TABLE 6.2 Measureable Parameters for Benthic Communities and Sediment Quality

Environmental Effects	Measurable Parameter	Rationale for Selection of the Measurable Parameter
Change in sediment quality, habitat quality, habitat use, or mortality for benthic habitat communities	Total surface area of benthic habitat altered or disturbed	The purpose of this measurable parameter is to describe the spatial extent of disturbance to benthic organisms and sediment in Sydney Harbour resulting from Project activities. The surface area affected is also a key measure for compensation calculations under DFO's *HADD* process.
	Recovery of benthic habitat communities and sediment quality	The purpose of this measurable parameter is to determine whether or not benthic communities and sediment that are affected by Project activities will recover, how long this recovery will take, and to what state will they recover to (*i.e.,* will there be permanent adverse effects, will there be improvements to the substrate that allow for healthier benthic communities and sediment, *etc.*)

Construction and Commissioning

During the Construction phase of the Project, a number of marine vessels will be used for activities such as the delivery of construction materials and equipment. These vessels will be relatively small in size and draft and will not be present in large numbers. These vessels will not have any interactions with benthic communities and marine sediments and are rated a "0" in Table 6.1. The environmental effects of Vessel Transportation are therefore rated not significant and there is no further consideration of this aspect of the Project in the assessment.

Clearing and grubbing of the proposed terminal site may increase the risk of erosion and siltation for benthic communities and has therefore been related as "1" in Table 6.1. The use of erosion control structures and a Stormwater Management Plan (Section 2.0) will confine exposed soils to the land-based site. Efforts will also be made to minimize the amount of exposed soil on-site, the time of soil exposure, as well as to avoid steep slopes and proximity to watercourses and sensitive habitats, and there will be no blasting on-site. Project activities associated with the construction of land-based components (*e.g.,* roads and rails, buildings) will not have any interactions with benthic habitat or marine sediment quality and have been rated a "0" in Table 6.1. The environmental effects of Site Preparation and Construction of Land-Based Components on Benthic Habitat Communities and Sediment Quality are therefore rated not significant. There is no further consideration of these aspects of the Project in the assessment.

Dredging and Dewatering activities and the Construction of the primary and secondary CDFs will interact directly with benthic communities and marine sediments and result in environmental effects. These phases of the Project have been rated as "2" in Table 6.1 and are considered further in the assessment and are discussed in Section 6.1.4.

Operation

Environmental effects to Benthic Habitat Communities and Sediment Quality that result from dredging and infilling activities during the Construction phase will be ongoing during the Operation phase, in particular those resulting from infilling, which will be permanent. For simplicity, these effects are discussed only once, under the Construction phase assessment.

During Project Operation, marine vessel traffic will enter and depart Sydney Harbour by way of the newly dredged navigational channel, and will dock at the marine Terminal in the South Arm of the Harbour. The navigational channel is being designed to accommodate high draft vessels. Most vessels navigating in the channel will not interact with the benthic community or with sediment quality because the depth of water will easily accommodate low and medium draft vessels. The environmental effects of prop-wash (re-suspension of sediments due to boat propeller rotation near the sea bed) can be of concern in some instances, particularly when large vessels maneuver at port. Prop-wash would likely be spatially and temporally limited to within a few hundred metres of the propeller and a timeframe of a few hours. It is therefore possible that vessel navigation conducted near port may reduce habitat quality (by increasing localized re-suspended solids concentrations), may cause benthic animals to move to less-disturbed areas (*i.e.,* result in a change in habitat use), and may even result in mortality for some benthic communities. Based on existing knowledge of the sea bottom in Sydney Harbour, and the underwater video survey and sediment samples, benthic life in the proposed area of the Terminal potentially subject to prop wash is relatively limited, (see Appendix E). Instances of Project-related prop wash will be intermittent (*i.e.,* one large container vessel per week during Phase I Operation and two per week during Phase II). The environmental effects of Vessel Traffic on Benthic Habitat Communities and Sediment Quality are therefore rated as "1" in Table 6.1 and are not considered significant and are not discussed further in this assessment.

Stormwater and wastewater (including ballast water) runoff could potentially interact with benthic communities and marine sediments and has been rated a '1" in Table 6.1. Surface water on-site could drain into the South Arm of Sydney Harbour. If stormwater and/or wastewater were to become contaminated by toxic substances as they run-off from the site, the benthic community and the sediments surrounding the terminal could be affected. The Project, however, will meet or improve upon applicable regulations or standards with respect to effluent discharges and waste management, and will employ good engineering practices and standard industry controls. A Stormwater Management Plan (Section 2.0) will be developed in accordance with all provincial requirements, and will include the use of catch basins, piping, manholes, and retention ponds. Sewage will be piped to a wastewater treatment plant operated by the CBRM. Alternatively, wastewater from the Project site could be handled by a small packaged treatment facility installed exclusively to service the site. Chemical storage and handling will be done in accordance with federal and provincial regulations, and a site-specific emergency spill prevention and response plan will be developed to contain and control any potential releases of hazardous material. It is therefore unlikely that stormwater and wastewater will enter Sydney Harbour potentially affecting benthic communities and sediments.

Discharging ballast water from vessels has been identified as one of the major causes of the introduction of harmful aquatic organisms and pathogens into Canadian Waters. If ballast water containing invasive species or harmful pathogens is discharged into the South Arm of Sydney Harbour, benthic communities could be affected. All Project-related vessels entering Sydney Harbour will be expected to comply with Transport Canada's legislation and regulations, TP 13617" *A Guide to Canada's* Ballast Water Control and Management Regulations". Controlling ballast water exchange and management will reduce the risk of introducing invasive species to Sydney Harbour. the environmental effects of Site Stormwater and Wastewater Management (including ballast water) are therefore rated not significant. There is no further consideration of these aspects of the Project in the assessment.

Activities associated with the Loading and Unloading of Vessels, Storage of Equipment and Materials, and Maintenance/Repairs to the Terminal will not have any interaction with benthic communities or sediment quality and have been rated a "0" in Table 6.1. The environmental effects of Equipment and Materials Storage, Maintenance/Repair to the Terminal, and Loading and Unloading Vessels on Benthic Habitat Communities and Sediment Quality are therefore rated not significant. There is no further consideration of these aspects of the Project in this assessment.

6.1.4 Analysis, Mitigation and Residual Environmental Effects Prediction

The Dredging and Dewatering phase and the Construction of the Confined Disposal Facility have both been rated as a "2" in Table 6.1 due to their potentially significant interactions and environmental effects to benthic communities and sediment quality. Each of these Project components is discussed in the following sections, along with an assessment of their potential environmental effects. The section includes a discussion of mitigative measures which will be put in place to limit any residual environmental effects, including details of the proposed HADD compensation plan to be submitted to DFO.

6.1.4.1 Construction and Commissioning

Dredging and infilling activities during the Construction phase represent the most important interactions between the Project and Benthic Habitat Communities and Sediment Quality. Dredging, removal of dredged materials, and infilling will disturb the benthic communities and sediments in the identified portions of Sydney Harbour, resulting in benthic habitat alteration, changes to the use of benthic habitats, and direct mortality for slow-moving or immobile benthic flora and fauna. Dredging activities will also result in the dispersal of re-suspended sediments and contaminants which could have adverse environmental effects on benthic communities and sediment quality. As a result of these environmental effects to benthic habitat, the dredging process and infilling of the marine environment in the CDFs will constitute a habitat alteration, disruption or destruction (HADD) under the *Fisheries Act*.

Under the Policy on the Management of Fish Habitat (DFO 1986), DFO-Habitat Protection and Sustainable Development (DFO-HPSD) employs a no-net loss guiding principle to habitat conservation in its decision to authorize the alteration of fish habitat under section 35(2) of the *Fisheries Act*. To compensate for the direct loss of benthic habitat, including loss of habitat for the commercially important rock crab and lobster, the proponent will be directed to create new habitat (or improve existing habitat) by DFO-HPSD. The type and area of habitat to be created will be detailed in a Habitat Compensation Agreement signed by both the proponent and DFO before DFO will authorize the alteration of habitats. The specifications of the HADD compensation program will depend on the type of habitat compensation to be employed and the assesed ecological value of existing habitat at the dredge and infill sites. The preferred location for the creation of new habitats is within the ecological boundary of the HADD (*e.g.,* within Sydney Harbour) although this may not be possible or practical. The proposed HADD compensation plan is outlined later in this Section.

Dredging the seafloor in Sydney Harbour will result in direct mortality to some benthic flora and fauna and will temporarily alter benthic habitat in the areas that are dredged. In particular, concerns have been raised about how the channel dredging will affect stocks of commercially fished species such as lobster and rock crab. Rock crab are known to be present in and around the area of the proposed

dredge channel, and there is some anecdotal information from fishers to suggest that despite the fact that the benthic habitat in the channel is not well-suited for lobsters (see Appendix E), at certain times of year, there are lobster present in the navigation channel (see Section 4.7 for description of lobster and rock crab populations). Preliminary results from an experimental fishing study conducted in the fall of 2008 appear to confirm this anecdotal information (Hatcher *et al*. 2008). If the final results of the experimental fishing study indicate that there are lobsters present in large numbers in the channel during the approximate season proposed for dredging, the proponent will undertake or facilitate technically and economically feasible mitigation measures to reduce mortality for commercially important species potentially directly affected by dredging and infilling activities. Potential mitigation activities (subject to DFO approval) could include an intensive fishing and relocation program immediately prior to dredging. Another option is to petition DFO to permit a special commercial fishing season in the channel dredge area. Despite these mitigative efforts, there will be some mortality of benthic animals and the Proponent is currently working with DFO to develop a habitat compensation plan to satisfy the requirements for "no net loss" of fish habitat and HADD authorization under the *Fisheries Act*. Habitat compensation projects will increase the area of suitable habitat for lobster in Sydney Harbour and could potentially increase lobster stocks in the Harbour over time.

