SCIENCE ADVICE ON POTENTIAL IMPACTS OF SYDNEY HARBOUR ACCESS CHANNEL DEEPENING AND THE PROPOSED SYDPORT CONTAINER TERMINAL

Context

In December 2008, the Laurentian Energy Corporation (LEC) submitted a draft Environmental Assessment (EA) report to the Canadian Environmental Assessment Agency (CEAA) as part of its application for approval of the Sydney Harbour Access Channel Deepening and Sydport Container Terminal project (hereafter referred to as "the draft EA"). Fisheries and Oceans Canada (DFO) received the draft EA for review under the lead of the Environmental Assessment and Major Projects (EAMP) division of the Oceans, Habitat, and Species at Risk Branch in the Maritimes Region. EAMP requested DFO Science advice on the draft EA document related to two issues:

1) Sedimentation rates and dispersion
   i) Are changes to the tidal currents in Sydney Harbour likely as a result of the Terminal construction and could this potentially result in the resuspension of contaminated sediments?
   ii) How do the predicted plume deposition models compare with naturally occurring sediment dispersion as a result of storm events? Are there likely any impacts to benthic habitats as a result of the plume deposition?

2) Lobster habitat
   i) Would the increase in depth as a result of the dredging (increasing depth by a maximum of 3 meters) impact the suitability of the habitat for benthic species such as lobster (assuming no change in substrate composition)? Could the new change impact the movement of species such as lobster and rock crab?

A response to these questions was requested by the end of January 2009. Given the short timeframe for review, DFO's Science Special Response Process was used. Representatives from Maritimes Science met with representatives from EAMP on January 21, 2009, to discuss the issues and concerns relating to sedimentation rates and dispersion.

The final EA for the Sydney Harbour Access Channel Deepening and Sydport Container Terminal project (hereafter referred to as "the final EA") was provided to DFO in early March 2009. DFO Science was asked by EAMP whether previous comments had been adequately addressed in the final EA, and also what the feasibility might be of relocating lobsters out of the way prior to the initiation of the dredging project. A response was requested by 30 March 2009. Given the short timeframe for response, DFO's Science Special Response Process was used again to develop the response.

The DFO Science responses to EAMP's questions on both the draft and final EAs have been combined and published in this single Science Response Report.

Background

Laurentian Energy Corporation (LEC) has proposed to develop a marine container terminal facility in the Sydport Industrial Park, located in south arm of Sydney Harbour, Nova Scotia. To accommodate large container ships (e.g., Post-Panamax size) at this marine container terminal, it would be necessary to dredge a navigation channel in Sydney Harbour and a berth area next to the proposed container terminal. Some of the dredged material will be used to infill an area of the shoreline that will house the terminal, the rest will be transferred to a confined disposal facility in the south arm.

Response

Review of Draft EA

The following comments on the draft EA were provided by Maritimes DFO Science to EAMP on 29 January 2009.

Sedimentation Rates and Dispersion

There were six issues identified by DFO Science for which inadequate information was contained within the draft EA. These issues were:

Lack of recognition for the resuspension of contaminants and fine grain-sediments during dredging

Sediments in the outer part of Sydney Harbour do not present a major concern as they are composed of 80-90% sand and have low contaminant levels. Dredging of this material would not be expected to release significant amounts of contaminants. Inside the South Bar, sediment texture changes abruptly to mud as bottom stress decreases. This region of Sydney Harbour has accumulated high levels of contaminants including trace metals, polycyclic aromatic hydrocarbons (PAHs), and polychlorinated biphenyls (PCBs) with the highest levels found in the area of Muggah Creek (Stewart et al. 2001; TSRI #93). It has been proposed to remove between 1 and 3m of sediment in the South West Arm. It is these sediments that pose the greatest risk to local ecosystem health.

