Spatial Distribution and Abundance | Temporal Distribution |
|---|---|---|---|
| Bay Anchovy [1] | *Anchoa mitchii* | E: highly abundant (M), common (T) | E: abundant April and August |
| | | L: highly abundant (M), abundant (T) | L: rare May and November, abundant June and August through September, highly abundant July, common October |
| | | J: abundant (M), common (T) | J: abundant all year |
| | | SA: highly abundant (M), common (T) | SA: abundant April and August |
| | | A: abundant (M), common (T) | A: common January through June and October through December, abundant July through September |
| Rainbow Smelt [1] | *Osmerus mordax* | E: common (M), abundant (T) | E: rare January and February, common March and May, abundant April |
| | | L: abundant (M) and (T) | L: rare February and march, common April, abundant May and June |
| | | J: rare (M), common (T) | J: common March through August, rare September through December |
| | | SA: common (M), abundant (T) | SA: rare January and February, common March and May, abundant April |
| | | A: rare (M), common (T) | A: common January through May and October through December, rare July through September |
| Atlantic Salmon [1] | *Salmo salar* | J: rare (M) and (T) | J: rare March through August |
| | | A: rare (M) and (T) | A: rare February through November |

# TYPICAL SPATIAL AND TEMPORAL DISTRIBUTION, AND ABUNDANCE FOR THE SPECIES CONSIDERED SIGNIFICANT TO THE LONG ISLAND SOUND ESTUARY

| Common Name | Scientific Name | Spatial Distribution and Abundance | Temporal Distribution |
|---|---|---|---|
| Atlantic Tomcod (1) | *Microgadus tomcod* | E: abundant (M), common (T) | E: abundant January and February, common March and November through December |
| | | L: abundant (M), common (T) | L: common January through February and December, abundant March through May |
| | | J: abundant (M), common (T) | J: abundant all year |
| | | SA: abundant (M), common (T) | SA: abundant December and January, common February and November |
| | | A: common (M), common (T) | A: common all year |
| Pollock (1) | *Pollachius virens* | L: rare (M) | L: rare March and April |
| | | | J: common December though March |
| | | J: rare (M) | A: common December though March |
| Red Hake (1) | *Urophycis chuss* | J: common (M) | J: rare December through February, common March through April and July through October, abundant May through June and November |
| | | A: common (M) | A: rare December through February, common March through April and July through October, abundant May through June and November |
| Oyster Toadfish (1) | *Opsanus tau* | E: common (M) | E: common June through September |
| | | L: common (M) | L: common June through September |
| | | J: common (M) | J: common all year |
| | | SA: common (M) | SA: common June through September |
| | | A: common (M) | A: common all year |

## TYPICAL SPATIAL AND TEMPORAL DISTRIBUTION, AND ABUNDANCE FOR THE SPECIES CONSIDERED SIGNIFICANT TO THE LONG ISLAND SOUND ESTUARY

| Common Name | Scientific Name | Spatial Distribution and Abundance | Temporal Distribution |
|---|---|---|---|
| Sheepshead Minnow [(1)] | *Cyprinodon variegatus* | E: common (M) | E: common June through September |
| | | L: common (M) | L: common June through October |
| | | J: rare (M) and (T) | J: common all year |
| | | SA: common (M) | SA: common June through September |
| | | A: rare (M) and (T) | A: common all year |
| Killifish [(1)] | *Fundulus sp.* | E: abundant (M), common (T) | E: common May and August, abundant June and July |
| | | L: abundant (M), common (T) | L: common May and September, abundant June and August |
| | | J: abundant (M), common (T) | J: abundant all year |
| | | SA: abundant (M), common (T) | SA: common May and August, abundant June and July |
| | | A: abundant (M), common (T) | A: abundant all year |
| Silversides [(1)] | *Menidia menidia* | E: abundant (M), common (T) | E: common May and August, abundant June and July |
| | | L: abundant (M), common (T) | L: common May and August, abundant June and July |
| | | J: highly abundant (M), common (T) | J: abundant September through May, highly abundant June through August |
| | | SA: abundant (M), common (T) | SA: common May and August, abundant June and July |
| | | A: abundant (M), common (T) | A: abundant September through May, highly abundant June through August |
| Northern Pipefish [(1)] | *Syngnathus fuscus* | L: common (M) | L: rare May through October |
| | | J: common (M) | J: rare October through April, common May through September |
| | | SA: common (M) | SA: rare April, common May through August |
| | | A: common (M) | A: common all year |