In addition to direct mortality of some benthic species, the removal of several layers of material (generally 1 to 3 m) from the channel will also result in a change to benthic habitat quality and use; however, it is expected that this change to habitat will be temporary. Benthic communities have been shown to recover from dredging disturbance (*e.g.,* Dernie *et al*., 2003). The duration of this recovery period depends on site-specific conditions encountered at the dredge site. A conservative estimate of this recovery time would be on the order of 5 to 10 years (see Newell, 1998 for a discussion on benthic recovery rates following dredging), but could be as little as 2 to 3 years. As reported in the Comprehensive Study Report for the Deep Panuke Offshore Gas Development (EnCana 2002), the marine benthic habitat recovered fully within 3 years after trenching and pipeline installation for the Sable Offshore Energy Project in the nearshore environment. Marine plant life and bottom dwellers recolonized the disturbed areas, and kelp and other seaweeds re-established shortly after pipeline installation. Geotechnical and oceanographic studies conducted as part of the Sydport assessment indicate that the post-dredge seafloor will be very similar to the existing seafloor in terms of surficial grain size and type (Section 2.0), primarily because dredging depth will only be in the range of 1 to 3 m. It is therefore expected that the dredged channel will recover to a state similar to its current characteristics and that benthic habitat will be re-established in a relatively short period of time. Habitat compensation projects developed by the client will also help to improve habitat conditions for benthic animals in Sydney Harbour.

There is also concern about the potential environmental effects from sediments and contaminants that may be re-suspended by dredging activities. Current background levels of suspended sediments in Sydney Harbour are generally below 10 mg/l. The dispersion of sediments from the turbidity plume generated by the dredger will result in localized exceedences of background levels. Wilbur and Clarke (2003) provide a literature review of the effects of suspended sediment on fish and shellfish, noting both positive effects (reduced predation rate, increase in avoidance success) and negative effects (egg abrasion, mortality). Wilbur and Clarke note that suspended-sediment induced mortalities in most crustaceans occur at concentrations on the order of 10 g/l (Wilbur and Clarke 2003). For dredging in the Seaward Arm of Sydney Harbour, the expected re-suspended sediment concentrations from

dredging activities will rarely exceed 1 g/l and never exceed 2 g/l, and concentrations will return to background conditions of 10 mg/l or less within 8-10 hours. (See Appendix A). For dredging in the South Arm, plume modelling indicates that suspended sediment concentrations will generally remain below 100 mg/l and will dissipate to background conditions within 4-5 days. Sediment plume modelling also indicates that a 1-year return storm would have a greater sediment re-suspension footprint than that generated during dredging in the Seaward Arm. Based on this modelling, it is expected that while benthic animals may face some temporary disturbance to use of their habitat due to suspended sediments, these effects will be short-lived and will not result in mortality or long-term alterations.

Some concerns have also been raised about the potential for the re-distribution of contaminants contained in sediments in Sydney Harbour. Results of the literature review and sediment sampling undertaken for this assessment indicate that sediments in some areas of Sydney Harbour contain elevated levels of PAHs and metals, and sediments in the South Arm contain elevated levels of PCBs. Contaminant loading in Sydney Harbour decreased significantly in the 1980's, and therefore many of the existing contaminants are embedded in sediments that are overlain by 10-30 cm of relatively clean sediment. Dredging of the channel has the potential to bring some of these contaminants back to the seafloor surface and to re-distribute them spatially. This could result in a change to surficial sediment quality in some instances, and could increase the risk of contaminant-related effects on benthic animals, if the concentrations of contaminants are high enough.

Modelling of the sediment plume that will be generated by dredging indicates that re-suspended sediments will settle out within a 1.5 km wide track in the centre of the Seaward Arm and will not reach the shoreline. Historical data and recent sediment sampling in Sydney Harbour indicates that sediments in the Seaward Arm where the navigational channel will be dredged are considerably less contaminated than sediments elsewhere in the Harbour, such as the South Arm (see Section 4.7 and Appendix E). Contaminated sediments in the area of the proposed dredge channel do not exceed CCME guidelines for toxicity with the exception of some metals. Given these parameters, re-suspended sediments in the dredge channel will not be highly contaminated relative to other parts of Sydney Harbour, and will generally settle out within a few hundred metres of their point of origin. Sediment plume modelling also indicated that a 1-year return storm would cause a greater spreading of suspended sediment, with peak concentration occurring along the shorelines. As such, re-suspended sediments containing contaminants will not be widely dispersed in the Seaward Arm, and the relatively low contamination levels in this part of the harbour will limit any adverse effects. Sediments in the South Arm of Sydney Harbour are generally finer grained and more contaminated than other parts of the Harbour. Modelling of the sediment plume that will be generated by dredging near the proposed marine terminal suggests that re-suspended sediments would be confined to the South Arm and would therefore not spread contaminants to sediments outside the South Arm that are relatively clean in comparison (refer to Appendix E).

The spread of suspended sediment plumes will be limited by the use of a modern, state-of-the-art trailing suction hopper dredge (TSHD) vessel as opposed to a bucket dredge (see Section 2.0 for description of TSHD). Technological systems on-board this dredge vessel allow for more precise dredging, including improved control over draghead depth which reduces overdredging. The discharge of any excess water from dredged materials will be done directly below the dredge which minimizes the dispersion of fine sediments into the surrounding waters. The vessel has capabilities to monitor real time TSS. This overflow system is also designed to avoid the entrapment of air in the overflow water,

which minimizes further turbidity. Overflows will not be permitted when dredging upper, silty layers that are most often associated with relatively higher levels of contamination and resuspension risk.

Dewatering of the dredge spoils in the CDF is not expected to have a significant impact on benthic communities or sediment quality. Measures will be taken to avoid producing pockets of fine sediments during reclamation. Perimeter bunds will be constructed around the reclamation area to prevent the mixture of soil and water from flowing outside the reclamation site boundaries. Water boxes will be used and designed specifically to maximize the settling of soil particles into the reclamation area in order to reduce the release of suspended solids (see Section 2.1.1 for description of dewatering process).

In summary, dredging of the proposed navigation channel and construction of the confined disposal facility will result in changes to benthic habit and sediment quality, including direct morality of benthic species, alteration of benthic habitat, and changes to use of benthic habitat by various species. Mitigative efforts have been outlined which will limit the extent and magnitude of these environmental effects. Stipulations under the *Fisheries Act* will also ensure that adequate compensation is provided by the Proponent to account for alterations to benthic habitat prior to providing authorization for the Project. The residual environmental effects of Dredging and Dewatering and Construction of the Confined Disposal Facility are therefore rated as not significant. There is a moderate level of confidence in this significance prediction due to the scientific uncertainty surrounding a number of the variables described in this section, including the location and movements of lobster, variable contamination levels in parts of the Harbour, and the re-suspension and dispersion patterns of the sediments disturbed by dredging. The best scientific information available on these issues has been applied in making this significance prediction.

HADD Compensation Plan

The following sections describe the proposed approach to HADD compensation to satisfy requirements under the *Fisheries Act*. Additional information is provided in response to DFO-10 in Appendix K.

Channel Dredging

Dredging for deepening of the navigation channel will physically remove approximately 3.5 - 4 million m^3 of silt, clay and sandy material from the existing channel. The proposed channel is 150 m wide, 9,950 m long and 17 m deep. The surface area of potential benthic habitat and sediment that will be directly affected by the dredging of this channel is approximately 1,492,500 m^2. This represents approximately 5% of the total width of the harbour. The removal of this material will result in mortality of some benthic flora and fauna and will constitute a change to the quality and current use of that habitat. As described earlier in this section, the benthic habitats disturbed by dredging are expected to recover to a similar level of productivity over time; therefore, a net two times compensation ratio is proposed for the dredged channel areas.

Terminal Docking Area Dredging

This phase of dredging will take place adjacent to the terminal caisson dock area and is being conducted to provide a minimum of 16.5 m of water depth for larger vessels that will be docking at the terminal. The estimated area to be dredged is 93,665 m^2. Based on available information on the seafloor in this part of the South Arm, it is expected that there will be few marine plants disturbed and

that there is primarily a silty sand substrate, similar to the other substrates and habitats in the channel. As described earlier in this section, the benthic habitats disturbed by dredging are expected to recover to a similar level of productivity over time; therefore, a net two times compensation ratio is proposed for the dredged channel areas.

Terminal and Secondary Infill

The process for infilling the CDFs with the dredge material from the channel and terminal area is described in Section 2.0. There were two video transects in the terminal infill area and one just to the north of the site. Analysis of underwater video from these sites shows a variety of benthic habitats ranging from low density eel grass beds in the north inshore area to occasional cobble outcrops set in a silty sand bottom. There are no videos of the secondary infill area on the other side of the South Arm; however, it is known to be intertidal and shallow marine habitat that has been heavily affected by past industrial land uses. Once infilling occurs, both of these areas will be permanently lost as marine habitat; therefore, a compensation ratio of three times the areas impacted is proposed. The area to be infilled for the terminal is 856,161 m^2 and for the secondary site is 274,400 m^2 in area. It is possible that the secondary CDF will not be used, and in this instance the HADD compensation requirements will be revised accordingly.

Barachois Creek Stream Crossings

The new access road in the Barachois Creek area will cross two intermittent streams. Both road crossings will be designed to avoid a HADD by spanning the watercourses. If culverts are used, additional HADD compensation may be required, and would likely include habitat restoration projects in the nearby freshwater streams.

Barachois Creek Rail Crossing

This rail crossing near Barachois Creek will include an infill across an intertidal mud flat with a bridge of suitable span to allow the full tidal flow. The anticipated infill area is 6,390 m^2. This loss of fish habitat will be compensated by applying a three times compensation ratio factor to the area affected by the project.

Wetland Areas

There are several wetland areas that will be affected by the infill operations at the terminal site. The fish habitat lost due to this infill will be compensated for under the wetland compensation plan provided to the Province of Nova Scotia (see Section 6.4.4.1).

HADD Calculation

In Table 6.3 below, each aspect of the project is listed with the estimated area of habitat that will be affected. A three times compensation ratio is expressed for each affected area; however, the dredged areas (*i.e.,* channel and terminal dredging) are expected to recover to pre-dredge conditions naturally over time. As a result, those areas of recovery are subtracted from the total offsite habitat compensation efforts required. The expected natural recovery of habitat plus the offsite compensation work adds up to the total amount of fish habitat that is replaced.