There are data available on the contaminant levels in Sydney Harbour. Trace metal values in the surface sediments are documented in Stewart et al. (2001), and trace metals, PAH, and PCB levels were measured for approximately 40 cores collected as part of a study within the Toxic Substances Research Initiative (TSRI). A draft research paper (Smith et al. *in review*) has been prepared based on the data from the 40 cores and describes the historical accumulations of contaminants in Sydney Harbour. The raw data from this study is accessible through the lead researchers (i.e., Smith et al.) located at the Bedford Institute of Oceanography (BIO). Based on the approximately 40 cores from the area, Smith et al. (in review) showed inventories of PAHs and PCBs down to sediment depths of approx 1-1.5m, and have found that PAHs and PCBs reach a maximum concentration at depths between 0.5 and 1m. Based on Pb^{210} and Cs^{137} geochronologies these depths correspond approximately to dates between 1960-1980 in the area of the proposed dredge site. The results show that PCB/PAH concentrations in this area are on the order of 2-10 times above the US National Oceanic and Atmospheric Administration Effects Range Median (ER-M) level for sediment PCB/PAH. This ER-M level corresponds to the level of PCB/PAH in sediment below which adverse biological effects were measured 50% of the time (Jones et al. 1997). A similar pattern is observed for trace metals such as lead.

Concentrations of all contaminants decrease near the sediment surface as the contaminated sediment is capped by the deposition of cleaner muddy material that exists within the inner harbour since the closure of industrial sources (Smith et al. *in review*).

Dredging activities in the South West Arm, therefore, may lead to the release of contaminant laden fine-grain sediments. An inventory of contaminants at depth in the sediments to be removed during dredging activities in the south arm would support monitoring and mitigation efforts to reduce possible effects that may result from their release and resuspension.

Incomplete inventory of contaminants in the proposed south arm dredge areas and within the proposed dredge depths

The sediment transport modelling presented in the draft EA document is sound in relation to the initial deposition of fine-grained sediment released during dredging. As stated in the draft EA, levels of suspended sediment resulting from dredging can be expected to be similar to those reached during storms and other high stress events. As organisms in this area are subjected to these levels they can be expected to adapt. However, prolonged elevated levels may have adverse effects on the health of benthic organisms.

The model predicts a blanket of fine-grain sediment in the south arm of approximately 0.01 – 0.001 m, decreasing as you move away from the dredging near the proposed site of the container terminal. There is a concern that levels of contaminants in this blanket layer could be elevated if they are released from the underlying sediment during dredging. The borehole program presented in the draft EA document collected 9 composite samples, possibly from several depths, that show elevated PAH and PCBs for the area of proposed dredging within south arm. Levels were not as high as those found in the TSRI study, possibly as a result of mixing of contaminated sediment with clean sediment both above and below the region of maximum accumulation (i.e., composite samples). No trace metal analysis was performed on the borehole samples collected for the draft EA. The methods used in the TSRI study might be a more appropriate way of sampling sediments for contaminants. A more complete inventory of contaminant levels at depth within south arm sediments, such as those summarised in Smith et al. (*in review*), should be documented as the deposition of large quantities of contaminated sediment may pose adverse effects to habitat and benthic species.

Lack of discussion on the potential impacts of changes to tidal currents and water movements due to the constructed terminal

The proposed construction of the terminal will have an effect on tidal currents. Conventionally if you remove a percentage of the cross sectional area of a moving water body and the same volume is required to pass, then the speed of the moving water body will increase linearly. Quick calculations would estimate a removal of approximately 10% of the cross sectional area across the width of the south arm where the proposed container terminal is to be constructed. However, although local deposition will occur both in front and behind the terminal footprint, within Sydney Harbour the supply of fine-grained sediment is limited, thus large amounts of deposition within the south arm are not expected and should remain close to the present values of 0.2-2cm / yr based on the geochronologies of Smith et al. (*in review*) and the TSRI Report 93. Furthermore, since transport within Sydney Harbour is based on estuarine circulation, the direction of transport of material occurs into the harbour (Petrie et al. 2001). According to Petrie et al. (2001), seiches and storms may be responsible for most of the sediment movement in the south arm, and since the movement of water by these processes in the harbour likely would be affected by the Terminal construction, the Terminal likely would affect the resuspension and deposition of sediments.

