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Remote sensing of the bathymetry and substrate of selected areas of Lake St. Clair - using the Remote Operated Vehicle for Environmental Research (ROVER) to detect dredging spoil piles near selected river mouths

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Foreword

This series documents the scientific basis for the evaluation of aquatic resources and ecosystems in Canada. As such, it addresses the issues of the day in the time frames required and the documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

Research documents are produced in the official language in which they are provided to the Secretariat.

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TABLE OF CONTENTS

ABSTRACT

Lake margins are especially sensitive to coastal alteration by humans. Activities such as dredging have the potential to impact fish habitat. This is of special concern in Lake St. Clair, which is home to numerous species at risk including Northern Madtom, Eastern Sand Darter, and the Channel Darter. Yet, limited technology exists to survey shallow waters. We developed the remotely operated ROVER to collect high-resolution bathymetric data in shallow areas, such as undredged rivermouths. Our objectives were to assess substrate profiles and bathymetry in the navigation channels of Belle River, Pike Creek, Puce River, Ruscom River, Thames River, and Mitchell's Bay. Also, we surveyed 1 km^2 zones adjacent to the rivermouths to determine whether spoil piles could be detected. The condition of navigation channels varied from site to site; whereas some channels had well maintained trenches, other sites were unnavigable by boat. We found little to no vegetation at any of the sites, suggesting these areas may not be suitable fish habitat. We were unable to conclusively identify spoil piles at any sites, suggesting that either;

1) dredgeate was not dumped in the specified location or,
2) spoil sites do not remain intact for very long and likely dissipate after the first major storm event.

We also found that all proposed spoil sites were located at depths less than the prescribed 3 m boundary. This discrepancy was later clarified in that the 3-m limit was a maximum depth set by the local Conservation Authority and the Ministry of Natural Resources. Nevertheless, future studies and dredging activities should take water depth into account when choosing suitable spoil sites, and keep better records of the time and location of dredgeate dumping to help delineate spoil sites. If future work is to be done, researchers and Management should work together to align surveys with dredging activities to provide baselines for what a ‘fresh’ dredgeate site looks like and for how long spoil piles persist.

Télédétection de la bathymétrie et du substrat de certaines zones du lac Sainte-Claire – à l'aide du véhicule téléguidé de recherche environnementale – afin de détecter les matériaux de dragage empilés près de l'embouchure de certains cours d'eau

RÉSUMÉ

Les rives des lacs sont particulièrement sensibles aux altérations d'origine anthropique. Les activités telles que le dragage peuvent avoir une incidence sur l'habitat du poisson. Cette situation est préoccupante dans le lac Sainte-Claire, qui abrite de nombreuses espèces en péril, y compris le chat-fou du Nord, le dard de sable et le fouille-roche gris. Pourtant, les moyens technologiques permettant d'effectuer des relevés dans les eaux peu profondes sont limités. Nous avons mis au point un véhicule téléguidé pour recueillir des données bathymétriques à haute résolution dans les zones peu profondes, comme les embouchures de rivières non draguées. Nos objectifs étaient d'évaluer les profils du substrat et la bathymétrie dans les chenaux de navigation de la rivière Belle, du ruisseau Pike, de la rivière aux Puces, de la rivière Ruscom, de la rivière Thames, ainsi que dans la baie Mitchell. Nous avons également sondé 1 km^2 dans les zones adjacentes aux embouchures des rivières pour déterminer si elles contiennent des matériaux empilés. L'état des chenaux de navigation varie d'un site à l'autre; les tranchées de certains chenaux sont bien entretenues, tandis que d'autres sites se sont révélés impropres à la navigation. Nous avons trouvé peu ou pas de végétation à ces sites, ce qui laisse entendre que ces zones peuvent ne pas constituer un habitat approprié pour le poisson. Nous n'avons pas été en mesure de déterminer avec certitude la présence de matériaux empilés à ces sites, ce qui permet de penser que :

1) soit les déblais de dragage n'ont pas été rejetés à ces emplacements,
2) soit les sites des déblais ne restent pas intacts très longtemps et les matériaux se dispersent probablement après la première grosse tempête.

Nous avons également constaté que tous les sites de déblais proposés se trouvent à des profondeurs inférieures à la limite prescrite de 3 m. Cet écart a été expliqué par la suite : la limite de 3 m est une profondeur maximale établie par l'office local de protection de la nature et le ministère des Ressources naturelles. Néanmoins, les futures études et activités de dragage devront tenir compte de la profondeur de l'eau pour choisir des sites de déblais convenables et mieux consigner la date et le lieu de l'immersion des déblais de dragage pour permettre de délimiter les sites. Si d'autres travaux doivent être effectués, les chercheurs et les gestionnaires devraient collaborer afin de faire correspondre les relevés aux activités de dragage de manière à fournir des données de référence qui permettront de décrire à quoi ressemble à un site de déblais de dragage « frais » et de déterminer la durée pendant laquelle les matériaux empilés persistent.

INTRODUCTION

Lake St. Clair is home to many fish species at risk including species requiring specific substrates such as Northern Madtom, Eastern Sand Darter, and Channel Darter. As required by the recovery strategies for these species, critical habitat must be identified, and threats elucidated. The functional description of critical habitat will likely include bottom characteristics for these substrate specialists.

Dredging occurs widely in Lake St. Clair, and it is unknown if this activity is a threat to these substrate specialists as a consequence of removal or burial of these species and their habitats.

The Species at Risk group of Fisheries and Oceans Science Branch is currently undertaking a study to better understand the habitat requirements of, and threats to, fish species at risk in Lake St. Clair. In concert with a fish sampling program conducted by DFO scientists, we undertook a remote sensing survey of bathymetry and substrate characteristics at the mouths of six rivers draining into Lake St. Clair, all of which have commercial marinas and/or boat launching facilities.

Applications to dredge each rivermouth lead to the concern that channel alteration caused by dredging, and the associated deposition of spoils may significantly alter habitat suitability, leading to negative influences on resident fish populations, including species at risk.

Lake margins are especially sensitive to coastal alteration by humans. Yet, limited technology exists to survey shallow waters. We developed the Remote Operated Vehicle for Environmental Research (ROVER) to collect information on bathymetry and substrate characteristics (sediment texture, organic material accumulation, and macrophyte distribution) in aquatic habitats that are not amenable to surveys by conventional water-craft and remote sensing technology. This project used ROVER surveys to provide high resolution, shallow-water bathymetry maps in and adjacent to the river mouth channels of six Lake St. Clair locations. These surveys were used to determine whether spoil piles deposited following dredging activity are detectable in a 1 km^2 area adjacent to the channels.

OBJECTIVES

The objectives of this study were to assess substrate bathymetry at the mouths of Belle River, Pike Creek, Puce River, Ruscom River, Thames River, and Mitchell's Bay in areas specified by Fisheries & Oceans Canada, and to use sonar in 1 km^2 zones adjacent to the rivermouths to determine whether spoil piles could be detected and to estimate their persistence. In this document, we summarize the methods and results of the rivermouth surveys.

METHODS AND MATERIALS

STUDY SITES

Study sites were evaluated as per the terms of reference of agreement F2905-120050. The statement of work stipulated development of remotely sensed bathymetry and substrate in 1-km^2 grids centred over each dredged channel and, where located, each associated area of dredge spoils. Study sites were situated at the mouths of Belle River, Pike Creek, Puce River, Ruscom River, Thames River, and in Mitchell's Bay (Table 1; Figure 1). The specific areas to be assessed were provided by DFO colleagues.

Table 1. Location and timing of nearshore bathymetry surveys using ROVER.

Site Name	UTM Northing	UTM Easting	Start Date	End Date
Mitchell's Bay	384010	4703315	29/11/2012	29/11/2012
Thames River	380210	4686204	14/11/2012	21/11/2012
Ruscom River	366425	4684503	05/11/2012	10/11/2012
Belle River	358960	4684143	16/10/2012	16/10/2012
Puce Creek	348233	4686860	05/10/2012	12/10/2012
Pike Creek	348233	4686860	06/10/2012	12/10/2012

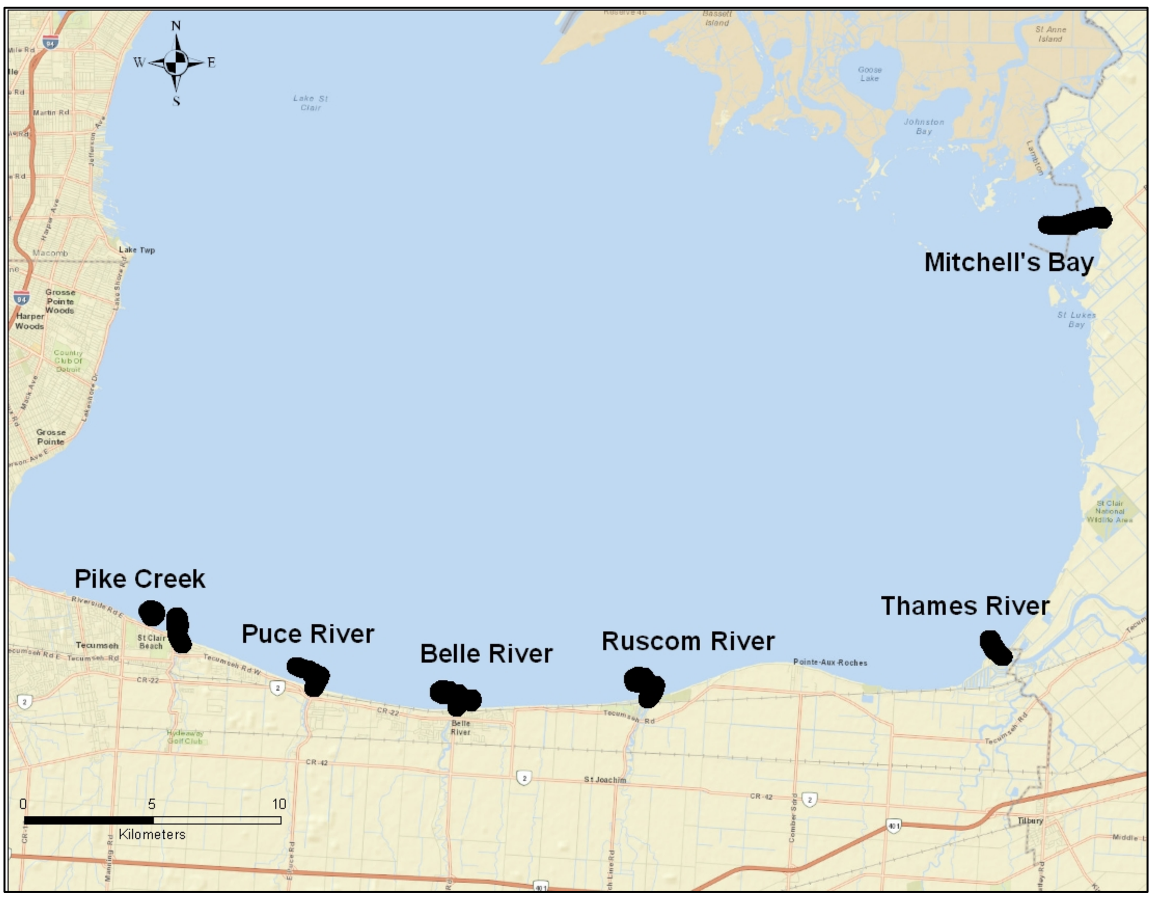

Figure 1. Location and transect lines for each sampling area within Lake St. Clair.