TABLE 6.3 HADD Compensation Summary Table

Project Effect	HADD Area (m^2)	Compensation Ratio	Compensation Required (m^2)	On Site Compensation (m^2)	Off site compensation (m^2)	Habitat Replaced (m^2)
Channel Dredging	1,492,500	3x	4,477,500	1,492,500	2,985,000	4,477,500
Terminal Dredging	93,665	3x	280,995	93,665	187330	280,995
Terminal Infill	856,161	3x	2568,483	0	2,568,483	2,568,483
Secondary Fill Area	274,400	3x	823,200	0	823,200	823,200
Barrachois Stream Crossings	0	3x	0	0	0	0
Barrachois Rail Crossing	6,390	3x	19,170	0	19,170	19,170
Total Area	2,650,616		8,169,348	1,586,165	6,583,183	8,169,348

Proposed Compensation Projects

According to harbour studies summarized in Section 4.7 and the anecdotal information that has been collected from the fishers in the fall of 2008 (Hatcher *et al*. 2008), areas of higher productivity in the Harbour are associated with hard rocky bottom. There are large areas of less productive hard sand/gavel/mud bottom that would be suitable for compensation projects by converting them to rocky bottom habitats. Studies by Glyn Sharpe (Sharpe 2007) have shown that the addition of suitably sized rock over sand /gravel bottoms increases the productivity of lobster populations by providing cover that is critical to avoid predation. In addition, these rocks improve biodiversity by supporting algae, rockweed and kelp communities. This is evident in the videos taken of the seafloor in Sydney Harbour (see Appendix E) where, despite the cold water of the January videotaping, lobster excavations can be detected in the areas with cobble on the sand /gravel areas, and depressions dug by larger lobster can be detected in the silty sand bottoms.

The South Arm is a priority area for habitat compensation projects. As an area closed to fishing, the South Arm acts as a refuge for the larger and breeding animals as well as a migration route. The productivity within this area contributes to the fishery outside of the South Arm. Prior to the habitat development work, benthic surveys will be conducted to ensure suitability of the substrate to receive the rock or habitat (*e.g.,* sediment quality, geotechnical competence). Preferred substrates for enhancement are sand /gravel bottoms with a minimum of silt cover that will support rock placements of sizes 20 to 100 cm. The selected area must also have a low silt deposition rate. Since Sydney Harbour is an estuary the areas selected will also be surveyed for salinity to ensure it is always above 21 ppt and suitable for lobsters.

For habitat compensation projects outside of the South Arm, the priority is to identify areas adjacent to existing fishing areas. Fishers will be consulted to help select site compensation outside of the shipping channel in areas accessible by the fishing communities. The addition of suitably sized patches of rock will expand the habitat used by lobster and increase the fishable area. All patches of rock will be in the order of 2 m in diameter and spaced so that there is still abundant habitat for the rock crab, which are

one of the lobsters' major food sources.

On both sides of the terminal infill there will be areas of low current velocity. The cove created to the north of the site is in an area that currently supports sparse eel grass growth. The new, more sheltered cove will likely be a deposition area for soft muds and with a general clockwise circulation will become more productive for eelgrass and shellfish. This new sheltered area will be much larger than the current eelgrass bed. Both the increase in area and the increase in productivity of the existing bed will contribute to habitat compensation. A rock reef could be designed at the outer edge of this eelgrass bed will to break the wave fetch from the north and still provide suitable tidal circulation.

The south side of the terminal infill will also be a low energy area. This area does not currently support eelgrass development and is generally comprised of silty sand bottom with low productivity. Productivity could be increased by adding softer muds to the area to develop an eelgrass bed. This would require some of the area to be shallower than is currently the case to allow sufficient light to reach the eelgrass and other marine plants that might establish. A rock reef along the outer edge would provide this drop in elevation and would also provide rockweed substrate and benthic cover for juvenile fish and invertebrates.

The side slopes of the terminal infill can be sloped and covered with a rock mixture to provide a variety of fish habitats. The wetted area of these slopes will be counted toward the compensation as rocky hard bottom. The caissons along the docking area could be designed to provide cover for pelagic fish and a substrate for certain benthic species by providing openings in the caisson face.

Based on the nautical charts, the circulation modeling, and the video available, there is more than enough suitable bottom with very low silt depositions rates for the compensation noted above.

Detailed design of the compensation will be provided for DFO's review prior to the preparation of the final compensation agreement. It is understood that DFO may wish to direct the Proponent to provide additional detail with respect to the candidate receiving environments and other aspects of the proposed compensation plan in an iterative planning process.

Monitoring of Habitat Compensation

Habitat monitoring is typically requested by the regulatory agencies for habitat compensation projects. The constructed eelgrass habitat, the rocky bottom habitats, and control sites for both types will be monitored for a period of five years. Initial surveys will be conducted at the enhancement sites prior to any work, immediately after construction, and then in the late summer or early each fall following the growing season. All monitoring will take place when water temperatures are above 7^{o}C. One transect will be surveyed in each of the two eelgrass areas and 6 transects will be surveyed in the rocky bottom areas plus two control transects one in each type. The rocky bottom transects will be sited to represent different groupings of habitat features based on depth and modeled current circulation over the site.

6.1.4.2 Operation

As outlined in Section 6.1.3 it is unlikely that operational activities, with the exception of maintenance dredging, would have any significant adverse environmental effects on benthic communities or sediment quality within Sydney Harbour. Geotechnical and oceanographic studies conducted for the environmental assessment have indicated that due to the low energy environment and low sedimentation rates in

Sydney Harbour, maintenance dredging will not be required during the life of the Project.

Environmental effects to Benthic Habitat Communities and Sediment Quality that result from dredging and infilling activities during the Construction phase will be ongoing during the Operation phase, in particular those resulting from infilling, which will be permanent. These environmental effects and the appropriate mitigation and compensation plans have been addressed in the Construction phase discussion (Section 6.1.4.1).

6.1.5 Follow-up and Monitoring

Authorization under Section 35(2) of the *Fisheries Act* will provide compensation for marine habitat lost as a result of capital dredging and infilling. The approved compensation program will likely include monitoring requirements as described in Section 6.1.4.1.

6.1.6 Summary of Residual Environmental Effects Prediction

Residual environmental effects of the Project on Benthic Habitat Communities and Sediment Quality in Sydney Harbour are summarized in Table 6.4.

TABLE 6.4 Environmental Effects Assessment Matrix: Benthic Habitat Communities and Sediment Quality

Project Activity	Potential Environmental Effect Positive (P) or Adverse (A)	Mitigation	Evaluation Criteria for Assessing Residual Environmental Effects					
			Magnitude	Geographic Extent	Duration/ Frequency	Reversibility	Ecological/Socio-economic Context	Prediction Confidence
CONSTRUCTION AND COMMISSIONING								
Dredge and Dewatering	▪ Mortality of benthic flora and fauna, change to habitat quality and use, dispersion of contaminants in marine sediments (A)	▪ HADD Authorization for capital dredging at a compensation ratio to be determined by DFO-HPSD. ▪ Intensive fishing and relocation program immediately prior to dredging. ▪ Extension to commercial fishing season in dredge and infill areas. ▪ Use of state-of-art dredging technology (suction dredging rather than bucket dredging).	2	2	2/1	R	2	M

TABLE 6.4 Environmental Effects Assessment Matrix: Benthic Habitat Communities and Sediment Quality

Project Activity	Potential Environmental Effect Positive (P) or Adverse (A)	Mitigation	Evaluation Criteria for Assessing Residual Environmental Effects					
			Magnitude	Geographic Extent	Duration/ Frequency	Reversibility	Ecological/Socio-economic Context	Prediction Confidence
Construction of confined disposal facilities (infilling)	▪ Mortality of benthic flora and fauna, change to habitat quality and use (A)	▪ HADD Authorization for infill of terminal and secondary CDFs at a compensation ratio to be determined by DFO-HPSD.	2	1	3/1	I	2	M

KEY

Magnitude:
1 = Low: Short-term disturbance of benthic habitat communities or sediment quality with no loss or degradation of critical habitat or function.
2 = Moderate: Compensated, long-term alteration of benthic communities or sediment quality with no permanent loss of habitat function.
3 = High: Permanent, uncompensated alteration of benthic habitat communities and sediment.

Geographic Extent:
1 = Environmental effects restricted to Project footprint.
2 = Environmental effects extend beyond the Project footprint but remain within Sydney Harbour.
3 = Environmental effects extend beyond Sydney Harbour

Duration:
1 = Short term: Effects are measurable for <1 year.
2 = Medium term: Effects are measurable for 1 to 5 years.
3 = 3 = Long term: Effects are measurable for >5 years.

Frequency:
1 = Occurs once.
2 = Occurs rarely and at sporadic intervals.
3 = Occurs on a regular basis and at regular intervals.
4 = Continuous.

.

Reversibility:
R = Reversible.
I = Irreversible

Ecological/Socio-economic Context:
1 = Area is relatively pristine or not adversely affected by human activity.
2= Evidence of existing negative environmental

Prediction Confidence:
Based on scientific information and statistical analysis, professional judgment and effectiveness of mitigation
L Low level of confidence
M Moderate level of confidence
H High level of confidence

6.2 Marine Fish and Water Quality

Marine Fish and Water Quality is a VEC in consideration of the potential environmental effects of Project-related activities on existing marine fish populations and the water column in which they reside. This VEC was selected to meet the specific regulatory requirements of the *Fisheries Act*, to address the potential presence of species listed under the federal *Species at Risk Act* (*SARA*), and in recognition of the intrinsic importance of fish populations and fisheries resources as socio-economic components of the human environment.

The federal *Fisheries Act* defines “fish” to mean all fish, shellfish, crustaceans, marine animals and any parts of shellfish, crustaceans or marine animals, and the eggs, sperm, spawn, larvae, spat and juvenile stages of fish, shellfish, crustaceans and marine animals. Potential environmental effects on benthic invertebrates and marine mammals are discussed separately in Sections 6.1 and 6.3. The

federal *Fisheries Act* defines “fish habitat" as spawning grounds, nursery, rearing, food supply and migration areas on which fish depend directly or indirectly. Fish habitat includes physical (*e.g.,* substrate, temperature, flow velocity and volumes, water depth), chemical (*e.g.,* dissolved oxygen, pH, nutrients) and biological (*e.g.,* fish, benthic invertebrates, plankton, aquatic plants) attributes of the environment that are required by fish to carry out life cycle processes (*e.g.,* spawning, rearing, feeding, overwintering, migration). Potential environmental effects to benthic habitat that marine fish may depend on directly or indirectly is discussed in the Benthic Habitat Communities and Sediment Quality section (see Section 4.7 and 6.1). Marine water quality can be measured a number of ways (DO, pH, *etc.*); however, for the purposes of this assessment, marine water quality will be assessed based on changes to suspended sediment (SS) levels in Sydney Harbour.