Lack of discussion on the potential impacts on benthic communities resulting from the deposition of released material from dredging activities in the south arm

The modelling effort in the draft EA only focuses on the deposition of sediments immediately after dredging and does not address the issue of resuspension. The fine-grained sediments that are recently deposited from dredging activities can be expected to form a fluff layer that can be easily resuspended and transported over large distances even under low shear stress conditions. It has been shown that these flocculated sediments can be resuspended at shear stresses as low as 0.01 Pa which correspond to flow velocities on order of 5cm/s (Law et al. 2008; Milligan et al. *in prep*). These floc layers have a high affinity for surface reactive contaminants making them available for uptake by suspension feeding organisms (Milligan and Loring 1997). Understanding the exact impacts of these contaminant laden sediments on the benthic communities requires further investigation.

Limited discussion on effective monitoring of dredging activities (e.g., dewatering) within south arm to ensure contaminants are not released

Cutter suction dredges have in the past been responsible for the release of fine-grain material back into the dredged environment during the dredging process either by dewatering or overflow due to filling the catchment area (Kranck and Milligan 1990). New technology as outlined in the Sydport draft EA should rectify this situation during the dredging of the fine-grain material but it is essential that no dewatering occurs when occupying regions with high contaminant load. Vessels with sensors that record total suspended solids (TSS) are now routinely used during dredging process and can monitor the release of dredged material which will be included in the Sydport dredging activities. Due to the possible release of contaminants and fine grained material during dredging a monitoring program should be put in place during the dredging process to ensure that levels remain low.

There is concern that contaminants associated with the fine grained fraction will be lost during dewatering of the spoils. Monitoring of contaminant levels in the supernatant released back to the harbour will minimise this risk.

Lack of recognition of the possibility of needing to re-dredge the outer harbour

The need for maintenance dredging in the outer harbour has not been addressed in the draft EA. Deepening of the channel in this high energy, sand dominated environment could lead to significant infill of the dredged channel over relatively short timescales. The MIKE21 model from the Danish Hydraulic Institute (DHI) or the commonly used Coastal Engineering Research Center (CERC) equation originally developed by the US Army Corps of Engineers to calculate long shore drift should give an idea of the time required for the infill of the channel in the outer harbour. Model results should be presented in the draft EA with a list of parameters used to run the model to determine channel infill rates.

<u>Lobster Habitat</u>

In general, the information contained within the draft EA is comprehensive; however, it assumes that the zone of impact is limited to the dredging and infilling areas.

Issues of concern are related to the potential effect of dredging the channel and infilling to the nearshore area, and their potential impact on natural populations of lobster and other species. The limited spatial scope of the EA with regards to potential effects within Sydney Harbour does not take into account connectivity in the marine ecosystem beyond the 10 km x 150 m dredging channel width.

Information contained within the draft EA is insufficient to determine that there would be minimal or no disturbance to the lobster population within this area or beyond. Lobster and rock crab fishing takes place within the area (inside and outside Sydney Harbour, excluding the closed area); however, since no lobsters were observed during the 2-day underwater survey on 7 and 11 January 2008, it might appear as if lobster do not use this area. This is confounding because lobsters are known to migrate inshore and to shallow waters in the spring, and they return to deeper waters in the fall. This may be why none were observed during the January survey. Furthermore, recently settled juvenile lobsters, and perhaps until they reach 3-4 years, seem to remain in shallow waters and might occur in the nearshore areas adjacent to the channel, but these were not surveyed.

There is a lack of information related to seasonal changes of spatial distribution of lobsters, which would be necessary for establishing a baseline to determine long term effects of this project, positive or negative.

Suggestions for additional research include a) seasonal distribution of lobster size structure at selected locations by conducting sea sampling within the proposed dredging channel, and within the vicinity, before the dredging takes place and to continue after the project is initiated, and b) a lobster collector study for Sydney Harbour and outside the harbour to address lobster settlement rates and biodiversity before and after the project is initiated.

Additional Considerations

Distribution of macrofauna and habitat descriptions from a visual examination of a 2 day underwater video survey (7 and 11 January 2008) was limited to 160 m transects, which are only 10 m broader that the proposed 150 m wide dredging channel. As the project would have an impact on the adjacent habitat, biological information does not match the scope of this project (particularly given its potentially long duration). Broader transects and biological samples of sediment and species to shallow waters on both sides of the dredging channel would have been desirable to establish a baseline for long-term monitoring. The connectivity of the proposed dredging area to the rest of the harbour needs to be considered. Other information available from Hatcher (2008) may provide additional insight.