SURVEY TIMING AND EXECUTION

The original sampling design called for the timing of bathymetric surveys to be synchronized with trawl sampling by DFO scientists. However, surveying schedules throughout the autumn were disrupted by inclement weather conditions and scheduling limitations. Use of the ROVER required conditions of light winds and relatively calm waters, with waves less than <0.5 m. Under these conditions, a river site could be surveyed in one day. Ultimately, nearshore bathymetry surveys were conducted using ROVER between October 5th and November 29th (Table 1), independently of the dates of the DFO trawl surveys.

Sidescan sonar was to be used as a complement to the ROVER work, providing large swaths of substrate maps for each of the study sites. Sidescan sonar surveys to locate and map spoil piles were scheduled to begin in mid-October following senescence of aquatic macrophytes. However, a combination of inclement weather and mechanical problems delayed deployment past the time deemed safe for operation. The sidescan surveys have been deferred. The Lake St. Clair region to be sampled included the same suite of rivermouths: Mitchell's Bay, the Thames, Ruscom and Belle rivers, and Puce and Pike creeks (Figure 1).

Two areas were sampled using ROVER around each rivermouth - the river channel and a suspected spoil site just outside of the river mouths. Maps showing the area of river channel of interest and most likely locations of spoil deposition were provided by Jason Barnucz, Fisheries and Oceans Canada (Appendix 1, included with raw data as a PDF file). The designated 'channel' area was taken to occur from just inside a rivermouth, extending to just past the most remote navigation buoys in the lake. Estimated channel lengths ranged from 300 – 2000 m. The length of each channel transect and spoil transects are detailed in each of the cross-sectional depth profiles, with transect length (m) as the x axis (see depth profile figures for each site). Spoil sites were typically illustrated to occur 100 m northeast of each channel, in an open area of the lake. These sites were initially expected to be in 2-3 m of water (as per permit designation) but this was not always the case as many of the sites were shallower.

Surveys of Mitchell's Bay and the Thames River were conducted before any dredging had occurred, so there was no spoil site for those areas.

ROVER

ROVER is an inflatable, one-person boat equipped with a remote-controlled trolling motor, and two sonar units. The vessel is able to collect high-resolution (HR) bathymetric data and assess substrate texture and submerged aquatic vegetation (SAV) distribution and height, from which areal estimates of biomass can be inferred. ROVER uses real-time differential GPS (transmitted via a wireless broadcast signal permitting the vessel's progress to be tracked from shore), a recording depth sounder (Lowrance HD5 fishfinder), and shallow-water scanning sonar to collect real-time, georeferenced bathymetric and epibenthic information. Data are recorded digitally onboard the vessel, and processed after the survey.

DATA COLLECTION PROCEDURES

Using a 5.2-m aluminum boat to navigate, we used ROVER to run transect lines at each sampling site to create a grid of depth measurements. We used onboard GPS to track ROVER's position and ensured that it stayed within the designated sampling site boundaries. Supplementary bathymetric data were gathered using a Lowrance HD5 fishfinder mounted on the aluminum boat. Post-processing of the data removed any offset differences of the placement of the sonar units on ROVER and aluminum boat. Using ROVER, parallel transects were spaced 20 m apart in the spoil areas. Transects were more closely spaced within the narrow confines of the river channels. The sonar-equipped aluminum boat was used to provide spot depth validation between the ROVER tracks.

ROVER DATA ANALYSIS

Sonar (primary) and downscan data were interpreted using ArcGIS (ESRI v 10.1) interpretive GPS software to map study sites on the lake as well as to trace transects and produce cross-sections of the lake. Depth, and XY coordinates were extracted from the storage medium in the

LOWRANCE unit (using LOWRANCE Sonic Log Viewer v.2.1.2.), saved as Comma Separated Value (CSV) files, and imported into Global Mapper© 13 (Blue Marble Geographics). The XY readings were converted to longitude and latitude coordinates and then exported as shapefiles, which were then opened in ArcGIS. Using the Geostatistical Analysis tool (with depth as our z-axis) we interpolated the area within which ROVER sampled to generate 10-cm water depth contours.

For channel maps, a cross-section profile was taken through the middle of the channel. For spoil sites ‘horizontal’ and ‘vertical’ transects were taken through the centre of the study area. Depending on the orientation, transects ran in either a West-East or South-North orientation.

RESULTS

SUMMARY

This report provides a suite of maps (Figures 2-11) for each of the six survey sites (Figure 1), illustrating the following:

a) the bathymetry of each river channel in plane view (10-cm contour intervals),

b) a cross-sectional depth profile running the surveyed length of the channel,

c) (where available) spoil site bathymetry in plane view (10-cm contour intervals),

d) a cross-sectional depth profile running along the long axis of the spoil site, and

e) a cross-sectional depth profile running perpendicular to the spoil site long axis.

Original data records will be provided separately in electronic (CSV) format.

Bathymetric contour maps show the variation of depth within the study site. The boundaries for each bathymetry map are determined by the data collected. All bathymetric interpolations were done within the bounds of the ROVER data. The shape of each mapped polygon reflected the survey pattern unique to that site. Note that although the colour schemes for each map are the same, the scales vary among sites. The use of colour provides a relative scale of depth (blue = deeper, red = shallow) for each of the maps that cannot be compared among sites.

Depth profile graphs depict the water column (blue) with substrate (beige), and changes in depth along the transect. These maps show a vertical cross section into each of the study sites. For the channel sites, we traced a track along the middle of the channel; often the location where most data were available. For spoil sites, we would quarter-sect each study area and trace transects through the most data-dense areas.

Substrate texture and vegetation were not measured directly. However, observational notes were recorded in the areas where substrate could be seen or touched. Lake St. Clair was often murky, which made it difficult to make these observations in deeper waters. Generally, little or no aquatic vegetation was observed at any of the sites. The substrate of most sites was composed mostly of sand interspersed with some fine clays. We are currently working with the ROVER data to more precisely interpret the types of substrate and presence of vegetation. Only preliminary, unvalidated results are presently available.

EXPECTATIONS

Mapping the channel sites provides insight into whether the channel was dredged and if so, how long ago. Well-maintained channels (clear navigation channels, with trenches leading out of the river mouth) suggest recent dredging activity, and make it more likely that a dredge spoil site could be found. Shallow, uneven channel bottoms suggest that either dredging hasn't occurred or it has been a long time since dredging occurred, making it less likely that a dredge spoil site could be located.

Spoil sites were expected to be characterized by sharply demarcated decreases in depth within the putative spoil disposal areas. Piles of material were expected to appear on maps as shallow areas in otherwise deeper areas of the lake. No information was available as to the size of the mounds or the amount of dredged material deposited, making it difficult to infer the specific location or extent of actual spoil sites. We anticipate that combining the ROVER-derived bathymetric data with information acquired by sidescan sonar surveys (which have not yet been done) will provide a more definitive picture of nearshore topography, increasing the likelihood of detecting and delineating the extent of altered benthic topography at spoil sites if it occurs.

MAPS AND DEPTH PROFILES

Mitchell's Bay: The survey track extended for approximately 2000 m (the longest transect) and was shallow throughout, reaching depths of only 1.5 m at its deepest (Figure 2a). The channel was very narrow (only a few meters wide) making it difficult to determine where it was suitable to navigate. The channel substrate was mostly composed of medium sand throughout. No aquatic vegetation was observed.

There was no spoil site as the channel had not yet been dredged. The shallow waters and poor navigation channel were good indicators that this was the case.

The only noticeable feature in the cross section graph is a shallow area (likely a sand bar – feature is boxed in red) almost 600 m long, roughly 1000 m from shore (shore is farthest east) (Figure 2b).

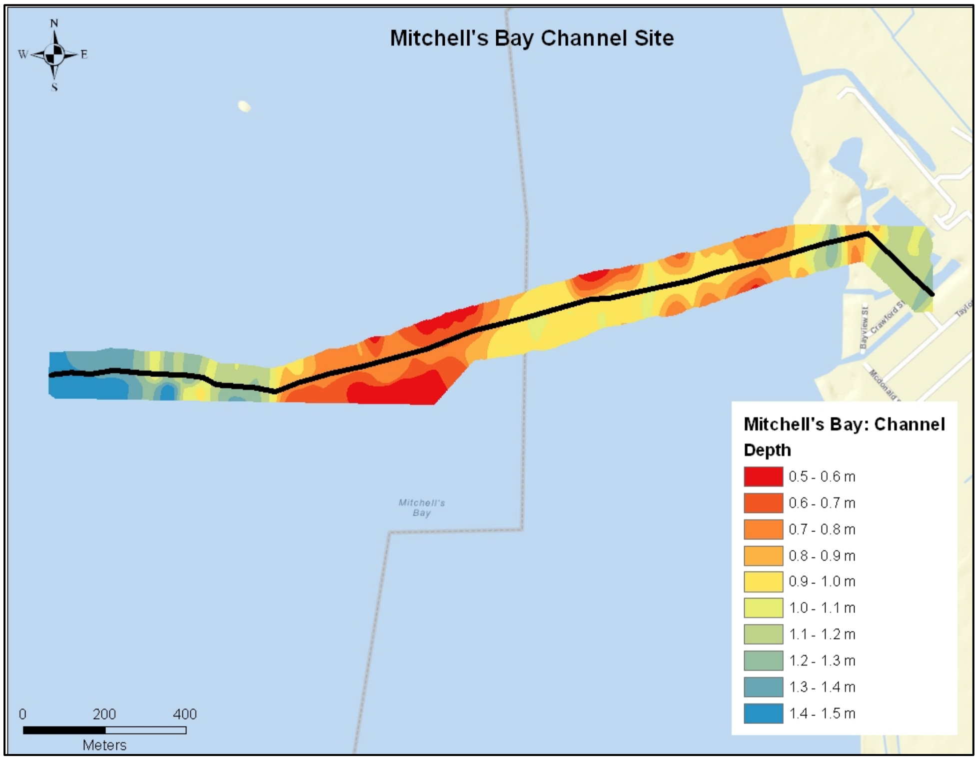

Figure 2a. Mitchell's Bay Channel. Depth contours are coloured, with changes in colour displaying a change in depth of 10 cm. Black lines indicate the track line included in the depth profile graph.