The assessment will also consider potential environmental effects to marine fish of special status that are present in the Assessment Area and that have been identified by federal or provincial agencies as being endangered, threatened, rare, or otherwise of conservation concern. Species at Risk (SAR) (*e.g.,* Atlantic wolffish) are protected by legislation (*i.e., SARA*) and require special attention during the assessment process as, by their very definition, these populations are more sensitive to anthropogenic and environmental stressors.

Fish occurring in Sydney Harbour and its approaches include resident species, which complete their life cycle in the Harbour (*e.g.,* winter flounder and cunner), and those that enter the Harbour only during spawning or feeding migrations (*e.g.,* Atlantic mackerel and herring). A description of existing conditions for marine fish and water quality within Sydney Harbour, including the list of marine fish species that are known to be present in the Harbour, is presented in Section 4.8. Environmental effects on Commercial Fisheries are assessed in Section 6.7.

6.2.1 Environmental Assessment Boundaries

Spatial and Temporal

The spatial boundaries for the assessment of Marine Fish and Water Quality include the dredge channel in the Seaward Arm of Sydney Harbour, as well as the Confined Disposal Facility (CDF) and marine terminal, and the potential secondary CDF in the South Arm. The spatial boundaries also include the zone of influence from any sediment plumes associated with the Project activities that disturb the seafloor (*e.g.,* dredging). The spatial boundary for this component of the assessment encompasses the marine waters of Sydney Harbour, which will be referred to as the Assessment Area. Fish, including eggs and larvae, are also distributed vertically within the water column from the surface to the ocean bottom. Benthic species and habitat are specifically discussed in Section 4.7 and 6.1.

The temporal boundaries for the assessment of Marine Fish and Water Quality include the, Construction and Operation phases of the Project. The temporal scope also includes the period of sediment resuspension and subsequent return to baseline water quality conditions once dredging of the channel is complete. The temporal boundaries also consider those times of year when fish species are more likely to be present in the Harbour and exposed to Project activities.

Administrative and Technical

Marine fish are protected primarily through federal legislation; fish habitat is protected under the *Fisheries Act*, and by the *Policy for the Management of Fish Habitat* (DFO). This policy applies to all projects and activities in or near water that could *"*alter, disrupt or destroy fish habitat by chemical, physical, or biological means*"*. Sections 20, 32, 35, and 36 of the *Fisheries Act* apply to the Project. Section 20 requires that fish passage be maintained at all times during construction and operation. Section 32 prohibits the destruction of fish by any means other than fishing. Section 35 protects fish habitat from harmful alteration, disruption or destruction (HADD), and Section 36 prohibits the deposit of a deleterious substance in waters frequented by fish. DFO has overall responsibility for the administration of the federal *Fisheries Act*. Environment Canada administers Section 36 of the *Fisheries Act*.

SARA is intended to prevent Canadian indigenous species, subspecies and distinct populations of wildlife from becoming extirpated or extinct, to provide for the recovery of endangered or threatened species, and to encourage the management of other species, to prevent them from becoming at risk. General prohibitions include Section 32(1), which states that no person shall kill, harm, harass, capture or take an individual of a wildlife species that is listed as an extirpated species, an endangered species or a threatened species as listed in Schedule 1 of *SARA*. No approvals under *SARA* are likely required for marine species with respect to the Project. However, species identified in Schedule 1 will be considered in this EA and mitigation will be developed where an interaction exists. Critical Habitat, as defined under *SARA*, is the habitat that is necessary for the continued survival of a SAR, or for the recovery of a SAR. Critical Habitat that has been identified for a given SAR and is part of an active recovery plan is listed on the Species at Risk Webpage (www.sararegistry.gc.ca). No critical habitat for any SAR has been outlined in Sydney Harbour or its approaches.

One key technical limitation to the assessment is the limited information available on the presence of marine fish species in Sydney Harbour. While there is substantial information available about the commercial species fished in the Assessment Area and in Sydney Bight, much less is known about the many non-commercial fish present and their role in the ecosystem (Schaefer *et al.* 2004).

6.2.2 Residual Environmental Effects Evaluation Criteria

A significant adverse residual environmental effect on Marine Fish and Water Quality is defined as one that affects marine fish populations or water quality in such a way as to cause a decline in abundance or change in distribution of common and secure population(s) such that these populations will not be sustainable within the Assessment Area.

A significant adverse residual environmental effect on any Marine Fish species of special status is defined as:

- One that results in a non-permitted contravention of any of the prohibitions stated in Sections 32-36 of *SARA* (*i.e.,* it is an offence to capture, take, possess, collect and sell endangered or threatened species, as well it is illegal to damage or destroy the residence of an endangered or threatened species); or
- One that alters the marine habitat within the assessment boundaries physically, chemically, or

biologically, in quality or extent, in such a way as to cause a change or decline in the distribution or abundance of a *SARA* listed Marine Fish population that is dependent upon that habitat such that the likelihood of the long-term survival of these populations within the Assessment Area is substantially reduced as a result.

6.2.3 Potential Interactions, Issues and Concerns

Based on the regulatory requirements and the issues raised by the public and key stakeholders, the environmental effect being evaluated in this assessment of Marine Fish and Water Quality is a Change in Marine Fish and Water Quality.

This environmental effect relates to the interaction between Project-related activities (including dredging, vessel traffic, and placement of marine infrastructure) with marine fish in the water column and changes to water quality. A change could consist of direct mortality to marine fish, eggs, or larvae, or changes to habitat use by marine fish or to the quality of their habitat in the water column. Potential Project interactions with this VEC are summarized in Table 6.5.

TABLE 6.5 Potential Interaction, Issues and Concerns for Marine Fish and Water Quality

Project Activities and Physical Works	Potential Environmental Effects		
	Change in Habitat Quality	Change in Habitat Use	Mortality
Construction and Commissioning			
Dredge and Dewatering	2	2	2
Vessel Transportation	1	1	1
Construction of confined disposal facility	2	2	2
Site Preparation (clearing and grubbing, grading)	0	0	0
Construction of land components (including road, rail, buildings)	0	0	0
Operation			
Marine Vessel Traffic	1	1	1
Loading and Unloading Vessels/Trains	0	0	0
Site stormwater and wastewater Management	1	1	1
Equipment and Materials Storage	0	0	0
Maintenance/Repairs to Terminal	1	1	0

Note - Project-Environment Effects were ranked as follows:
0 No interaction. No substantive interaction contemplated.
1 Interaction will occur. However, based on past experience and professional judgment, the interaction would not result in a significant environmental effect, even without mitigation, or the interaction would clearly not be significant due to application of codified practices
2 Interaction may, even with codified mitigation, result in a potentially significant environmental effect and/or is important to regulatory and/or public interest. Potential environmental effects are considered further and in more detail in the EIA.

Table 6.6 describes the measurable parameter(s) that will be used for the assessment of environmental effects, and the rationale for the selection of the measurable parameter(s).

TABLE 6.6 Measurable Parameters for Marine Fish and Water Quality

Environmental Effect	Measurable Parameter	Rationale for Selection of the Measurable Parameter
Change in water quality, habitat quality, habitat use, or mortality for marine fish	Fish Mortality	The purpose of this measurable parameter is to determine the amount of marine fish mortality that may result from Project-related activities such as dredging and placement of marine infrastructure.
	Suspended Sediment Concentrations (SS)	A concern during dredging operations is the amount of sediments that are re-suspended in the water column as a result of disturbance of the seafloor, dewatering, overflow of the dredge, or during the transfer of dredge materials to the CDF. High levels of SS can potentially affect marine water quality and fish populations.
	Noise Levels (decibels)	Increase in sound levels (magnitude, frequency, duration and character – tonal vs. impulsive) above background levels as a result of construction activities or increased vessel traffic may affect marine fish in Sydney Harbour
	Presence or absence of a *SARA* listed species	*SARA*-listed species are vulnerable species that must be protected in order to preserve their long-term population health and survival. Protection of these species is federally-legislated.

Construction and Commissioning

All Project activities or physical works during Construction and Commissioning associated with Site Preparation (clearing and grubbing, grading) and Construction of Land Components (including road, rail, and buildings) will not interact with Marine Fish and Water Quality and have been rated a "0" in Table 6.5. The environmental effects of these phases of the Project are therefore rated not significant, and there is no further consideration of these aspects of the Project in the assessment.

Vessel Transportation during the Construction phase of the Project will interact with Marine Fish and Water Quality and has been rated a "1" in Table 6.5. The increase in vessel traffic during the Construction phase could potentially lead to an increase in underwater noise levels which could have adverse effects on marine fish. There have been few studies on environmental effects of high levels of ambient sound on fish (Smith *et al.* 2004). Fish take advantage of the rapid propagation of sound through water to perceive and discriminate sounds in the marine environment. Fish use sound for communication and for predators and prey detection (Smith *et al.* 2004). Most fish species have the ability to detect low frequency sounds over great distances (Chapman 1973). Behavioural responses to loud noises may include swimming away from the sound source which could result in leaving a primary feeding or spawning area (Popper 2003). Altering these behaviours could affect long-term behaviour patterns, reproductive success and survival. Alternatively, loud noises could result in the fish "freezing" and staying in place which could leave the animal open to further hearing damage (Popper 2003). Hearing damage can increase risk of predation and alter reproduction or feeding behaviours (Laughlin 2005). Turnpenny and Nedwell (1994) summarized the following physiological effects of sound on fish:

- transient stunning at 192 dB re 1 µPa;
- internal injuries at 200 dB re 1 µPa;
- egg/larval damage at 220 dB re 1 µPa; and
- fish mortality at 230-240 dB re 1 µPa.

Typical vessel traffic (*e.g.,* barges, tugs and bulk carriers) produces sound levels of between 168 and 193 dB re 1 µPa @ 1 m (Richardson *et al.* 1995). The vessels used during the Construction phase will

be relatively small in size and draft and will not be present in large numbers. Noise levels from vessel traffic will therefore not exceed the thresholds for damage to marine fish. Fish in Sydney Harbour are currently and routinely subject to the noise from passing vessels.

Based on these anticipated noise levels, no adverse environmental effects are expected on adult, juvenile or eggs and larvae of commercial or non-commercial species from Project-generated noise from Construction-related vessel traffic. The environmental effects of these phases of the Project are therefore rated not significant, and will not be discussed further in the assessment.