## TYPICAL SPATIAL AND TEMPORAL DISTRIBUTION, AND ABUNDANCE FOR THE SPECIES CONSIDERED SIGNIFICANT TO THE LONG ISLAND SOUND ESTUARY

| Common Name | Scientific Name | Spatial Distribution and Abundance | Temporal Distribution |
|---|---|---|---|
| Northern Searobin [1] | *Prionotus carolinus* | E: common (M) | E: rare May and September, common June through August |
| | | L: common (M) | L: rare May and September, common June through August |
| | | J: common (M) | J: common April through November |
| | | SA: common (M) | SA: rare May and September, common June through August |
| | | A: common (M) | A: common April through November |
| White Perch [1] | *Morone americana* | E: common (M), highly abundant (T) | E: common April and August, highly abundant May through July |
| | | L: common (M), highly abundant (T) | L: common April and September, highly abundant May through August |
| | | J: common (M), highly abundant (T) | J: abundant October through June, highly abundant July through September |
| | | SA: common (M), highly abundant (T) | SA: common April and August, highly abundant May through July |
| | | A: common (M), highly abundant (T) | A: abundant October through April, highly abundant May through September |
| Striped Bass [1] | *M. saxatillis* | J: abundant (M), common (T) | J: common January through March, abundant April through December |
| | | A: common (M) and (T) | A: common December through May and September through October, abundant June through July and October through November |
| Black Sea Bass [1] | *Centropristis striata* | J: rare (M) | J: rare December through March, common April through November |
| | | A: rare (M) | A: rare all year |

# TYPICAL SPATIAL AND TEMPORAL DISTRIBUTION, AND ABUNDANCE FOR THE SPECIES CONSIDERED SIGNIFICANT TO THE LONG ISLAND SOUND ESTUARY

| Common Name | Scientific Name | Spatial Distribution and Abundance | Temporal Distribution |
|---|---|---|---|
| Yellow Perch [1] | *Perca flavescens* | E: rare (M), abundant (T) | E: abundant April, common May |
| | | L: common (M), abundant (T) | L: common April and June through July |
| | | J: rare (M), common (T) | J: common all year |
| | | SA: rare (M), abundant (T) | SA: abundant April, common May |
| | | A: rare (M), common (T) | A: common all year |
| Bluefish [1] | *Pomatomus saltatrix* | J: abundant (M), rare (T) | J: common June, abundant July through October, rare November and december |
| | | A: common (M) | A: common April through May and September through November, abundant June through August, rare December |
| Scup [1] | *Stenotomus chrysops* | E: rare (M) | E: common May and August, abundant June through July, rare September |
| | | L: rare (M) | L: common May and August, abundant June through September |
| | | J: rare (M) | J: abundant May and October, highly abundant June through September, common November |
| | | A: rare (M) | SA: common May and August, abundant June through July, rare September |
| | | | A: common May and November, abundant June through September, highly abundant October |
| Weakfish [1] | *Cynoscion regalis* | J: abundant (M) | E: rare May through September |
| | | A: common (M) | L: rare June through September |
| | | | J: common June through September and November, abundant October |
| | | | SA: rare May through September |
| | | | A: common May through November |

**TYPICAL SPATIAL AND TEMPORAL DISTRIBUTION, AND ABUNDANCE FOR THE SPECIES CONSIDERED SIGNIFICANT TO THE LONG ISLAND SOUND ESTUARY**

| Common Name | Scientific Name | Spatial Distribution and Abundance | Temporal Distribution |
|---|---|---|---|
| Spot [1] | *Leiostomus xanthurus* | J: rare (M) | J: rare April through November |
| | | A: rare (M) | A: rare April through November |
| Northern Kingfish [1] | *Menticirrhus saxatillis* | J: rare (M) | E: rare June through September |
| | | | L: rare June through September |
| | | | J: rare April through November |
| | | | SA: rare June through September |
| | | A: rare (M) | A: rare April through November |
| Mullet [1] | *Mugil sp.* | J: rare (M) and (T) | J: rare April through November |
| | | A: rare (M) and (T) | A: rare April through November |
| Tautog [1] | *Tautoga onitis* | E: abundant (M) | E: rare April and October, common May and August through September, abundant June through July |
| | | L: common (M) | L: rare May, common June through August |
| | | J: common (M) | J: common all year |
| | | A: common (M) | SA: rare April and October, common May and August through September, abundant June through July |
| | | | A: rare December through March, common April through November |
| Cunner [1] | *Tautogolabrus adsperus* | E: common (M) | E: common May and June, abundant July through August, rare September and October |
| | | L: common (M) | L: common May, abundant June through August, rare September and October |
| | | J: common (M) | J: common all year |
| | | A: common (M) | SA: common May, highly abundant June through July, abundant August, rare September and October |
| | | | A: common all year |