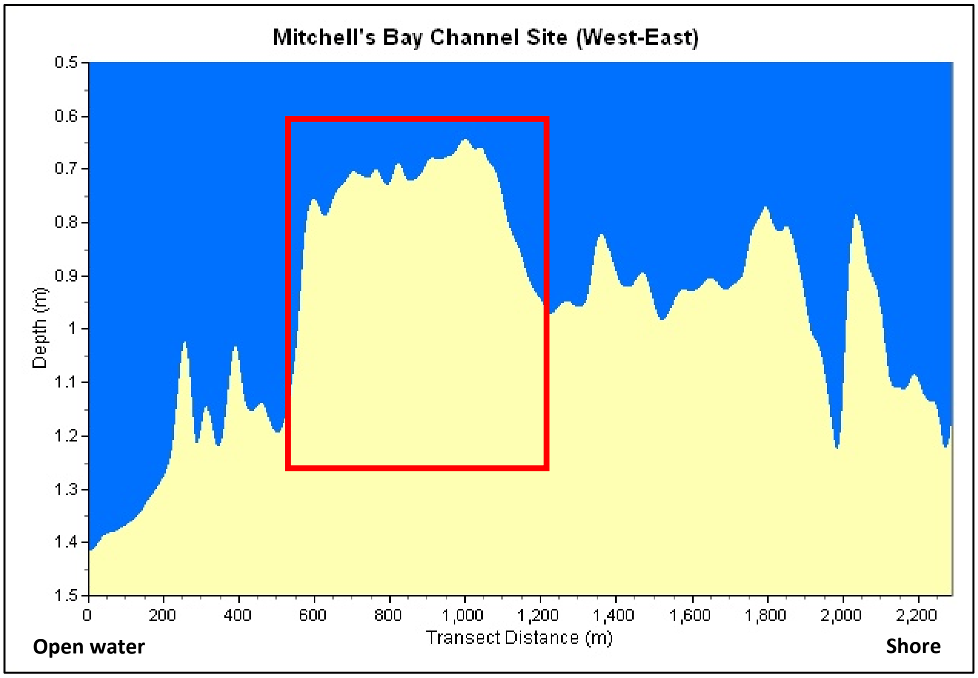

Figure 2b. Mitchell's Bay Channel W-E cross-section. This is a cross-section of the contour maps presented above. Substrate is beige and the overlying water is coloured in blue. Transect length is the x-axis and corresponds to the black lines found in the contour maps. The highlighted area (boxed in red) is most likely a sandbar along the channel.

Thames River: The transect ran approximately 1000 m long and showed the greatest range in depth (3.8-1 m) of all sites (Figure 3a). The area surveyed was large, and there was no clear navigation channel. However, the area was mostly easy to navigate; water depth was sufficient for our small vessel. Figures 3a and 3b illustrate the fact that the channel is not entirely level, with depth varying throughout the channel. The channel substrate was organic clay just within the mouth of the river, transitioning into a sandy bottom just outside the mouth. There was no sign of any aquatic vegetation. There was no spoil site as the channel had not yet been dredged.

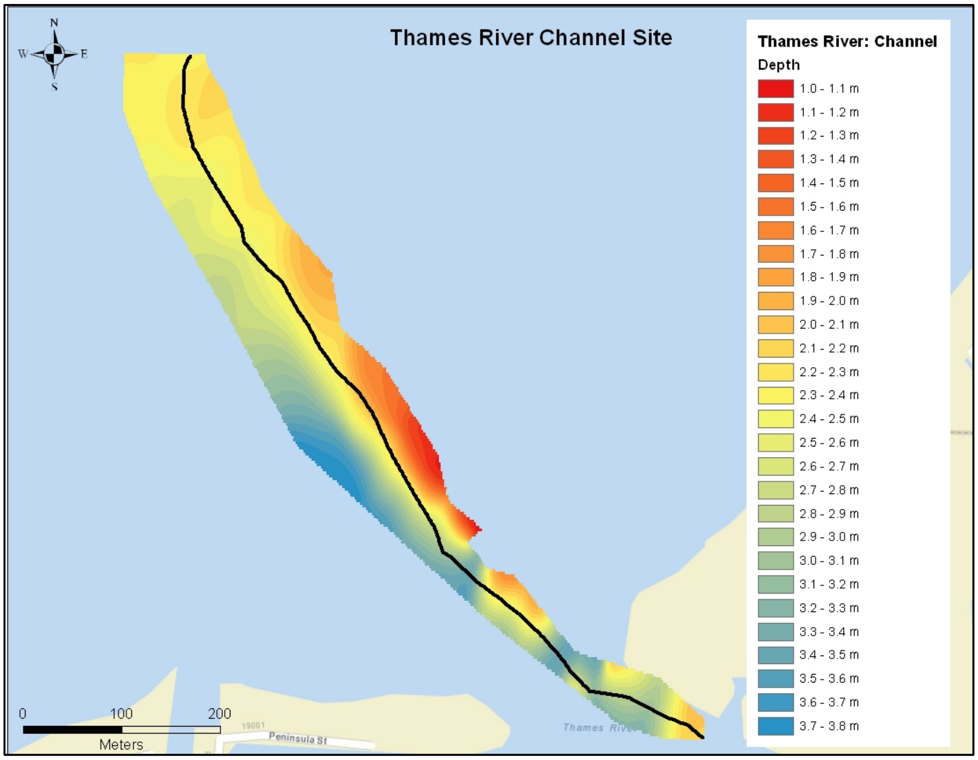

Figure 3a. Thames River Channel. Depth contours are coloured, with changes in colour displaying a change in depth of 10 cm. Black lines indicate the transect line included in the depth profile graph.

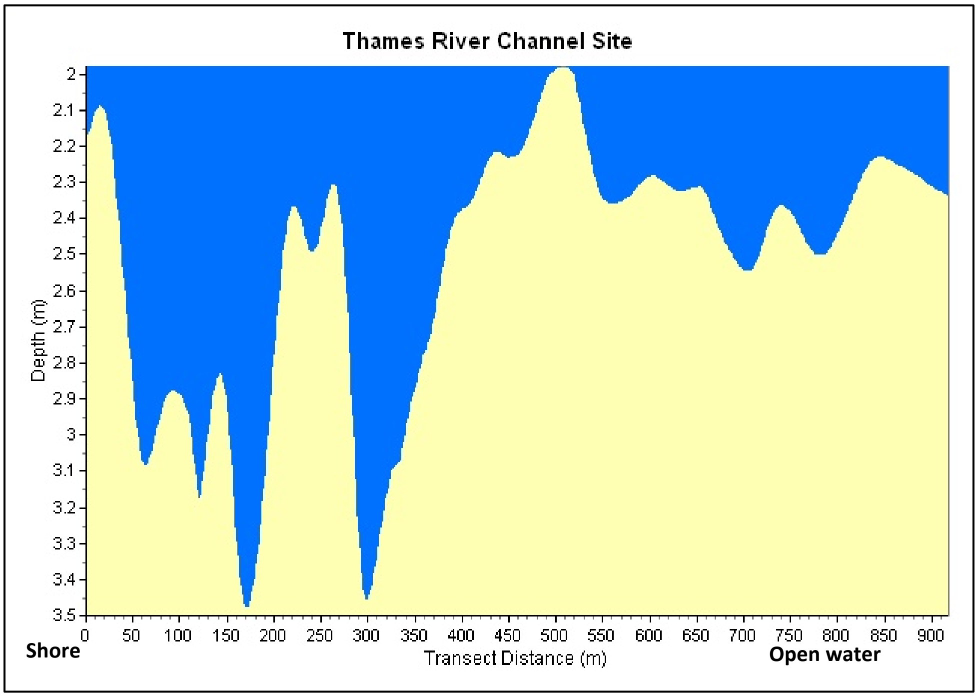

Figure 3b. Thames River Channel S-N cross-section. This is a cross section of the contour maps presented above. Substrate is coloured in beige with the overlying water coloured in blue. Transect length is the x-axis and corresponds to the black lines found in the contour maps.

Ruscom River Channel: The survey track was approximately 700 m long and was the shallowest area we sampled (Figure 4a). The area was too shallow for the aluminum boat. However, the ROVER had no problems within the 'channel'. At the mouth of the river, depths were almost 2 m but the water quickly became shallower outside of the river mouth. There was no evidence, at the time of sampling and according to Figures 4a and 4b, that the site had been dredged. The substrate was sandy, and there was little to no aquatic vegetation.

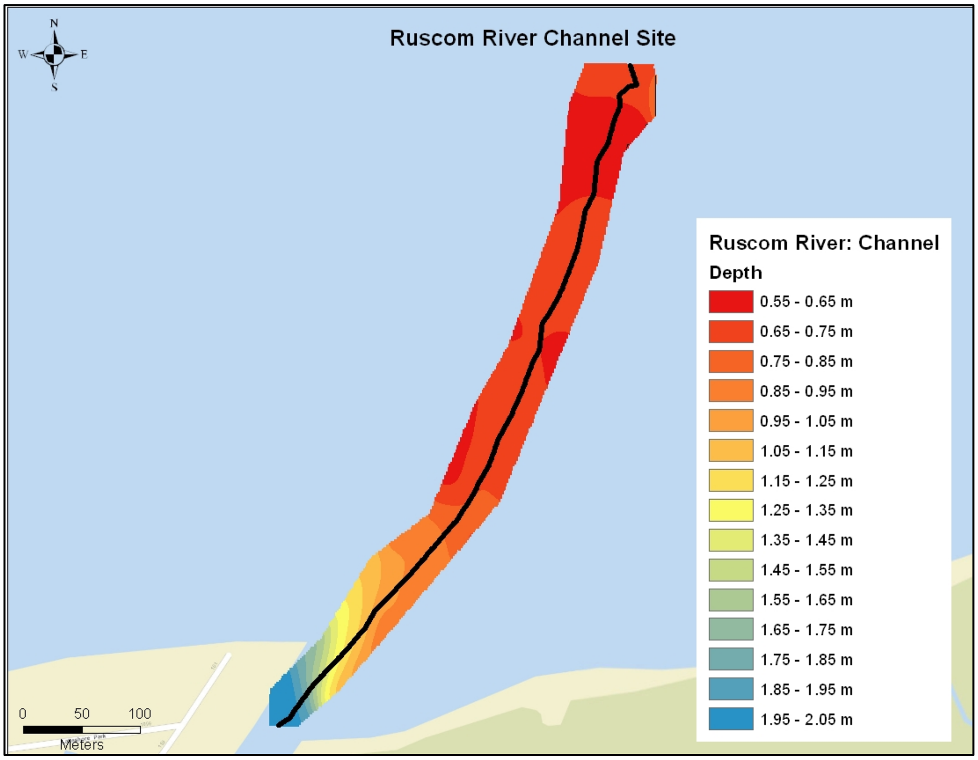

Figure 4a Ruscom River Channel. Depth contours are coloured, with changes in colour displaying a change in depth of 10 cm. Black lines indicate the transect line included in the depth profile graph.