Dredging and dewatering activities and the Construction of the CDF will interact directly with Marine Fish and Water Quality and potentially result in environmental effects. These phases of the Project have been rated a "2" in Table 6.5 and are considered further in the assessment and discussed in Section 6.2.4.

Operation

The Loading and Unloading of Vessels and Trains and Equipment and Materials Storage during Operation will not interact with Marine Fish and Water Quality and have been rated a "0" in Table 6.5. The environmental effects of these phases of the Project are therefore rated not significant and will not be considered further in the assessment.

Vessel traffic associated with operation of the Project will increase sound above background levels in the water column and has been rated a "1". Sound levels from vessels arriving at the Terminal during Operation will be similar to those experienced during construction (see above). Based on existing underwater sound levels in what is already an industrial harbour with regular vessel traffic, as well as the transient and low magnitude of Project-generated sound, the effects of noise generated by Vessel Traffic on Marine Fish and Water Quality are not expected to be of concern. The increased vessel traffic resulting from the Project could also increase the risk of the introduction of invasive species carried in ballast and bilge water in foreign ships. The introduction of invasive species is discussed in Section 6.1 and the risk was rated not significant. The environmental effects of Vessel Traffic are therefore rated not significant and are not considered further in the assessment.

Site Stormwater and Wastewater Management and Maintenance/Repairs to the Terminal have the potential to cause environmental effects on Marine Fish and have been rated a "1". Site stormwater and wastewater runoff may lead to the release of deleterious substances to the marine environment, which may degrade fish habitat and marine water quality. The Project, however, will meet or improve upon applicable regulations or standards with respect to effluent discharges and waste management, and will employ good engineering practices and standard industry controls. A Stormwater Management Plan (see Section 2.0) will be developed in accordance with all provincial requirements, and will include the use of catch basins, piping, manholes, and retention ponds. Sewage will be piped to a wastewater treatment plant operated by the CBRM. Alternatively, wastewater from the Project site could be handled by a small packaged treatment facility installed exclusively to service the site. Chemical storage and handling will be done in accordance with federal and provincial regulations, and a site-specific Emergency Response Plan (see Section 2.0) will be developed to contain and control any potential releases of hazardous material. It is therefore very unlikely that contaminated stormwater and wastewater will enter Sydney Harbour to significantly degrade fish habitat and water quality. The environmental effects of Site Stormwater and Wastewater Management are therefore rated not

significant. There is no further consideration of these aspects of the Project in the assessment.

Maintenance and Repairs to the Terminal may increase sound levels immediately adjacent to the Project footprint and has been rated a "1". These increased sound levels would be relatively infrequent and would not substantively increase sound levels in the inner Harbour. The environmental effects of this phase of the Project are therefore rated not significant and are not considered further in the assessment.

6.2.4 Analysis, Mitigation and Residual Environmental Effects Prediction

The Dredging and Dewatering phase and the Construction of the CDF have both been rated as a "2" in Table 6.5 due to their potentially significant interactions and environmental effects to Marine Fish and Water Quality. Each of these Project components is discussed in the following sections, along with an assessment of their potential environmental effects. The section also includes a discussion of mitigative measures which will be put in place to limit any residual environmental effects.

6.2.4.1 Construction and Commissioning

The process of dredging the navigational channel could result in direct mortality to marine fish. Mobile pelagic and demersal fin-fishes will likely avoid dredging activities due to the associated noise and direct mortality will be low; however, slow moving or cryptic species (*i.e.,* tend to take cover and hide from threats) will be less likely to avoid dredging activities and may suffer mortality as a result. The dredge area is characterised by a relatively flat, featureless soft sediment/sand bottom, and therefore fish densities, especially of cryptic species, are likely low given the lack of three-dimensional benthic habitat to provide cover.

There is little potential for *SARA* listed fish species to be present in the dredge area. There is some potential for Atlantic wolffish to be present in Sydney Harbour, although anecdotal evidence from local fishers suggests that the Atlantic wolffish has not been spotted in Sydney Harbour in recent years (B. Hatcher, pers. comm. 2008). Atlantic wolffish is typically found in coastal areas of Nova Scotia, although their distribution is patchy and not abundant. Moreover, adult wolffish prefer hard bottom substrates with boulders/ledges to hide under; this habitat is sparse in the dredge area. If wolffish were present, adult wolfish are strong swimmers and individuals would likely be able to avoid the dredge. Wolffish spawning takes place in deeper water and the entire pelagic larval stage is spent near the spawning area (Bigelow and Schroeder 1953, in DFO 2000). As young wolffish are rarely found in shallow waters, it is thought that they remain in deeper waters (>30 m) until sexual maturity (>50 cm), as such, wolffish eggs, larvae and juvenile are not likely to be found within the dredge area.

Of greatest concern to marine fish and water quality during the Construction phase is the potential for dredging operations to increase suspended sediment concentrations (SS) in Sydney Harbour. SS levels vary naturally in coastal marine environments with lowest levels found in quiescent conditions and highest during high-rainfall conditions, as the wind and rain mixes the water column (Birch and O'Hea 2007). High SS levels are also associated with nearshore areas, and lower production values (Aumack *et al.* 2007). SS levels have a profound influence on the structure and function of marine ecosystems. Background levels of SS in Sydney Harbour are typically below 10 mg/l (see Section 4.7 and Appendix D for description of oceanographic conditions in Sydney Harbour).

While suspended sediments are important in the marine environment for benthic organisms, high levels of SS can decrease habitat quality (Park 2007). There is generally a lower amount of dissolved oxygen associated with high SS values (Ntengwe 2006). At high concentrations or during extended periods of exposure, environmental effects of suspended sediments on fish include decreased feeding success, reduced ability to see and avoid predators, damaged gills, reduced growth rates, decreased resistance to disease or impaired development of embryos. An increase in suspended sediments will also reduce the amount of light reaching any submerged vegetation (Park 2007), thereby decreasing photosynthesis. Waters with high SS levels have also been found to have a significantly reduced amount of periphyton, a benthic organism indicator (Birkett *et al.* 2007).

Sublethal environmental effects have been reported (Appleby and Scarratt 1989) for a variety of fish species continually exposed for a period of several days in waters with suspended sediment concentrations of approximately 650 mg/L or greater. Plume modelling undertaken for the Project indicates that this threshold for SS will rarely be exceeded during dredging, and even in cases where an exceedence occurs, SS levels will return to background levels of less than 10 mg/l within several hours, up to a maximum of 4-5 days for suspended sediments in the South Arm. As such, although elevated SS concentrations from dredging may cause temporary changes to marine water quality and to marine fish habitat quality and use, there will not be any long-term effects and it is unlikely that there will be any direct mortality from SS. In addition, turbidity modelling undertaken for the assessment also suggests that a 1 year return storm would have a greater turbidity footprint than that generated during dredging of the Seaward Arm, except along the narrow centreline of the channel. Such a storm would also create a much greater spreading of suspended sediment than dredging, with peak concentrations occurring along the shorelines (see Section 2.1.5 and Appendix D).

An additional concern with the re-suspension of sediments by the dredging operations is that contaminants in the sediment could also be re-suspended and dispersed in the areas around the dredge channel. As discussed in Section 4.7, benthic sediments in Sydney Harbour are subject to varying levels and types of industrial contaminants, and the re-suspension of contaminated sediment could potentially have environmental effects on marine fish, particularly if they consume organisms that reside on the seabed. The potential for environmental effects from the re-suspension of contaminants is predicted to be quite low. According to turbidity and sediment deposition modelling, the dispersion of re-suspended sediments will not be widespread and will be short-lived. The potential environmental effects of re-suspended contaminants are discussed in Section 6.1 and are rated not significant.

Mitigation will be provided to the extent practical to reduce the environmental effects of SS on fish species and fish habitat. Mitigation measures to reduce or prevent potentially adverse environmental effects could include the use of silt curtains where feasible, and booms and coffer dams associated with CDF dredging and construction if a persistent turbidity plume exists. Dredging will likely occur during the fall and early winter months when many species of marine fish have moved offshore and when fish egg and larvae densities are low.

The spread of suspended sediment plumes will also be limited by the use of a modern, state-of-the-art trailing suction hopper dredge (TSHD) vessel as opposed to a bucket dredge (see Section 2.0 for description of TSHD). Technological systems on-board this dredge vessel allow for more precise dredging, including improved control over draghead depth which reduces overdredging. The discharge of any excess water from dredged materials will be done directly below the dredge which minimizes the

dispersion of fine sediments into the surrounding waters. Overflows will not be permitted when dredging upper, silty layers that are most often associated with relatively higher levels of contamination and resuspension risk.

Dewatering of the dredge spoils is not expected to have a significant effect on Marine Fish and Water Quality. Measures will be taken to avoid producing pockets of fine sediments during reclamation. Perimeter bunds will be constructed around the reclamation area to prevent the mixture of soil and water from flowing outside the reclamation site boundaries. Water control devices ("water boxes") will be used and designed specifically to maximize the settling of soil particles into the reclamation area in order to reduce the release of suspended solids during dewatering (see Section 2.0 for description of dewatering process). Discharge water quality limits will be established for TSS by regulatory authorities as condition of Project permit. It is assumed that the limits will be consistent with those set for other large scale construction projects in the region.

Construction of the CDFs (terminal and secondary facility) will result in permanent loss of marine habitat. As with the capital dredging activities, this component of the Project will be classified as a *HADD* under the *Fisheries Act*. In accordance with DFO-HPSD guiding policy on the Management of Fish Habitat (DFO 1986), the Proponent will be required to compensate for the loss of fish habitat at the location of the CDFs and in the dredge channel. It is assumed that the compensation ratio (area of habitat required for compensation vs. that lost or altered) will be determined in consideration of a variety of factors including habitat types and productivity as well as recovery potential. Recovery of benthic communities after dredging is discussed in Section 6.1., as is the proposed HADD compensation plan.

Sounds emitted to the marine environment during construction of the CDF could possibly reduce the quality and use of fish habitat, leading directly or indirectly to changes in fish health and behaviour; however, sound levels during construction of the CDF are not anticipated to exceed the thresholds for harming fish nor are they anticipated to greatly exceed background noise levels in this industrial harbour. There will be no underwater blasting. Dredging operations are not expected to result in significant or harmful increases to underwater sound levels. Previous underwater noise surveys suggest that noise levels produced by a dredging vessel will typically not exceed any of the thresholds that could result in harm to marine fish that were outlined in Section 6.2.3 (CO.L.MAR, 2003).