Suggestions include: a) characterization of the macrofauna and habitat for areas outside the dredging and infilling areas within the harbour, and collection of samples from within and outside the harbour to set a baseline of biological diversity for monitoring after development is initiated, and b) lobsters mark and recapture studies within and outside the fishing season could provide useful information on connectivity and potential impact.

With regard to eelgrass habitat, these seem to be prevalent on the inner harbour where the infilling would take place. These areas are known to act as refuge area for many species, nursery areas for some of the fish (e.g., herring), as well as potential for lobster settlement and habitat in summer. No information is presented to evaluate its significance and potential impacts of infilling.

Review of Final EA

The following comments on the final EA were provided by Maritimes DFO Science to EAMP on 31 March 2009.

Contaminants in Sediment

Although the revised EA does address a number of points, there are still some outstanding issues that have not been covered. These points are specific to the activity in the south arm.

The proponents should have a more complete inventory of the contaminants and their concentration in the sediment. Dr. John Smith's data would go a long way with this inventory. This is required to have a better assessment of the risk of potential contaminant exposure to fish and fish habitat. The proponents claimed that they have tried numerous times by e-mail and phone to contact Dr. Smith, but he has stated that he has received no e-mails and only one voice mail, which he returned and subsequently left a message. The samples that were collected by the proponent, and for which values were reported, are located where the proponent will not be dredging. As this is the source of the 2 g/l plume that will deposit up to 10 cm of sediment, the proponent should have some idea of the level of contaminates that are present.

The proponents have not addressed the question of the identity and concentration of contaminants in the surface sediment after dredging. There are two cases for which new surface sediments are a concern: (i) the new sediment surface exposed in the dredged area once the dredging is complete; and (ii) the new sediment surface created by the deposition over the south arm of the material suspended by the dredging activity. These new surface sediments may have high levels of contaminants which would be available for resuspension, thereby increasing exposure to fish / shellfish in the area.

During the dredging activity, the contaminated sediment, which is in an anoxic layer (since it has been buried over time by deposition), likely will become oxic as it reaches the surface. This may result in a change in water chemistry with a higher concentration of metals and contaminants in the water. This change is due to the change in valence of the metals making them more soluable in water, and no longer attached to sediment particles. Since there may be a higher concentration of contaminants in the dredging water, the proponents should monitor contaminant concentration during the dewatering of the infilled cells. Currently they are proposing to monitor just turbidity and are assuming all contaminants are affiliated with the sediments, which may not be correct. The identity and concentration of contaminants in this water needs to be known to assess the risk to local fish and fish habitat.

Furthermore, it would be useful to have the details on the additional modeling to which the proponents referred in their disposition table. There appears to be high levels of resuspension of exposed sediments as suggested by their model predictions of up to 20mg/l in the water column.

Feasibility of Moving Lobsters before the Dredging Project

Trapping could be used to remove some lobsters, and trapping would not be expected to result in harm to the lobsters trapped. However, it is not possible based on the information available to determine how many animals would be present in the area or to predict what percentage of the animals present would be protected through removal by traps.

The benefits would depend upon the distribution and density of animals at the time, when the trapping is done (season and how soon before the dredging) and the amount of effort intended. It is not expected to be possible to remove all the lobsters present in the area, and possibly not even the majority of lobsters present. In particular, the removal of juvenile lobsters or the few (if present) jumbo lobsters will be difficult as commercial lobster traps do not trap them as well as the average legal-sized animals. With sufficient effort and using a variety of traps to target different sizes, this problem could be reduced.