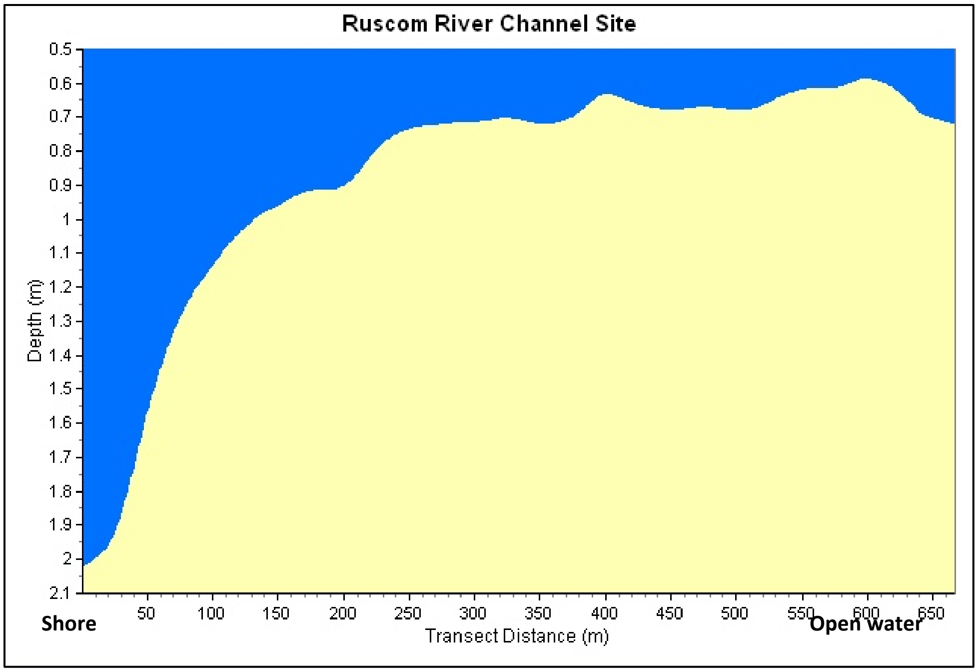

Figure 4b. Ruscom River Channel S-E cross-section. This is a cross section of the contour maps presented above. Substrate is coloured in beige with the overlying water coloured in blue. Transect length is the x-axis and corresponds to the black lines found in the contour maps.

Ruscom River Spoil Site: The spoil site had dimensions of 500 x 300 m comprising an approximate area of 0.15 km^2. Changes in depth are gradual, and the area gets deeper with increasing distance from shore (Figures 5a and 5b). Only one area in the spoil site suggests a possible dredging spoil site (a raised area approximately 100 m in length, boxed in red in Figure 5c). Otherwise, there were no apparent decreases in depth that would indicate the presence of dumped dredging spoil.

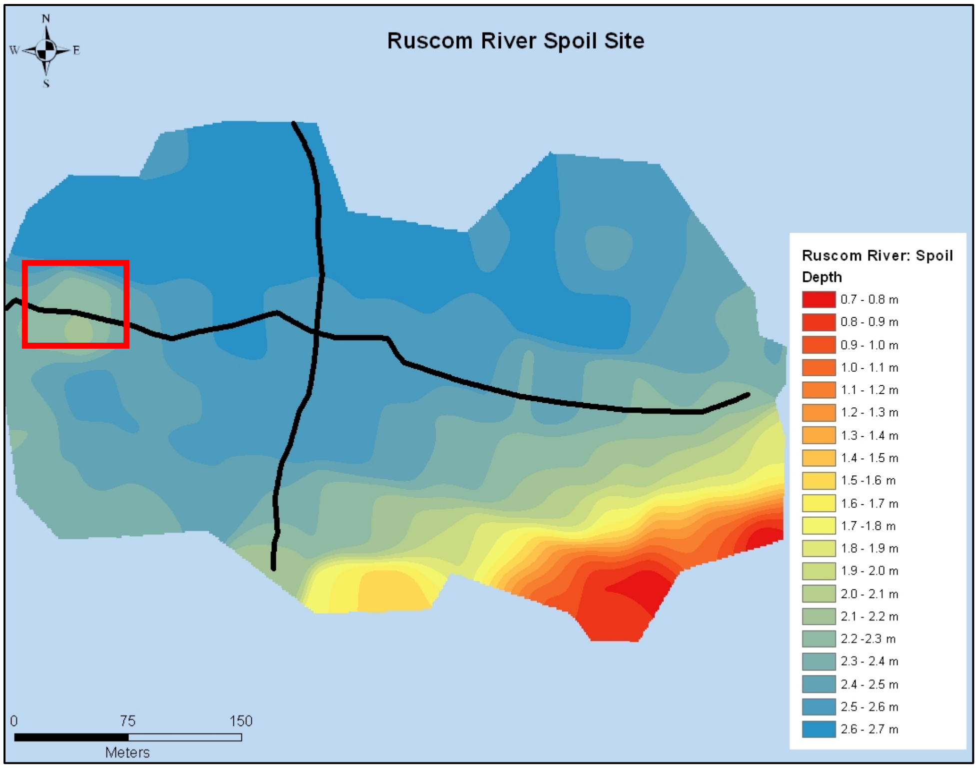

Figure 5a. Ruscom River Spoil site. Depth contours are coloured, with changes in colour representing a change in depth of 10 cm. Black lines indicate the transect line included in the depth profile graph. The red box indicates a potential dredging spoil pile.

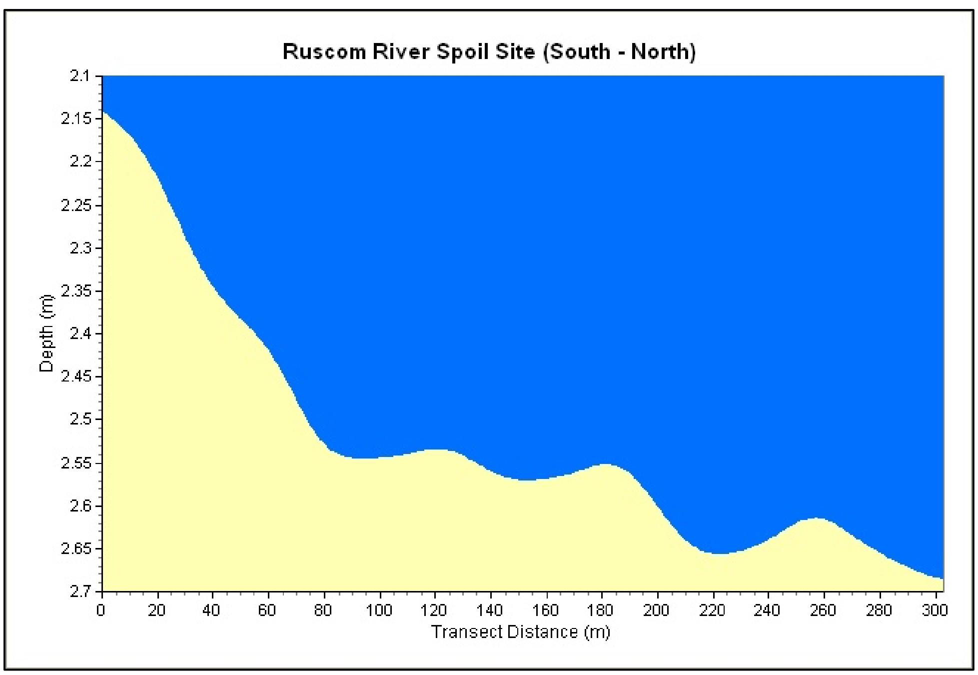

Figure 5b. Ruscom River Spoil site S-N cross-section. This is a cross section of the contour maps presented above. Substrate is coloured in beige with the overlying water coloured in blue. Transect length is the x-axis and corresponds to the black lines found in the contour maps.

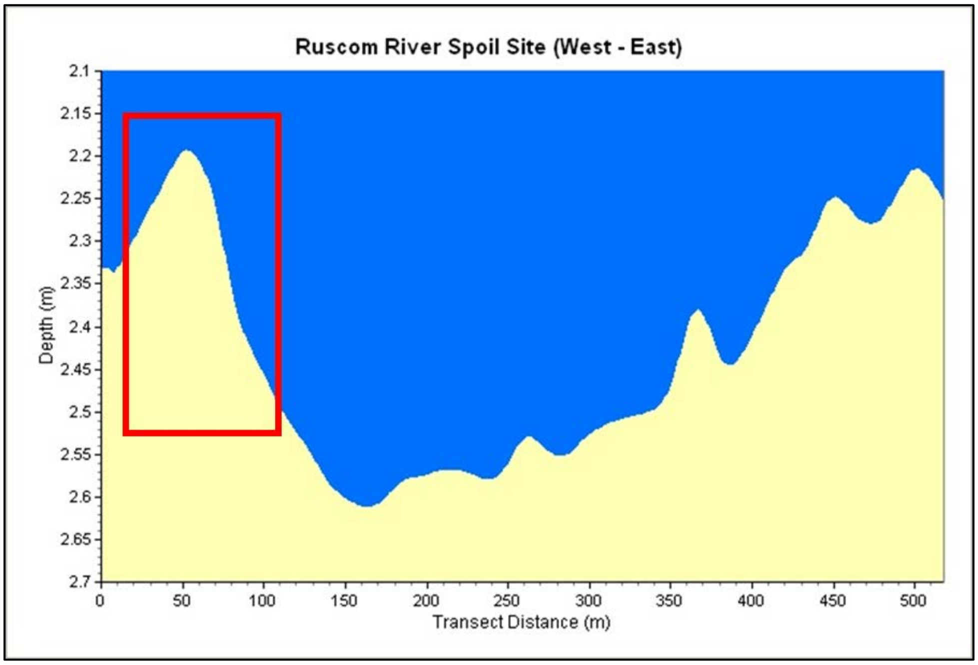

Figure 5c. Ruscom River Spoil site W-E cross-section. This is a cross section of the contour maps presented above. Substrate is coloured in beige with the overlying water coloured in blue. Transect length is the x-axis and corresponds to the black lines found in the contour maps. This highlighted feature (boxed in red) is a possible dredging spoil dump site.

Belle River Channel: The transect ran approximately 600 m; most of the channel was approximately 1.4 m deep (Figure 6a). A beach was situated immediately adjacent to the channel (on the west side) and seemed to 'spill' into the channel, making part of the channel shallow in areas (highlighted with a red box in Figure 6a). The water was rough inside the channel; waves would reflect off the wall and make the water choppy. Some of the apparent variation in depth along the middle of the transect is likely due to this wave action (Figure 6b). Within the channel the substrate was sandy and there was no aquatic vegetation.