Lighting will be required during Construction and Installation of the Pier and Other Marine-Based Infrastructure and during the operational life of the marine terminal. The environmental effects of natural and artificial light on different fish species has been examined in the literature although findings have often been contradictory. For many species of fish, light is an aid for orientation, foraging, maturation, breeding, and avoiding predators (Marchesan *et al.* 2005). It is anticipated that artificial lights associated with the Project may result in a localized behaviour modification for fish; however, the magnitude of the potential environmental effects is low and the geographic extent is limited.

In summary, with mitigation, the Project will result in elevated SS within the footprint of and immediately adjacent to dredging. This environmental effect would occur intermittently during Construction while dredging is undertaken. This environmental effect is reversible, transient and of limited geographic extent and thus will not affect populations of marine organisms outside the Assessment Area and is rated not significant. While placement of the CDF will permanently reduce available marine fish habitat,

this loss of habitat will be compensated by the proponent through the HADD process. Dredging is considered harmful alteration of fish habitat, and likewise requires compensation; but benthic communities will recover within several years and these effects are thus considered reversible. Sound and lighting increases during construction of the CDF are not anticipated to exceed thresholds at which they would harm marine fish. The environmental effects of this phase of the Project are therefore rated not significant.

6.2.5 Follow-up and Monitoring

Follow-up and monitoring programs will be implemented for Marine Fish and Water Quality. The following monitoring programs are suggested:

- Land-based effluent from the Project will be monitored to check that contaminant levels are within acceptable ranges. Water discharged from the outfall will be monitored to check that contaminant levels are within acceptable ranges.
- Authorization under Section 35(2) of the *Fisheries Act* will provide compensation for marine habitat lost as a result of capital dredging and infilling. The approved compensation program may have monitoring requirements.

6.2.6 Summary of Residual Environmental Effects Prediction

Residual environmental effects of the Project on Marine Fish and Water Quality in Sydney Harbour are summarized in Table 6.7.

TABLE 6.7 Environmental Effects Assessment Matrix: Marine Fish and Water Quality

Project Activity	Potential Environmental Effect Positive (P) or Adverse (A)	Mitigation	Evaluation Criteria for Assessing Residual Environmental Effects					
			Magnitude	Geographic Extent	Duration/ Frequency	Reversibility	Ecological/Socio-economic Context	Prediction Confidence
CONSTRUCTION AND COMMISSIONING								
Dredge and Dewatering	▪ Direct mortality of marine fish (A) ▪ Re-suspension of sediments resulting in elevated levels of suspended sediment concentrations (A)	▪ HADD Authorization for capital dredging at a compensation ratio to be determined by DFO-HPSD. ▪ Use of state-of-art dredging technology (suction dredging rather than bucket dredging) ▪ Control of SS levels in CDF dewatering	2	2	1/1	R	2	H

TABLE 6.7 Environmental Effects Assessment Matrix: Marine Fish and Water Quality

Project Activity	Potential Environmental Effect Positive (P) or Adverse (A)	Mitigation	Evaluation Criteria for Assessing Residual Environmental Effects					
			Magnitude	Geographic Extent	Duration/ Frequency	Reversibility	Ecological/Socio-economic Context	Prediction Confidence
Construction of confined disposal facility (placement of offshore structures, driving or drilling/grouting of piles, placement of decking)	▪ Permanent loss of marine habitat due to placement of CDF and infrastructure (A)	▪ HADD Authorization for port footprint at a compensation ratio to be determined by DFO-HPSD	2	1	1/1	I	2	H

KEY

Magnitude:
1 = Low: Temporary disturbance of marine fish and water quality limited to the Assessment Area with no permanent loss or degradation of critical habitat.
2 = Moderate: Permanent alteration of marine fish, marine fish habitat, or water quality limited to the Assessment Area with no loss of critical marine habitat.
3 = High: Permanent alteration of habitat critical to the survival of marine fish species or permanent loss of population or stock.

Geographic Extent:
1 = Environmental effects restricted to Project footprint.
2 = Environmental effects extend beyond the Project footprint but remain with Assessment Area.
3 = Environmental effects extend beyond Assessment Area.

Duration:
1 = Short term: Effects are measurable for <1 year.
2 = Medium term: Effects are measurable for 1 to 5 years.
3 = Long term: Effects are measurable for >5 years.

Frequency:
1 = Occurs once.
2 = Occurs rarely and at sporadic intervals.
3 = Occurs on a regular basis and at regular intervals.
4 = Continuous.

Reversibility:
R = Reversible.
I = Irreversible.

Ecological/Socio-economic Context:
1 = Area is relatively pristine or not adversely affected by human activity.
2= Evidence of existing negative environmental effects (*e.g.,* existing stream crossings).

Prediction Confidence:
Based on scientific information and statistical analysis, professional judgment and effectiveness of mitigation
L Low level of confidence
M Moderate level of confidence
H High level of confidence

6.3 Marine Mammals and Marine Related Birds

Marine Mammals and Marine-related Birds is a VEC in consideration of the potential environmental effects of Project-related activities on existing populations of these species in Sydney Harbour. This VEC was selected to meet various regulatory requirements and due to the important role that marine mammals and marine-related birds play in the marine ecosystem. These species are also of public concern and of socio-economic importance for the tourism industry in Cape Breton (*i.e.,* whale watching).

Marine Mammals refers to all seals, dolphins, whales and porpoises that may be present for at least part of their life cycle (*e.g.,* breeding, feeding, and migration) in Sydney Harbour. Marine-related Birds are those species of birds present for at least part of the year in Sydney Harbour that depend directly on marine habitats for foraging, breeding, and migration. Environmental effects to bird species that depend primarily on terrestrial habitats have been assessed in Section 6.4. Marine mammals and marine-related birds that are considered at risk for the purpose of this assessment are those species that live for large parts of their life cycle in Sydney Harbour, and that have been identified by federal or

provincial agencies as being endangered, threatened, rare, special concern or otherwise of conservation concern. Species at risk are important indicators of ecosystem health and regional biodiversity.

A description of existing conditions for Marine Mammals and Marine Related Birds within Sydney Harbour is presented in Section 4.14. Marine Mammals and Marine-related Birds are closely linked to Marine Fish, which are an important source of food for these populations, and thus the assessment of Project environmental effects on Marine Fish and Water Quality should be consulted (Section 6.2). Existing conditions for bird species that depend primarily on terrestrial habitats are described in Section 4.9.

6.3.1 Environmental Assessment Boundaries

Spatial and Temporal

The general spatial boundaries for the assessment of Marine Mammals and Marine-related Birds are the marine waters and coastal areas of Sydney Harbour, which will be referred to as the Assessment Area. Of particular importance are the areas adjacent to the proposed dredge channel in the centre of the Seaward Arm, the proposed Confined Disposal Facilities in the South Arm, and the marine terminal site in the South Arm. The South Bar area (located 2 to 3 kilometres north of Whitney Pier, just south of Fishery Cove on the eastern bank of the South Arm) is also of particular concern as it is known to be an important area for shorebirds in Sydney Harbour (Schaefer *et al*. 2004). Bird species that depend primarily on terrestrial habitats are also present in the Assessment Area but are excluded from this VEC (see Section 6.4).

The temporal boundary for the assessment of environmental effects to Marine Mammals and Marine-related Birds includes the Construction and Operation phases of the Project. The temporal boundaries also include seasonal patterns and movements of different species of marine mammals and marine-related birds, including breeding seasons and particular times of year when these species are most-likely to be present in Sydney Harbour or most-likely to have migrated out of the Assessment Area.

Administrative and Technical

Marine mammal species are protected under the federal *Fisheries Act* and administratively managed by DFO. In Nova Scotia waters seals are the only commercial or subsistence exploitation of marine mammals. Field studies, marking, and collecting samples from marine mammals, both alive and dead, are permitted only with authorization by DFO. The *Species at Risk Act* (*SARA*) provides legal protection for some rare marine mammal species that have been proclaimed as endangered, rare, of vulnerable under the Act.

The *Migratory Birds Convention Act* (*MBCA* 1994) is a federal law which protects migratory birds in Canada and the United States. The Act prohibits killing, injuring or harassing migratory birds without a permit. Jurisdiction for migratory birds is federal, due to the fact that migratory birds cross both provincial and international boundaries. The *MBCA* is administered by the Canadian Wildlife Service under the authority of the federal Minister of the Environment. The Act applies to migratory birds across Canada, whether located on federal or provincial lands. The *Nova Scotia Wildlife Act* and Regulations protect all non-game bird species that are not considered pests. The *Nova Scotia Endangered Species Act* and the federal *Species at Risk Act* (SARA) offer legal protection to some rare

species that have been proclaimed as endangered, rare, special concern or vulnerable under the Acts.

A key technical limitation of the assessment is the lack of detailed information available on the presence and movements of marine mammals and marine-related bird species in Sydney Harbour. While there is substantial information available about the general presence of species in Nova Scotia waters, and more specifically in Sydney Bight (Schaefer *et al.*, 2004) (see Figure 4.3), much less is known about the movement of these species in and out of Sydney Harbour over the course of the year. General information on marine mammals and marine-related birds in Sydney Bight and other published information on marine mammals in Nova Scotia waters have been used to determine which species could potentially be present in Sydney Harbour for at least part of their life-cycle. This general information has been supplemented with data specific to Sydney Harbour where available, including information from contacts with the Canadian Wildlife Service and DFO.

6.3.2 Residual Environmental Effects Evaluation Criteria

A significant adverse residual environmental effect on any secure Marine Mammal or Marine-related Bird species is:

- One that affects Marine Mammal or Marine-related Birds populations in such a way as to cause a decline in abundance or change in distribution of common and secure population(s) such that populations will not be sustainable within the Assessment Area.

A significant adverse residual environmental effect on any Marine Mammal or Marine-related Birds species of special status is defined as:

- One that results in a non-permitted contravention of any of the prohibitions stated in Sections 32-36 of *SARA* (*i.e.,* it is an offence to capture, take, possess, collect and sell endangered or threatened species, as well it is illegal to damage or destroy the residence of an endangered or threatened species);
- One that alters the marine habitat within the assessment boundaries physically, chemically, or biologically, in quality or extent, in such a way as to cause a change or decline in the distribution or abundance of a *SARA* listed Marine Mammal or Marine-related Birds population that is dependent upon that habitat such that the likelihood of the long-term survival of these populations within the Assessment Area is substantially reduced as a result; or
- Direct mortality of individuals or communities such that the likelihood of the long-term survival of these rare, uncommon and/or non-secure population(s) with Nova Scotia is substantially reduced as a result.