Some of the trapping concerns and issues would be:

1. What percentage of lobsters could be removed in a short period of time before the dredging? Over a 2-month season the commercial fishery remove 60-80% of the legal sized lobsters using a considerable amount of effort.
2. Season and temperature will affect the catch rate. During the fall, temperatures are dropping so catch rates will also drop meaning more effort will be needed to catch the same number of animals.
3. Not all sizes of lobsters will be removed equally. Commercial lobster traps are selective and designed to maximize the catch of legal sizes and are thus less effective on very large and very small lobsters.
4. Very smaller lobsters are not trappable so would not be removed. They are, however, less likely to migrate and are more limited by the lack of shelter in the dredge area, so they may not be present in any number unless this area is also a settlement area.
5. Sexes are not equally trappable in each season, so the removal rates of males, females or ovigerous females will differ.
6. Movements are not necessarily well synchronized and may extend over a period of time. The work done so far does not allow us to know the timing or duration of the movements.
7. Movement timing and speed are likely affected by temperature, so they will differ a little each year.
8. Traps can attract lobsters, so they should be removed well before the dredging operation to prevent lobsters being attracted to the area by the bait.

Some of the concerns in moving the lobsters would be:

1. Handling and exposure to air and heat or cold must be minimal and time from capture to release as short as possible.
2. Uncertainty in where the lobsters will be moved to.
3. The release site should be distant enough from the dredge site to avoid possible return of the lobsters to the dredge area during the dredging operation yet within the general harbour area to increase the chances of returning in the spring.
4. The release site should be similar to the capture site in depth and bottom type. This is particularly true in the late fall and winter as the lower water temperatures may prevent lobsters from redistributing themselves before winter temperatures reduce movement even further.
5. Released lobsters should be spread over an area and not dumped in high concentrations at a single location.

From the Hatcher Report, the conclusion drawn upon completion of a research program was that lobsters tend to migrate from the nearshore areas of the Seaward Arm during the autumn months into the softer sand and mud seabed in the central channels of the harbour. The tag and release program revealed that lobster were highly mobile during this time, and each of the four lobsters that were recaptured had moved further out in the channel toward the mouth of the harbour. "While results were not sufficient to determine the precise movements of the lobsters once they leave the channel, it is generally assumed that the lobsters move out into the deeper waters of Sydney Bight for over wintering."

Lobsters do move out, but it is not known how far and the data available does not allow determination of their winter habitat location. Given the water temperatures and behaviour of lobsters in similar areas, the movement may not be very far (unlike areas such as the Gulf of Maine where the deepwater offers warmer temperatures over the winter), so the assumption should be that they are still in the deeper area of the harbour or harbour mouth.

Conclusions

Based on the review of the draft Environmental Assessment for the proposed Sydney Harbour Access Channel Deepening and Sydport Container Terminal, six issues related to sedimentation were identified as being potentially useful to have addressed within the final EA. These included:

- Lack of recognition of the potential for resuspension of contaminants and fine grain-sediments during dredging.
- Incomplete inventory of contaminants in the proposed south arm dredge areas and within the proposed dredge depths.
- Lack of discussion on the potential impacts of changes to tidal currents and water movements due to the constructed terminal.
- Lack of discussion on the potential impacts on benthic communities resulting from the deposition of released material from dredging activities in the south arm.
- Limited discussion on effective monitoring of dredging activities (e.g., dewatering) within south arm to ensure contaminants are not released.
- Lack of recognition of the possibility of needing to re-dredge the outer harbour.

In addition, potential impacts to lobster habitat and other benthic organisms were not considered to have been fully addressed within the draft EA. Suggestions for additional work were provided.

While some of these issues were addressed with the final EA, a few outstanding issues were identified. These included:

- Incomplete inventory of the contaminants and their concentration in the sediment.
- Insufficient monitoring of contaminant concentration during the dewatering of the infilled cells proposed.
- Insufficient detail on additional modeling provided by the proponent, particularly in terms of the high levels of resuspension of exposed sediments (up to 20mg/l in the water column) suggested by their model predictions.

It was expected that trapping could be used to remove some lobsters from the project area (as a potential mitigation measure) prior to dredging, and trapping would not be expected to result in harm to the lobsters trapped. However, it was not possible to predict what percentage of the animals present would be protected through removal by traps. In particular, the removal of juvenile lobsters or jumbo lobsters was expected to be difficult as commercial lobster traps do not trap them as well as the average legal-sized animals. With sufficient effort and using a variety of traps to target different sizes, this problem could be reduced.

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