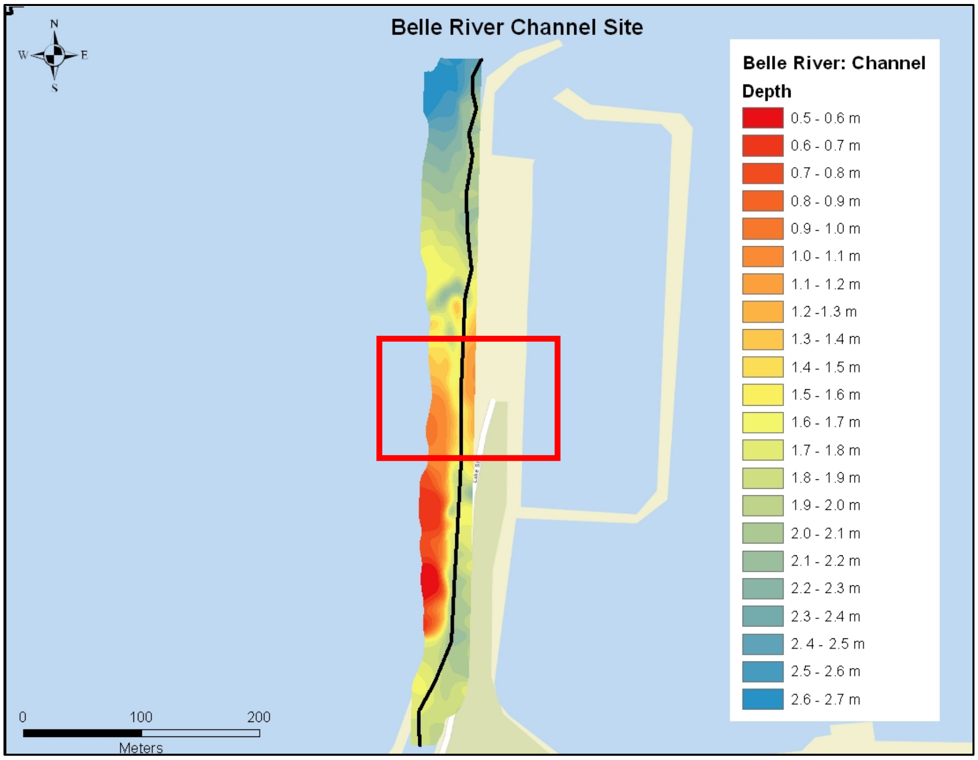

Figure 6a. Belle River Channel. Depth contours are coloured, with changes in colour displaying a change in depth of 10 cm. Black lines indicate the transect line included in the depth profile graph.

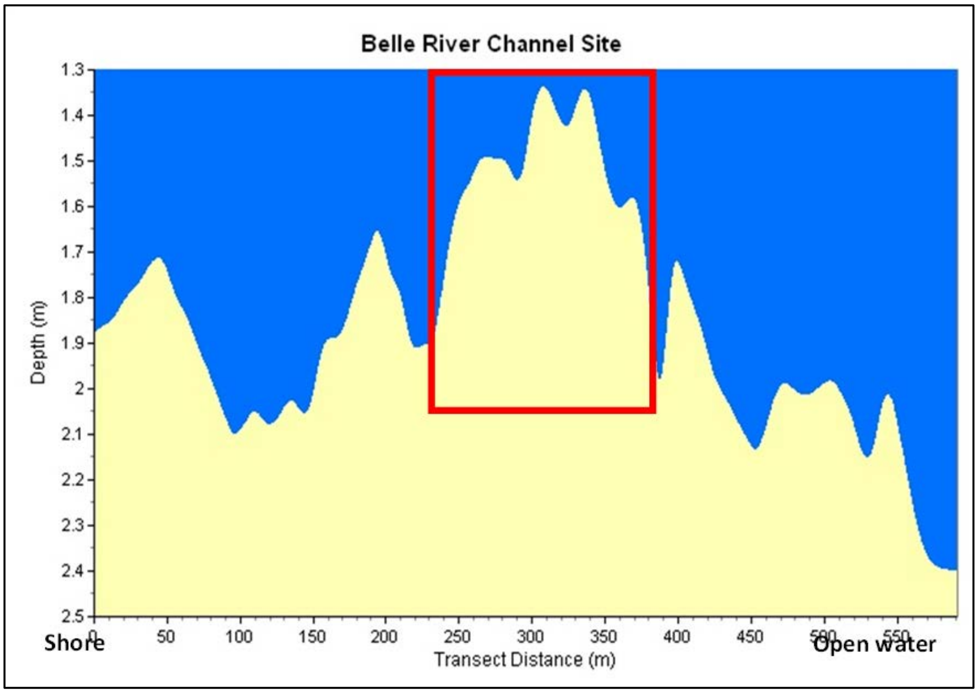

Figure 6b. Belle River Channel S-N cross-section. This is a cross section of the contour maps presented above. Substrate is coloured in beige with the overlying water coloured in blue. Transect length is the x-axis and corresponds to the black lines found in the contour maps. The depth varies along the transect, choppy water may have contributed to this. The shallow area in the middle of the transect (boxed in red) may be due to sediment spilling over from a nearby beach.

Belle River Spoil: The spoil site had dimensions of 450 x 250 m for an approximate area of 0.23 km^2. The spoil site is largely featureless with no drastic changes in depth and a very gradual increase in depth with increasing distance from shore (Figures 7a, 7b and 7c). There were no apparent decreases in depth to indicate the presence of dumped dredging spoil.

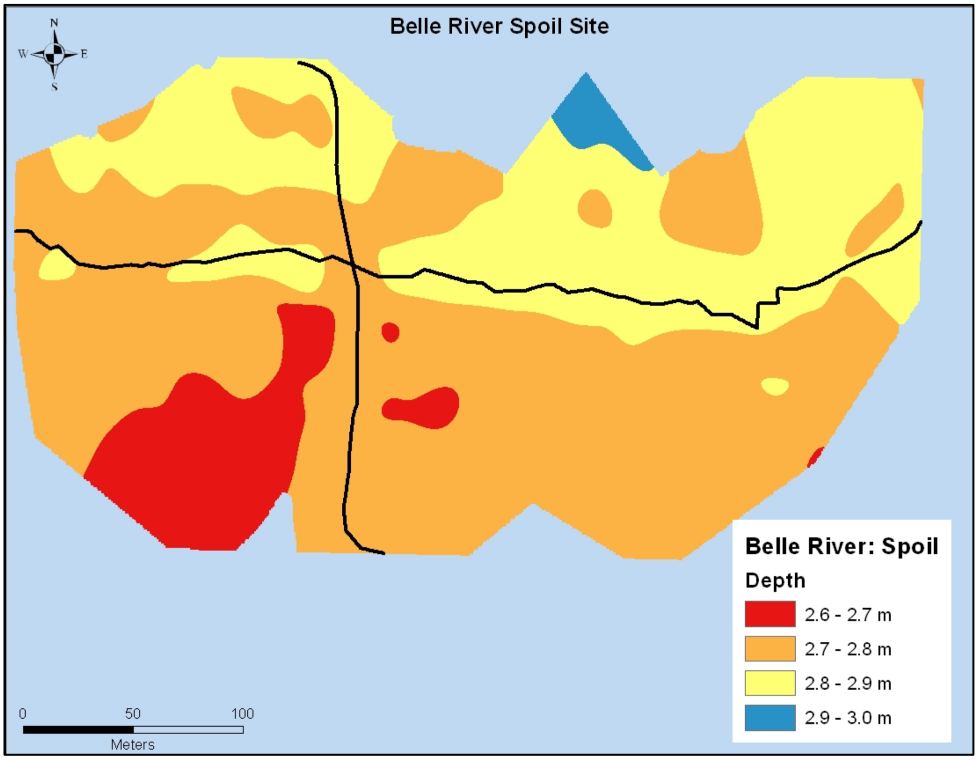

Figure 7a. Belle River Spoil site. Depth contours are coloured, with changes in colour displaying a change in depth of 10 cm. Black lines indicate the transect line included in the depth profile graph.

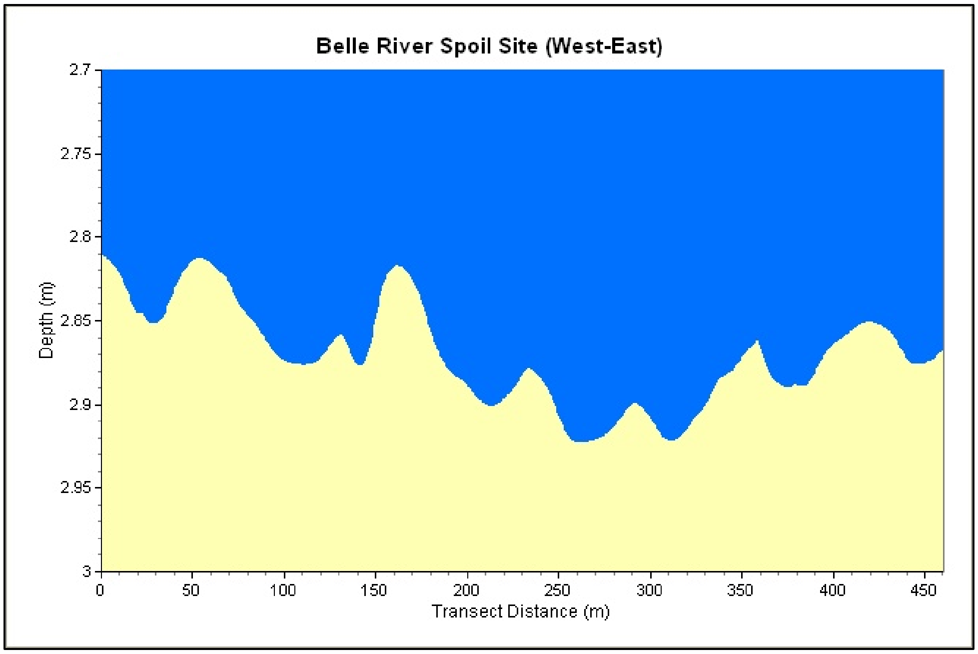

Figure 7b. Belle River Spoil site W-E cross-section. This is a cross section of the contour maps presented above. Substrate is coloured in beige with the overlying water coloured in blue. Transect length is the x-axis and corresponds to the black lines found in the contour maps.