6.3.3 Potential Interactions, Issues and Concerns

Based on the regulatory requirements and professional judgment of the Study Team, the environmental effect being evaluated in this assessment is a Change in Marine Mammal and Marine-related Birds Populations.

This environmental effect relates to the interaction between Project activities (including dredging, vessel traffic, and marine infrastructure) with marine mammals and marine-related bird populations that are present at different times of year in Sydney Harbour. A change in population could be a result of direct

mortality to marine mammals or bird species, or indirectly through alteration, disruption, or destruction of key habitat and food sources.

Potential Project interactions with this VEC are summarized in Table 6.8.

TABLE 6.8 Potential Interaction, Issues and Concerns for Marine Mammals and Marine-related Birds

Project Activities and Physical Works	Change to Marine Mammal and Marine-related Bird Populations		
	Change in Habitat Quality	Change in Habitat Use	Mortality
Construction and Commissioning			
Dredge and Dewatering	2	2	2
Vessel Transportation	2	2	2
Construction of confined disposal facility	1	1	0
Site Preparation	0	0	0
Construction of land components	0	0	0
Operation			
Marine Vessel Traffic	2	2	2
Loading and Unloading Vessels/Trains	0	0	0
Site stormwater and wastewater Management	1	1	0
Equipment and Materials Storage	0	0	0
Maintenance/Repairs to Terminal	1	1	0

Note: Project-Environment Effects were ranked as follows:

0 No interaction. No substantive interaction contemplated.

1 Interaction will occur. However, based on past experience and professional judgment, the interaction would not result in a significant environmental effect, even without mitigation, or the interaction would clearly not be significant due to application of codified practices

2 Interaction may, even with codified mitigation, result in a potentially significant environmental effect and/or is important to regulatory and/or public interest. Potential environmental effects are considered further and in more detail in the EIA.

Table 6.9 provides the measurable parameter(s) that will be used for the assessment of environmental effect, and the rationale for the selection of the measurable parameter(s).

TABLE 6.9 Measurable Parameters for Marine Mammals and Marine-related Birds

Environmental Effect	Measurable Parameter	Rationale for Selection of the Measurable Parameter
Change in Marine Mammal and Marine-related Birds Populations	Marine vessel traffic	Vessel strikes can lead to direct injury or mortality of marine mammals and marine-related birds. As vessel traffic levels and patterns change in the harbour, the risk for vessel strikes may also change.
	Noise levels (decibels)	Increase in noise levels (magnitude, frequency, duration and character – tonal vs. impulsive) above background levels as a result of construction activities or increased vessel traffic may result in changes to behaviour and habitat use by marine mammals and marine-related birds.
	Loss of species of special status	Species of special status are protected by federal and provincial legislation. This measurable parameter addresses the potential loss of species of special status due to Project effects.

6.3.3.1 Construction

Project activities associated with Site Preparation (clearing, grubbing, grading) and Construction of Land Components (including road, rail, buildings) will not have any significant interactions with the marine environment and were ranked as “0” in Table 6.8. The environmental effects of these phases of the Project on Marine Mammals and Marine-related Birds are therefore rated not significant and are not considered further in the assessment.

Construction of the CDF and related marine activities in the South Arm could potentially interact with marine mammals and marine-related birds and has been rated “1” in Table 6.8. The infilling of the CDF will permanently alter an area of marine habitat, and increased noise levels from construction activities could lead to a change in habitat use by marine mammals and marine-related birds in the area. Noise from construction activities may cause some marine mammals and birds to avoid this particular area of the South Arm temporarily. This disruption will subside once construction is complete, The South Arm has traditionally been host to a number of industrial activities and marine vessels, and as such, noise levels produced by construction of the CDF will not be abnormal compared to background noise conditions. There will be no marine pile-driving or blasting during construction of the CDF, which will reduce the amount of additional noise being produced at the site. The loss of marine habitat due to the construction of the CDF will be minimal in relation to the amount of available habitat in Sydney Harbour, and there is no information to suggest that large numbers of marine mammals or marine-related birds are regularly present in this highly-developed part of the harbour (see Section 4.14). Marine mammals and marine-related birds are more likely to be present in the outer edges of the Seaward Arm of the Harbour, which is in close-proximity to the open-water areas of Sydney Bight. Given that the amount and importance of the area of marine habitat lost is low, and that noise disruptions from construction of the CDF will be minimal and temporary, the environmental effects of this phase of the Project are rated not significant and will not be considered further in the assessment.

Dredging and Dewatering and Vessel Transportation during Construction could potentially have significant environmental effects on Marine Mammals and Marine-related Birds. These phases of the Project have been rated “2” in Table 6.8 and are considered further in the assessment and discussed in Section 6.3.4.

6.3.3.2 Operation

Project activities associated with Equipment and Materials Storage and the Loading and Unloading of Vessels and Trains will not have any significant interactions with the marine environment and were ranked as “0” in Table 6.8. The environmental effects of these phases of the Project on Marine Mammals and Marine-related Birds are therefore rated not significant and are not considered further in the assessment.

Site Stormwater and Wastewater Management and Maintenance/Repairs to the Terminal could potentially cause indirect changes to habitat quality and habitat use for Marine Mammals and Marine-related Birds. Site stormwater and wastewater runoff could result in the release of substances to the marine environment, which could have adverse environmental effects on important food sources for marine mammals and marine-related birds, such as pelagic fish and shellfish. The environmental effects of wastewater and stormwater runoff on Benthic Habitat Communities and Marine Fish and Water Quality

were assessed in Section 6.1 and 6.2 and were rated not significant due to planned mitigation procedures by the Proponent. As such, there will be no significant adverse effects on habitat and food sources for marine mammals and marine-related birds resulting from stormwater and wastewater run-off. The environmental effects of Site Stormwater and Wastewater Management are therefore rated not significant. There is no further consideration of these aspects of the Project in the assessment.

Maintenance/Repairs to the Terminal may increase noise levels in areas immediately adjacent to the Project footprint depending on the nature of the repairs. Maintenance dredging will not be required for the Project, and the increased noise levels associated with other maintenance and repairs to the Terminal would be relatively infrequent and would not increase noise levels in the inner Harbour in any substantive way given the relatively high levels of ambient noise that currently exist from other industrial activities. Furthermore, the habitat area that would be affected by increased noise is located in the inner harbour area, a heavily developed area, and thus Marine Mammal and Marine-related Birds densities are likely low and any individuals that are routinely present in the area have likely become accustomed to increased noise in this industrial harbour. The environmental effects of Maintenance/Repairs to the Terminal are therefore rated not significant and will not be discussed further in the assessment.

Marine Vessel Traffic during Operations will interact directly with Marine Mammals and Marine-related Birds and could result in significant adverse environmental effects. This phase of the Project has therefore been rated a "2" in 6.8 and will be considered further in the assessment and discussed in Section 6.3.4.

6.3.4 Analysis, Mitigation and Residual Environmental Effects Prediction

Dredging and Dewatering, Vessel Transportation during Construction, and Marine Vessel Traffic during Operations have all been rated as a "2" in Table 6.8 due to their potentially significant interactions and environmental effects to Marine Mammals and Marine-related Birds. Each of these Project components is discussed in the following sections, along with an assessment of their potential environmental effects. The section also includes a discussion of mitigative measures which will be put in place to limit any residual adverse environmental effects.

6.3.4.1 Construction and Commissioning

Dredging of the navigational channel and increased vessel traffic during the Construction phase of the Project could have adverse environmental effects on Marine Mammals and Marine-related Birds via several pathways, including direct mortality or injury from collisions, changes in habitat use resulting from increased underwater noise levels, and changes to habitat quality resulting from environmental effects to key food sources (*i.e.,* marine fish and shellfish).

Vessel Noise

Dredging and Vessel Transportation activities during the Construction phase of the Project could result in increased underwater noise levels in the Assessment Area. At close proximity, these sounds have the potential to impair marine mammal feeding efficiency, predator detection, and/or migratory success (Richardson *et al*. 1995). Marine mammals depend highly on their ability to perceive and discriminate between sounds in the marine environment. Sound production and audition play instrumental roles in

spatial orientation and migration, communication, predator and prey detection, courtship displays and mating, and locating conspecifics (Richardson *et al*. 1995; Nowacek *et al.* 2004). Depending on the species in question, high noise levels could lead to reduced foraging efficiency; increased predation; reduced fecundity; and increased energy expenditure (Richardson *et al*. 1995; Nowacek *et al.* 2004).

Underwater noise produced from dredging would only affect marine mammals that are present near the centre of the Seaward Arm and near the proposed terminal site in the South Arm during scheduled dredging activities. Underwater noise from dredges is highly variable and changes with the mode of operation. Although there has been limited research done on the underwater noise levels generated by dredging vessels, research suggests that the level of danger for marine mammals would likely only be reached directly under the keel of the vessel (CO.L.MAR, 2003). Limited monitoring of marine mammals during dredging operations by a TSHD operator has not found any adverse effects on marine mammals (M. Van Parys, pers. comm., 2008). Underwater noise from the TSHD is anticipated to be equivalent to that of a large marine vessel. Sydney Harbour is an active industrial harbour which currently has regular port calls from large marine vessels. The underwater noise levels generated by the dredger are generally not expected to exceed the current noise levels that marine mammals are occasionally exposed to if present in the harbour. Marine mammals will be easily able to detect and avoid the dredging operations, and any such disturbance will be limited to the term of active dredging.

Noise originating from Construction-related vessels, including tugs, barges, and supply vessels, may affect marine mammals throughout the Assessment Area, but particularly in the navigational channel in the Seaward Arm and near the proposed marine terminal site in the South Arm. In general, the source level of ship noise increases with ship size, speed, propeller blade size, number of blades, and rotations per minute (Ross 1976; Gray and Greeley 1980; Scrimger and Heitmeyer 1991; Richardson *et al*. 1995; Hamson 1997). Marine vessels present in Sydney Harbour during Construction will be relatively smaller vessels and barges and will not be present in large numbers. The noise levels generated by these vessels will therefore be less intense than those generated by the larger vessels which currently transit the harbour on a regular basis.