## TYPICAL SPATIAL AND TEMPORAL DISTRIBUTION, AND ABUNDANCE FOR THE SPECIES CONSIDERED SIGNIFICANT TO THE LONG ISLAND SOUND ESTUARY

| Common Name | Scientific Name | Spatial Distribution and Abundance | Temporal Distribution |
|---|---|---|---|
| American Sand Lance (1) | *Ammodytes americanus* | E: rare (M) | E: highly abundant December and January, abundant February through March and November |
| | | L: common (M) | L: highly abundant December through February, abundant March, common April. Rare May and June |
| | | J: common (M) | J: abundant November through May, common June through October |
| | | SA: rare (M) | SA: highly abundant December and January, abundant February and November, common March |
| | | A: common (M) | A: abundant November through May, common June through October |
| Gobies (1) | *Gobiosoma sp.* | E: common (M) | E: rare May and August, common June and July |
| | | L: common (M) and (T) | L: rare June and September, common July and August |
| | | J: common (M), rare (T) | J: common all year |
| | | SA: common (M) | SA: rare June and October, common July through September |
| | | A: common (M), rare (T) | A: common all year |
| Atlantic Mackerel (1) | *Scomber scombrus* | J: rare (M) | E: common April and June, abundant May |
| | | | L: common May, rare June |
| | | | J: common April through November |
| | | | SA: rare April through June |
| | | | A: common April through November |

# TYPICAL SPATIAL AND TEMPORAL DISTRIBUTION, AND ABUNDANCE FOR THE SPECIES CONSIDERED SIGNIFICANT TO THE LONG ISLAND SOUND ESTUARY

| Common Name | Scientific Name | Spatial Distribution and Abundance | Temporal Distribution |
|---|---|---|---|
| Butterfish [1] | *Peprilus triacanthus* | J: abundant (M), rare (T) | E: common June through August, rare September |
| | | A: abundant (M) | L: common June through August, rare September through November |
| | | | J: common May through June and November, abundant July and November, highly abundant August through October |
| | | | SA: common June through August, rare September |
| | | | A: common May through June and November, abundant July and November, highly abundant August through October |
| Summer Flounder [1] | *Paralichthys dentatus* | J: rare (M) | J: rare March through November |
| | | A: rare (M) | A: rare March through November |
| Windowpane Flounder [1] | *Scopthalamus aquosus* | E: highly abundant (M) | E: abundant April and June, highly abundant May, common July and August, rare September through November |
| | | L: abundant (M) | L: common May and August through October, rare November |
| | | J: highly abundant (M), rare (T) | J: abundant December through March and July through October, highly abundant April through June and November |
| | | SA: highly abundant (M) | SA: abundant April and June, highly abundant May, common July and August, rare September through November |
| | | A: highly abundant (M), rare (T) | A: abundant December through March and July through October, highly abundant April through June and November |

## TYPICAL SPATIAL AND TEMPORAL DISTRIBUTION, AND ABUNDANCE FOR THE SPECIES CONSIDERED SIGNIFICANT TO THE LONG ISLAND SOUND ESTUARY

| Common Name | Scientific Name | Spatial Distribution and Abundance | Temporal Distribution |
|---|---|---|---|
| Winter Flounder [1] | *Pleuronectes americanus* | E: abundant (M) | E: rare January, common February and March, abundant April and May |
| | | L: abundant (M) | L: common February through March and June, abundant April and May, rare July and August |
| | | J: highly abundant (M), rare (T) | J: highly abundant January through May, abundant June through December |
| | | SA: abundant (M) | SA: rare January through February and July, common March and June, abundant April and May |
| | | A: highly abundant (M) | A: abundant January through February, June through July and November through December, highly abundant April through June, common August through October |
| Hogchoker [1] | *Trinectes maculatus* | E: common (M), rare (T) | E: common May through August |
| | | L: common (M), and (T) | L: common May through August |
| | | J: common (M), and (T) | J: common all year |
| | | SA: common (M), rare (T) | SA: common May through August |
| | | A: common (M), and (T) | A: common all year |

NOTES: E: egg stage, L: larval stage, J: juvenile stage, SA: spawning adult stage, Mt: mating adult stage, A: adult stage; (T) tidal fresh, (M) tidal mixing.

REFERENCES: (1) Stone et al. 1994. Distribution and Abundance of Fishes and Invertebrates in Mid-Atlantic Estuaries. ELMR Rep. No. 12. NOAA/NOS Strategic Environmental Assessments Division, Silver Springs, MD. pgs 280.