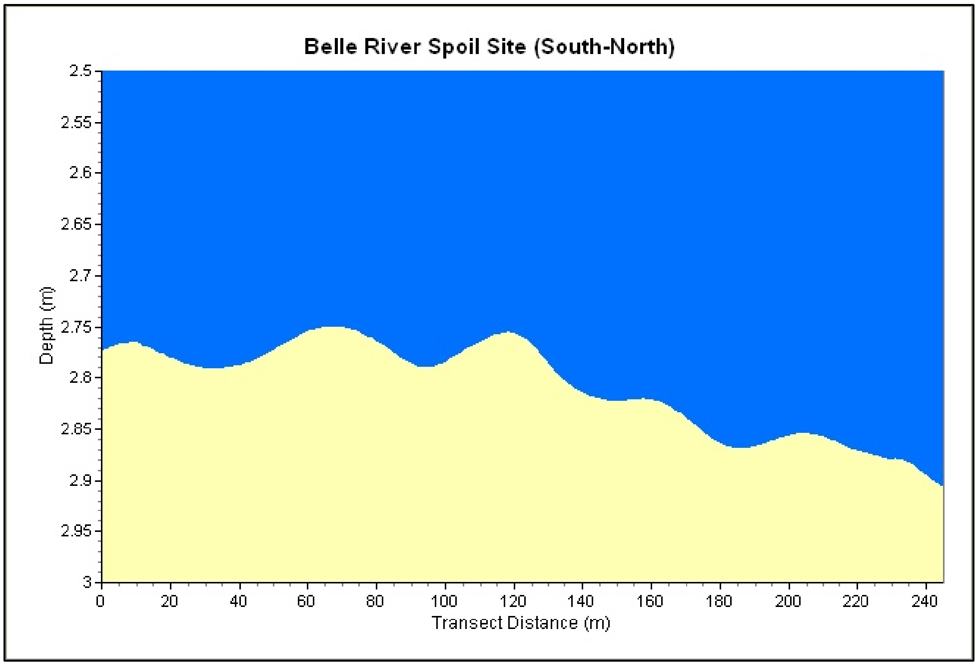

Figure 7c. Belle River Spoil site S-N cross-section. This is a cross section of the contour maps presented above. Substrate is coloured in beige with the overlying water coloured in blue. Transect length is the x-axis and corresponds to the black lines found in the contour maps.

Puce River Channel: The transect ran for approximately 700 m; most of the channel was approximately 1.4 m deep (Figure 8a). Puce River was the most ‘channel’-like of all the study sites. The channel depth is fairly consistent throughout and very clearly dredged (Figure 8b). Figure 8a illustrates a very clear trench surrounded by shallow water, indicative that the site was dredged for the navigation channel. The substrate was sandy clay with light aquatic vegetation cover.

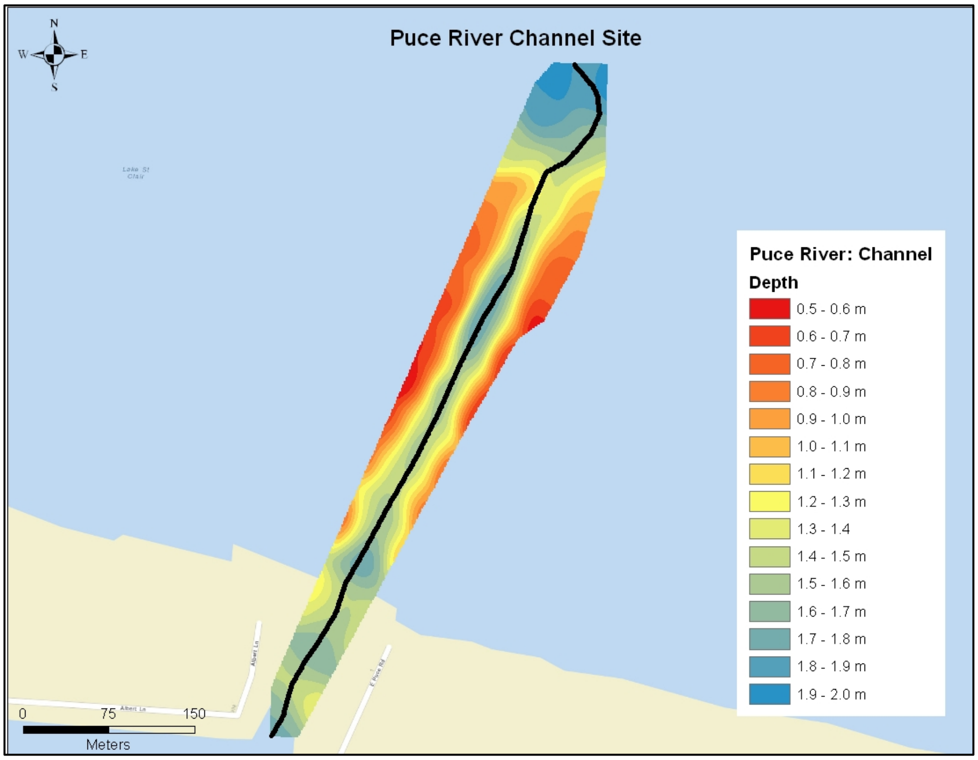

Figure 8a. Puce River Channel. Depth contours are coloured, with changes in colour displaying a change in depth of 10 cm. Black lines indicate the transect line included in the depth profile graph.

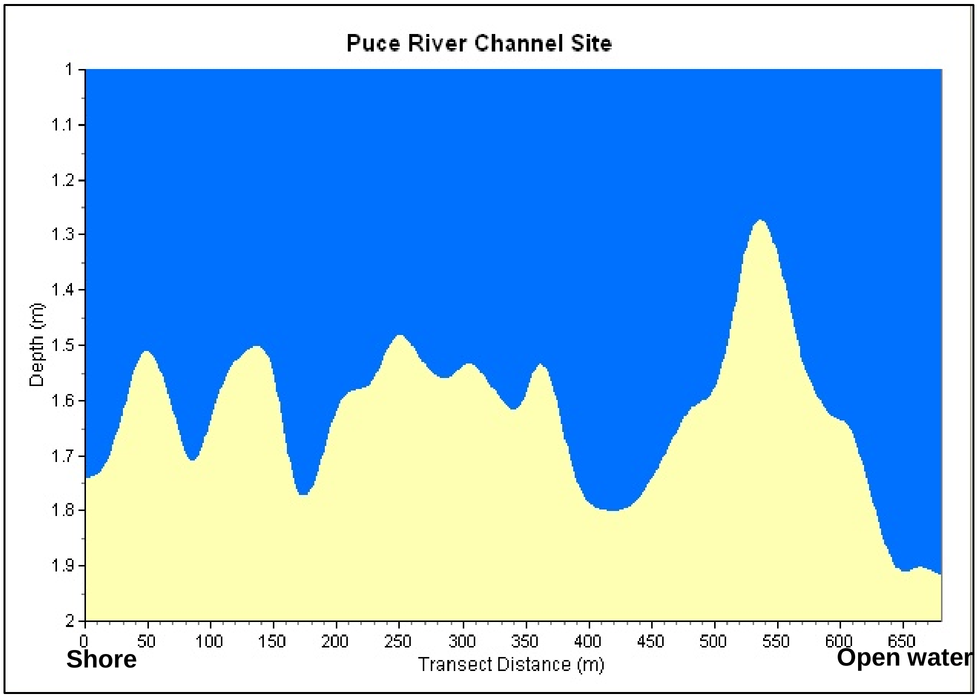

Figure 8b. Puce River Channel S-E cross-section. This is a cross section of the contour maps presented above. Substrate is coloured in beige with the overlying water coloured in blue. Transect length is the x-axis and corresponds to the black lines found in the contour maps.

Puce River Spoil: The spoil site had dimensions of 1000 x 250 m for an approximate area of 0.25 km^2. The area to the southeast is shallow (~ 0.5 m) but is technically outside the proposed spoil site, but we decided to include the data (Figure 9a). The site most likely to be the dredging spoil site (northwest section), is lacking in features (Figures 9a, 9b and 9c); there is no indication of a dredging spoil site.

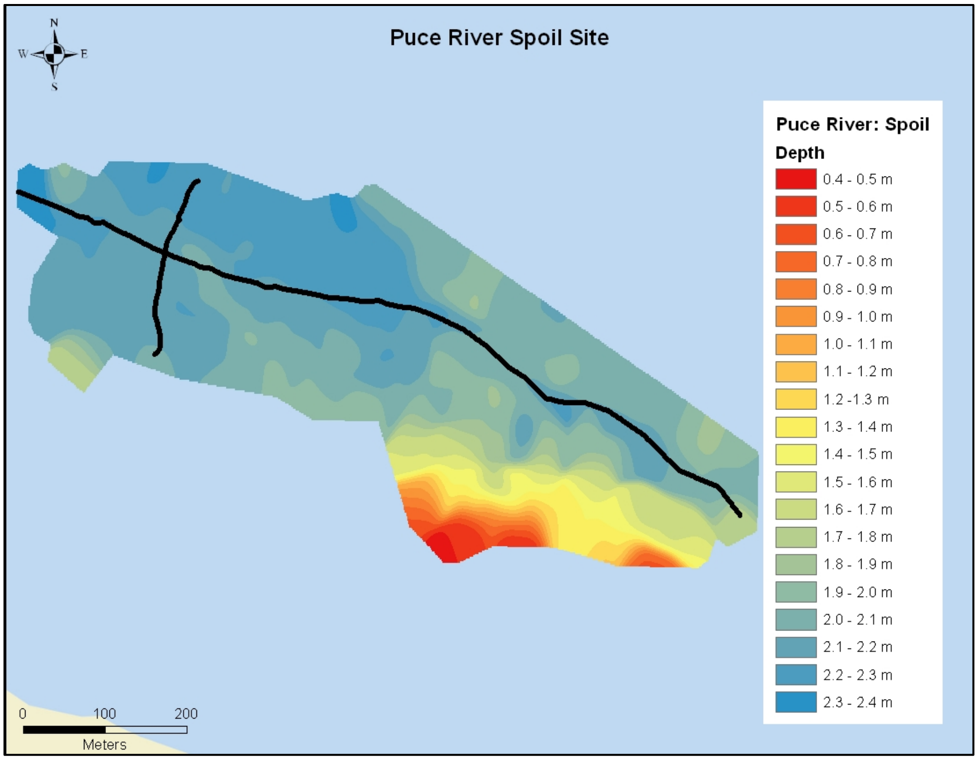

Figure 9a. Puce River Spoil site. Depth contours are coloured, with changes in colour displaying a change in depth of 10 cm. Black lines indicate the transect line included in the depth profile graph.