The spatial distribution of marine mammals in Sydney Harbour is not well known. Based on the likely distribution of marine mammals in the Assessment Area, underwater noise produced during construction activities is most likely to affect seals and harbour porpoises, as larger marine mammals such as whales are not known to be present in the harbour on a regular basis, and would tend to be present in the outer reaches of the harbour in those instances (see Section 4.14). Dredging and marine vessels produce low-frequency sounds with most acoustic energy below 1 kHz. As seals and harbour porpoises are most sensitive to mid-frequency sounds (> 1 kHz), much of the acoustic energy produced by dredging and vessel transportation will not be audible to these marine mammals. Based on the Southall *et al.* (2007) exposure criteria, neither dredging nor vessels will produce sounds intense enough to induce negative effects in any marine mammals as described above.

Underwater noise levels from dredging and from construction-related vessels will not affect the health or well-being of marine mammals in Sydney Harbour; however, they may result in a temporary change to habitat use by marine mammals, as most species would move away from the dredger to avoid the noise and potential for collision. This will be a temporary disruption to habitat use, as dredging will be completed within a few months, and maintenance dredging is not planned for the Project. Dredging will be occurring in the centre of the Seaward Arm of the Sydney Harbour, which is currently an area with

regular vessel traffic. As such, marine mammals and birds present in the harbour are already accustomed to vessel noise in this part of the harbour.

Underwater noise from dredging and construction-related vessels will not result in harm to seabirds; however, the noise and the presence of these vessels during Construction will likely cause seabirds to avoid the navigation channel and the Terminal area of the South Arm during periods of high vessel activity. This temporary change in habitat use will not have any significant effects on marine-related bird populations, particularly because marine birds in Sydney Harbour are already subjected to similar noise levels from regular vessel traffic.

Vessel Collisions

Movements of the TSHD during dredging of the navigational channel could increase the risk of marine mammal and marine bird mortality from vessel collisions. The dredger will be transiting back and forth between the Seaward Arm and the South Arm for several months while dredging is being completed. These transits represent vessel movements that will occur in addition to existing vessel traffic, increasing the potential for interactions with marine mammals. During the Construction phase of the Project, a number of marine vessels will be used for the delivery of construction materials and equipment and the placement of marine infrastructure. Increased Vessel Transportation during the Construction phase of the Project could also increase the risk of collisions with marine mammals and birds. In addition, some marine-related birds are attracted to bright lighting on marine vessels, and some species (such as Leach's Storm Petrels) are particularly sensitive to lighting. Some marine-related birds may be attracted to lighting associated with nighttime operation of the dredge which could increase the risk of collisions. While additional lighting may cause a decrease in habitat quality in the navigational channel, it is likely that birds in the area are habituated to this type of lighting due to the other industrial activities currently operating in Sydney Harbour, and increased numbers of bird collisions are therefore not anticipated. Crews onboard the dredge vessel will monitor the deck for evidence of bird strikes and will consult with CWS should there be an abnormal number of incidents. The Proponent will also adopt mitigative measures recommended for Leach's Storm Petrel by CWS, as outline in "The Leach's Storm-Petrel-General Information and Handling Instructions". Marine-related birds may also be attracted to lighting at the Terminal in the South Arm. This issue has been discussed for terrestrial birds in Section 6.4, including mitigation strategies for reducing the effects of lighting on birds.

Vessel collisions with marine mammals are more likely to occur when vessel speeds are high and with slow-moving marine mammals such as whales. Ship collisions with whales are relatively rare and based on reported strike statistics, collisions are primarily a threat to whales where shipping lanes traverse areas of high whale densities and where transit speeds are high (Laist *et al.* 2000). The TSHD will be moving at relatively slow speeds, as will the small number of vessels associated with Project construction. Sydney Harbour and its approaches are not commonly frequented by large, vulnerable whale species such as humpback and right whale. If whales were present in Sydney Harbour, they would tend to be in the outer-reaches of the harbour, not the highly developed inner areas. Marine mammals that are more likely to be present, such as seals and harbour porpoises, are fast-swimming and agile, and can effectively modify their behaviour (*i.e.,* swim away, dive) to avoid approaching vessels. There are very few documented cases of vessel strikes to any species of seal or small toothed whale (Richardson *et al.* 1995). In addition, the noise produced by the dredge vessel will likely cause marine mammals and marine-related birds to avoid the dredging area altogether. Given the

context of the Project (*i.e.,* a highly developed inner Harbour area) and the lack of critical or important habitat for any species of marine-related mammals or birds, the likelihood of mortality for marine mammals and marine-related birds due to vessel strikes is extremely low.

The likelihood of vessel collisions with marine mammals and marine-related birds will be reduced further by several mitigation procedures developed by the Proponent. Standard marine vessel operating procedures will be followed by Project vessels, including avoidance of whales and further reduction in speed if they are sighted. In addition, Project vessels will navigate at low speeds in Sydney Harbour and will travel on fixed navigation routes.

There are several species of special concern that may be present in Sydney Harbour. The Harlequin Duck, considered a Schedule 1 species of Special Concern under *SARA,* may winter in Sydney Bight; however, Sydney Harbour does not provide critical habitat for the Harlequin Duck and there are no anticipated interactions between this species and Project activities. The Piping Plover is also considered a Schedule 1 species of Special Concern under *SARA* and is Red listed under the Nova Scotia *Endangered Species Act*. The Red Knot is listed as Endangered by COSEWIC and is Yellow listed under the Nova Scotia *Endangered Species Act*. The Purple Sandpiper is considered a species of Yellow status under the Nova Scotia *Endangered Species Act*. According to historical data from CWS (P. Hicklin, pers. comm., 2008), the Piping Plover, Red Knot and Purple Sandpiper are rare visitors to Sydney Harbour, and therefore, there are no anticipated interactions between these species and the Project. Common Terns are also rated as a Yellow species under the Nova Scotia *Endangered Species Ac*t, and they are known to breed in the South Bar area of Sydney Harbour (Schaefer 2004). South Bar is located well northeast of the proposed Terminal site in the South Arm and therefore dredging and construction activities are not expected to have any interactions with Tern colonies on South Bar. The navigational channel passes well west and southwest of South Bar, and therefore dredging and vessel transportation will not have any direct interactions with Tern colonies. Common terns fly slowly over water, diving to catch fish or other aquatic prey in shallower waters. The infilling and construction of the Terminal in the South Arm will permanently reduce a small area of the available feeding grounds for Common Terns; however, this loss of habitat will be minor relative to the remaining feedings grounds available in Sydney Harbour, and will not have a significant effect on tern populations.

Changes to Habitat Quality

Dredging of the navigational channel in Sydney Harbour and infilling associated with the CDFs could potentially have indirect adverse environmental effects on marine mammals and marine-related birds by reducing the availability or quality of their primary food sources through removal of benthic habitat and communities. Suspended sediments resulting from the disturbance of the seafloor may also have environmental effects on marine fish and shellfish. Most marine mammals and marine-related birds rely on marine fish and shellfish as an important component of their food sources. Pelagic species such as herring and mackerel and benthic shellfish found in the intertidal zone are key food sources for many species (see Section 4.8).

The environmental effects of dredging on benthic habitat communities and marine fish were assessed in Section 6.1 and were rated not significant. The effects to benthic communities within the dredge channel will regenerate within a few years and all harmful alteration of fish habitat will be compensated as required under the *Fisheries Act*. As a result, there are no anticipated long-term adverse effects to

the food sources of marine mammals and marine-related birds in Sydney Harbour.

In summary, there is expected to be some short-term changes to habitat use by marine mammals and marine-related birds as a result of the underwater noise produced by dredging and construction-related vessel traffic. Despite the increase in vessel traffic resulting from dredging and construction activities, the risk of direct mortality from collisions for marine mammals and marine-related birds was determined to be extremely low. Dredging of the navigational channel is not expected to have substantive residual environmental effects on food sources or marine habitat for marine mammals and marine-related birds. The environmental effects of Dredging and Vessel Transportation during Construction are therefore rated not significant.

6.3.4.2 Operation

During Project Operation, it is expected than marine vessel traffic will increase by 2-4 vessels per week by Phase II of the Project. Many of these vessels will be larger, post-panamax vessels that will be able to navigate Sydney Harbour after dredging of the navigational channel. The increase in vessel traffic introduces the potential for increased risk of collisions with marine mammals and marine-related birds and the potential for increased underwater noise levels along the navigation route. The increase in vessel traffic could also potentially increase the risk of accidental spills in the marine environment which could have significant environmental effects on marine-related bird populations and their habitats. Accidental Events are discussed in Section 7.0.

Project vessels will travel through Sydney Harbour along the navigational channel in the centre of the Seaward Arm and the South Arm. As discussed in Section 6.3.4.1 for dredging and vessel transportation during the Construction phase of the Project, vessel collisions during terminal Operation have the potential to result in injury or mortality for marine mammals and marine-related birds, and vessel noise can lead to changes in habitat quality and habitat use for these species when vessels are present.

If underwater noise from Project vessels is loud enough, it could impair normal marine mammal behaviour; however, as discussed in Section 6.3.4.1., noise from Project vessels will not exceed the noise levels that marine mammals are currently exposed to from regular vessel traffic. As a result of the distribution of marine mammals in Sydney Harbour, it is likely that only seals and porpoises will be consistently exposed to Project vessel noise during Operation and will not be significantly affected. Vessel collisions can result in injury or mortality for marine mammals and marine-related birds; however, as discussed in Section 6.3.4.1., vessel strikes are more likely to occur when vessels travel at high speeds through areas of high whale concentrations which will not be the case in Sydney Harbour. Seals and porpoises would be at higher risk of being affected; however, they are able to avoid ships in advance of collisions. There will be no significant environmental effects from increased vessel traffic on species at risk, as described in Section 6.3.4.1. The risk of collisions will be further reduced by various mitigation procedures that are described in Section 6.3.4.1 and Table 6.10.

In summary, there is expected to be some short-term changes to habitat use by marine mammals and marine-related birds as a result of the underwater noise produced Marine Vessel Traffic. Despite the increase in vessel traffic, the risk of direct mortality from collisions for marine mammals and marine-related birds in the Assessment Area was determined to be extremely low. The environmental effects of Dredging and Vessel Transportation during Operation are therefore rated not significant.