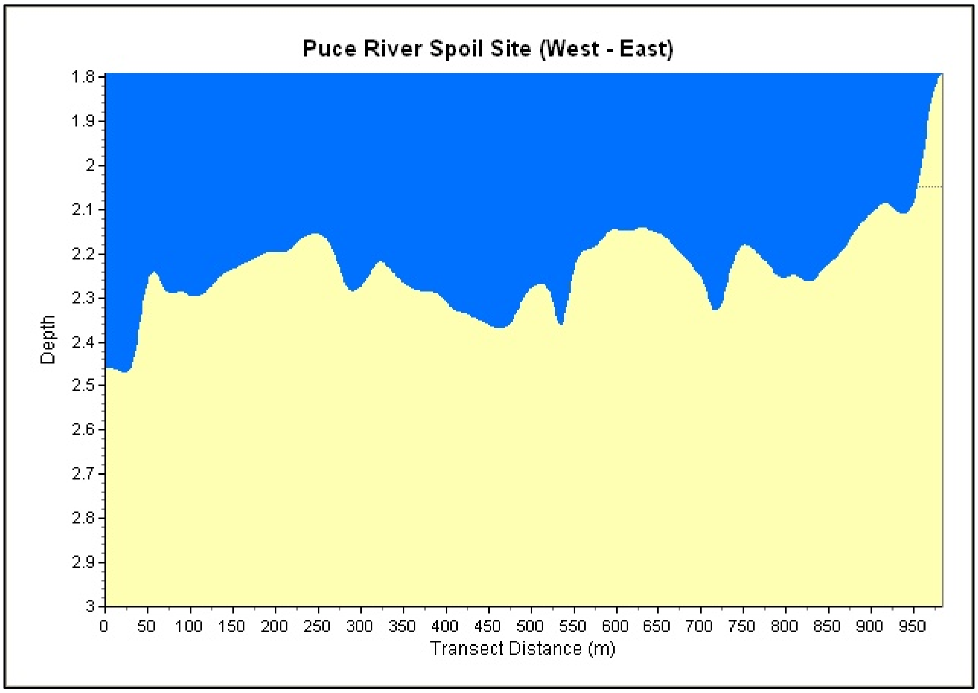

Figure 9b. Puce River Spoil site W-E cross-section. This is a cross section of the contour maps presented above. Substrate is coloured in beige with the overlying water coloured in blue. Transect length is the x-axis and corresponds to the black lines found in the contour maps.

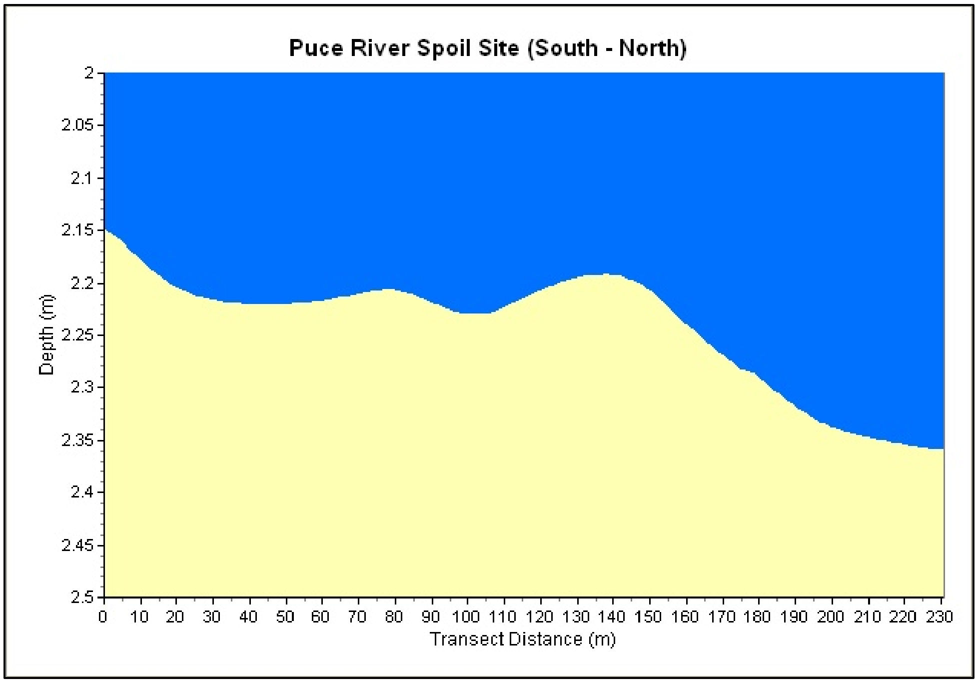

Figure 9c. Puce River Spoil site S-N cross-section. This is a cross section of the contour maps presented above. Substrate is coloured in beige with the overlying water coloured in blue. Transect length is the x - axis and corresponds to the black lines found in the contour maps.

Pike Creek Channel: The transect ran for approximately 1200 m; the section of channel upstream of the mouth was deeper (~1.4 m) than the section of channel outside of the river mouth (~ 1.0 m) (Figures 10a and 10b). It seemed as though the channel had not been dredged in some time. The channel was fairly narrow (3-4 m wide) and we would often run aground trying to stay within the channel. The substrate was sandy with no aquatic vegetation cover.

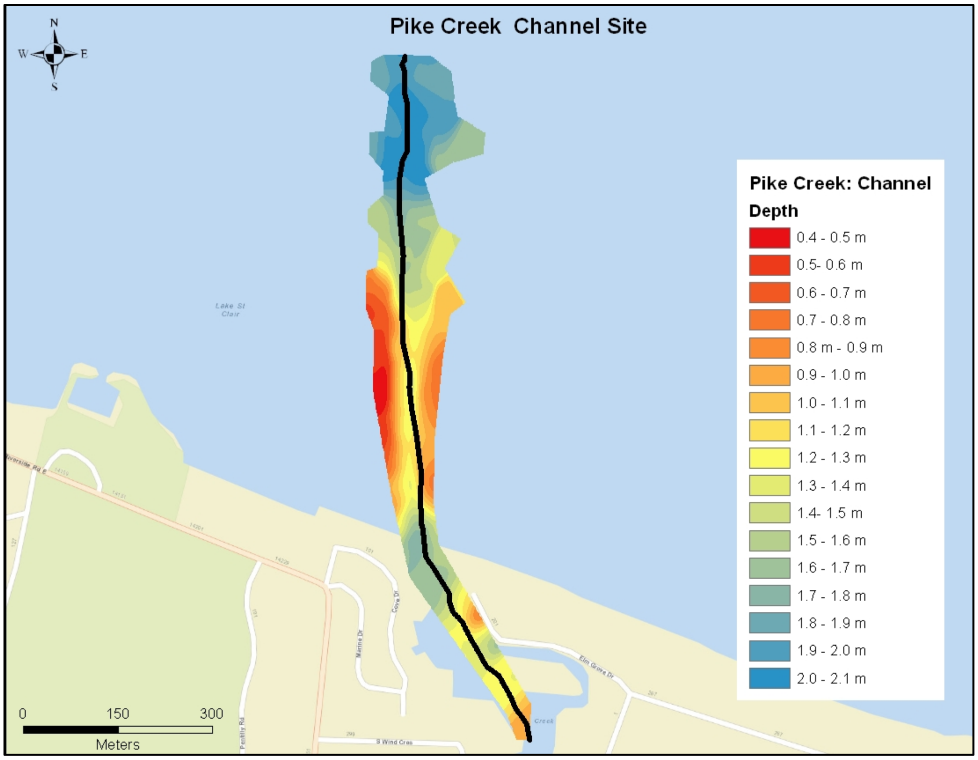

Figure 10a. Pike Creek Channel. Depth contours are coloured, with changes in colour displaying a change in depth of 10 cm. Black lines indicate the transect line included in the depth profile graph.

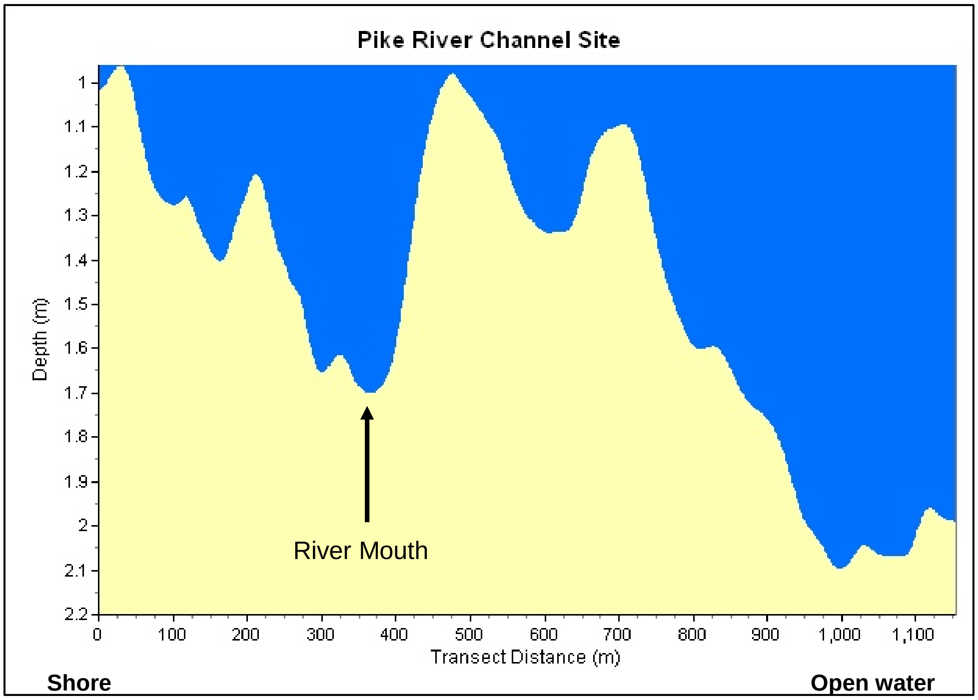

Figure 10b. Pike Creek Channel S-E cross-section. This is a cross section of the contour maps presented above. Substrate is coloured in beige with the overlying water coloured in blue. Transect length is the x-axis and corresponds to the black lines found in the contour maps.

Pike Creek Spoil: The spoil site had dimensions of 300 x 200 m for an approximate area of 0.06 km^2. The site shows almost no notable features (Figures 11a, 11b and 11c), and gradual increases in depth as one moved away from shore (Figures 11a and 11b). The area highlighted in Figure 11a (red box) has a diameter of almost 50 m and could be the remains of dumped dredging materials. It is important to note that it is only 10 cm shallower than the surrounding area, and although this could be an area of interest this it was not situated at the designated location of a dredging spoil site.

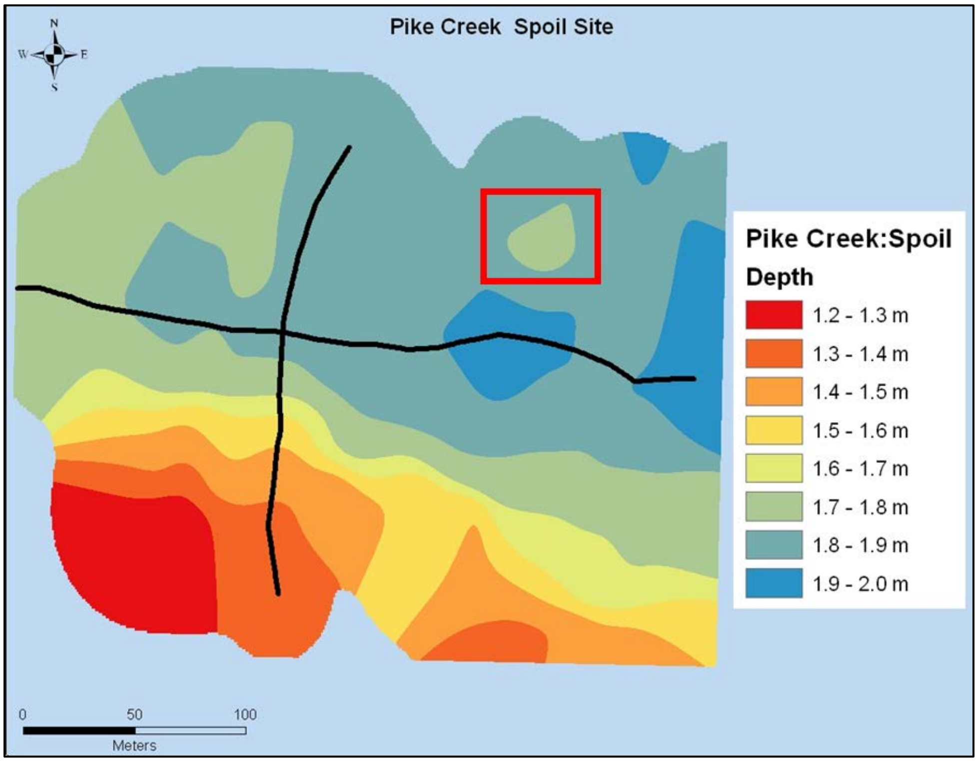

Figure 11a. Pike Creek Spoil site. Depth contours are coloured, with changes in colour displaying a change in depth of 10 cm. Black lines indicate the transect line included in the depth profile graph. The area highlighted in green is a potential area of interest.

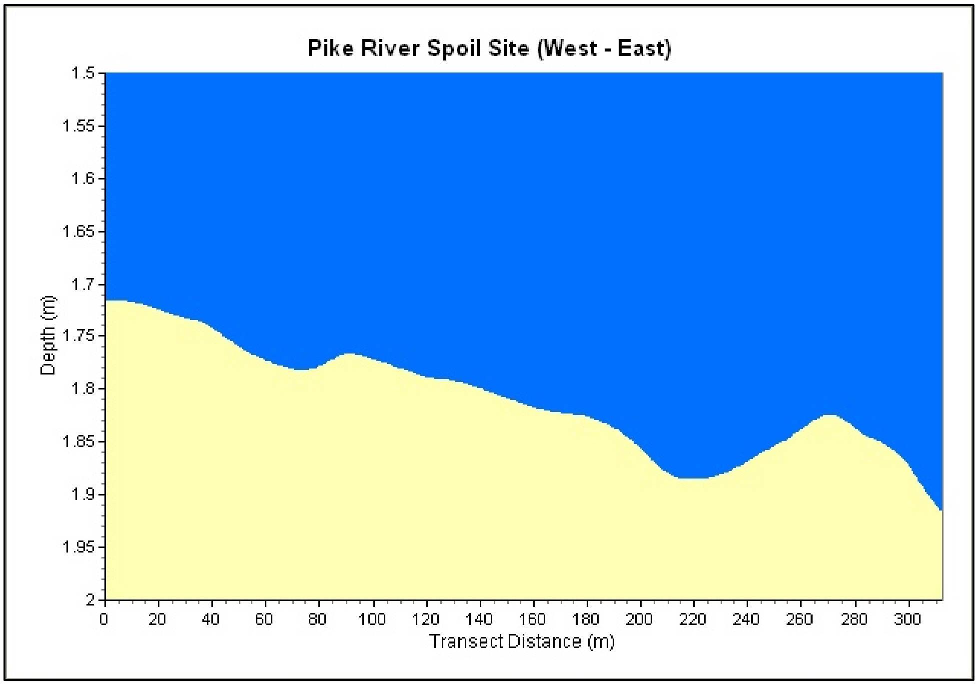

Figure 11b. Pike Creek Spoil site W-E cross-section. This is a cross section of the contour maps presented above. Substrate is coloured in beige with the overlying water coloured in blue. Transect length is the x-axis and corresponds to the black lines found in the contour maps.

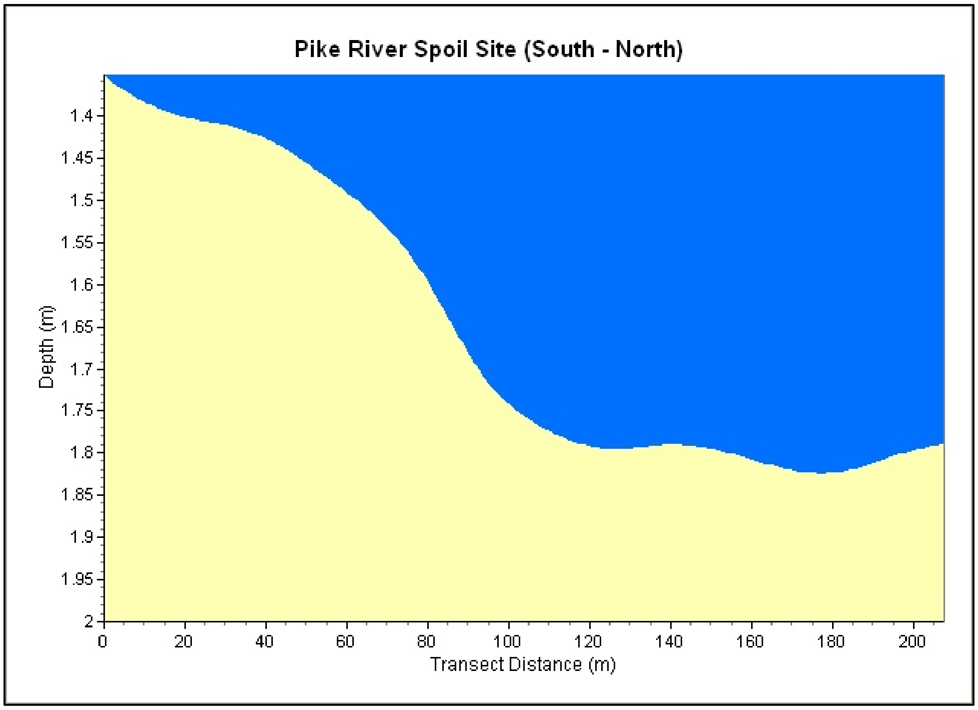

Figure 11c. Pike Creek Spoil site S-N cross-section. This is a cross section of the contour maps presented above. Substrate is coloured in beige with the overlying water coloured in blue. Transect length is the x-axis and corresponds to the black lines found in the contour maps.

DISCUSSION

Overall, the condition of navigation channels varied from site to site. The condition of each channel closely matched the status of dredging provided before the study began (suggesting that the records were very reliable). Thus, recently dredged channels had well maintained trenches, while other sites that were undredged were unnavigable by boat. Transects were extended well past the the locations of proposed sampling sites, and we found that some of the dredged channels would perhaps benefit from extending the length of dredging channel (see the Belle River navigation channel, Figure 6a). Additionally, little to no vegetation was found around these navigation sites, suggesting these areas may not be suitable fish habitat; it is unknown whether this is because the habitat is already degraded or whether such sites are typically unvegetated.

There was no clear evidence of the presence of spoil piles at any site, suggesting that either

1) dredgeate was not dumped in the specified location or
2) spoil sites do not remain intact for very long.

The former scenario was discussed during a telephone conference with the DFO; and it was noted that while dredging, workers occasionally 'side cast', spreading dredged material to either side of the boat as it moves along the channel, lumping materials at the side of a channel. If side casting occurred then the dredgeate would not be detectable in the proposed dumping sites.

In the latter scenario we assume that the dredgeate was properly placed within the proposed area. However, we were still unable to detect distinct spoil piles. We found no spoil sites at any rivermouth, recently dredged or not. This suggests that the spoil piles may dissipate quickly, perhaps after the first major storm event. We were unable to distinguish between the two scenarios. However, more precise recording-keeping of the location and timing of dredging and dumping would ensure more accurate follow-up surveying and assessment of the persistence of spoil piles.

While analyzing our data, we performed some simple calculations to determine what size a spoil site might be if dumped in Lake St. Clair with a 30 cm grade (as outlined by the Essex Region Conservation Authority (ERCA) guidelines):

<u>Expected size of a spoil site:</u>

Amount of Dredged material:

Channel volume: length x height x width
30 m x .8 m x 300 m = 7200 m^3 of dredgeate

Is 7200 m^3 of dredgeate detectable in a spoil site?

Volume of a cylinder - $V= \pi r^2 \times h$

If the material is spread in a circular area of 200 m diameter
$7200\ m^2 = \pi 100^2 \times h$

h = 23 cm

If spread evenly and in compliance with the specifications of ERCA and the rules for dredging permits, spoil piles would cover an area of 0.031 km^2 or less; this a small fraction of the area we set out to find the spoil piles (1 km^2). If dredgeate is spread thinly over a broad area of the lake bottom, piles may be impossible to detect. This reinforces the need for precise record keeping.

Exact location of spoil piles would make surveying much quicker, with tighter survey lines for higher resolution maps.

Currently, were are unable to distinguish between scenarios, however, this can be easily rectified with good record keeping which would lead to quicker and better surveys.

RECOMMENDATIONS

For management: For future dredging, managers should consider the water depth of any proposed spoil sites. The disposal location may change as water levels fluctuate. The bathymetry maps provided in this study can direct dredging contractors to locations where it may be appropriate to dump dredgeate. Additionally, the navigation channel maps will give guidance on what area of each of the surveyed channels should be dredged to ensure well maintained channels.

Good recording keeping is essential to ensure the quality of further monitoring and data collection. Delineating spoils sites and channel lengths by providing multiple GPS readings (at least 3) will ensure precise assessment of any spoil site. Date and time (weather information if at all possible) are simple measurements that can be taken to help keep track of any dredge spoils. Water depth may be a useful variable to measure, and should already be known from the spoil site selection.

For research and monitoring: If research and monitoring continue for any current or future sites, managers and researchers must work together to coordinate the timing of dredging and sampling activities. Regardless of the type of sampling (fish, vegetation, bathymetry, water quality etc.), adopting a 'repeated measures'-like design - sampling before, immediately after and periodically after dredging has occurred will likely yield the most information about the effects of dredging on Lake St. Clair. Repeated bathymetric surveys done in this manner would provide information of on the movement and persistence of spoil piles. A short-lived dredging pile may dissipate before it is likely to affect resident fish or their habitat.

ACKNOWLEDGMENTS

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