Severn Sound

Environmental Association

PENETANGUISHENE REMEDIATION PROJECT

Report on Wood Pile Removal Phase

March 1996

PENETANGUISHENE REMEDIATION PROJET

Penetanguishene, Ontario

Report on the Wood Pile Removal Phase

Produced for :

Severn Sound Remedial Action Plan

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SUMMARY

In the fall of 1992, a seiche lowered the water level of Severn Sound by one meter exposing several hectares of degraded fish habitat (approximately 300 m x 200 m) in the shallow nearshore area of Penetang Bay. Logs, wood slabs and sawdust was covering the area. In 1994, a remediation strategy was put in place in order to remove the wood wastes from the most impaired area of Penetanguishene's nearshore.

Following workshops, public and technical meetings and calls for proposals from dredging contractors, a removal demonstration plan was designed. Operations started in October 1994 and included the removal of larger and finer wood wastes, transport to the temporary holding facility and mechanical screening of the removed material.

The project also included the demonstration of an innovative sediment removal technology brought to Penetanguishene from the Netherlands.

Results have indicated that approximately 4,000 m^3 of wood wastes was removed from the bay using both conventional and innovative removal technologies. No adverse effects to the surrounding environment was noted.

Results from the demonstration of the Visor Grab indicate that additional testing is required on a modified, more adapted to North America's environmental conditions bucket.

RÉSUMÉ

À l'automne de 1992, le niveau de l'eau de Severn Sound s'est abaissé d'un mètre et exposa plusieurs hectares d'habitat du poisson détérioré (approximativement 300 m x 200 m) dans les eaux peu profondes des rives de la baie Penetang. Toute la zone exposée était couverte de billots, de lattes de bois et de bran de scie. En 1994, une stratégie de restauration fut mise sur pied afin d'enlever les débris de bois de la zone la plus touchée des rives de Penetanguishene.

Suite à des ateliers, des réunions techniques et publiques et des appels d'offre envers les compagnie de dragage, un plan de démonstration fut fondé. Les opérations de dragage ont débuté en octobre 1994 et ont compris l'enlèvement de débris de bois grossiers et plus fins, le transport vers le site de disposition temporaire ainsi que la séparation mécanique du matériel extrait.

Le projet avait également comme objectif secondaire la démonstration d'une technique innovatrice d'extration de sédiments amenée pour l'occasion à Penetanguishene directement des Pays-Bas.

Les résultats ont indiqué qu'environ 4 000 m^3 de débris de bois ont été extraits du fond de la baie à l'aide de techniques traditionelles et innovatrices. Aucun effet négatif n'a été noté sur le milieu environnant.

Les résultats de la démontration du Visor Grab ont indiqué que des tests additionels sont nécéssaires afin de bien évaluer cette technique. Des modifications sont cependant essentielles afin d'adapter ce godet hydraulique aux réalités nord-américaines.

1) Introduction

Severn Sound is located in the South-Eastern portion of Georgian Bay and is composed of a group of bays including Penetang Bay, Midland Bay, Hog Bay, Sturgeon Bay and Matchedash Bay (Figures 1 & 2). Severn Sound was first identified as an Area of Concern (AOC) by the International Joint Commission (IJC) in 1973, mainly due to excessive algal growth linked to elevated concentrations of phosphorus and other nutrients in the water column. The IJC Water Quality Board recommended that a Remedial Action Plan (RAP) be developed outlining a "systematic and comprehensive approach to restoring beneficial uses... consistent with and 'ecosystem approach' to the protection of the Great Lakes" (IJC, 1985).

In 1989, a survey of nearshore fish habitat in Penetang Bay was conducted. An area of shoreline in the south end portion of the bay was identified as providing poor habitat and requiring restoration. A rare wind-induced water level change occurred in Severn Sound on Monday, November 6, 1992. This seiche lowered the water level by one meter. As a result, several hectares of degraded fish habitat were exposed (approximately 300 m x 200 m) in the shallow nearshore area of the bay. The area was covered by logs, wood slabs and sawdust. Subsequent borehole survey (February, 1994) indicated that the debris layer was up to 1 m thick over the original lakebed.

In 1993, the Town of Penetanguishene requested assistance from the Severn Sound Remedial Action Plan (RAP) to design a cleanup and restoration strategy for the area; the restoration area being located both in the water and on land. In the early fall of 1993, the Severn Sound RAP approached the Great Lakes Cleanup Fund and the Remediation Technologies Program of Environment Canada for funding and expertise in order to remediate a section of Penetang Bay where wood slabs, wood chips and saw dust are present in great concentration, and where habitat rehabilitation was needed. In the spring of 1994, a formal proposal was submitted to the Great Lakes 2000 Cleanup Fund.

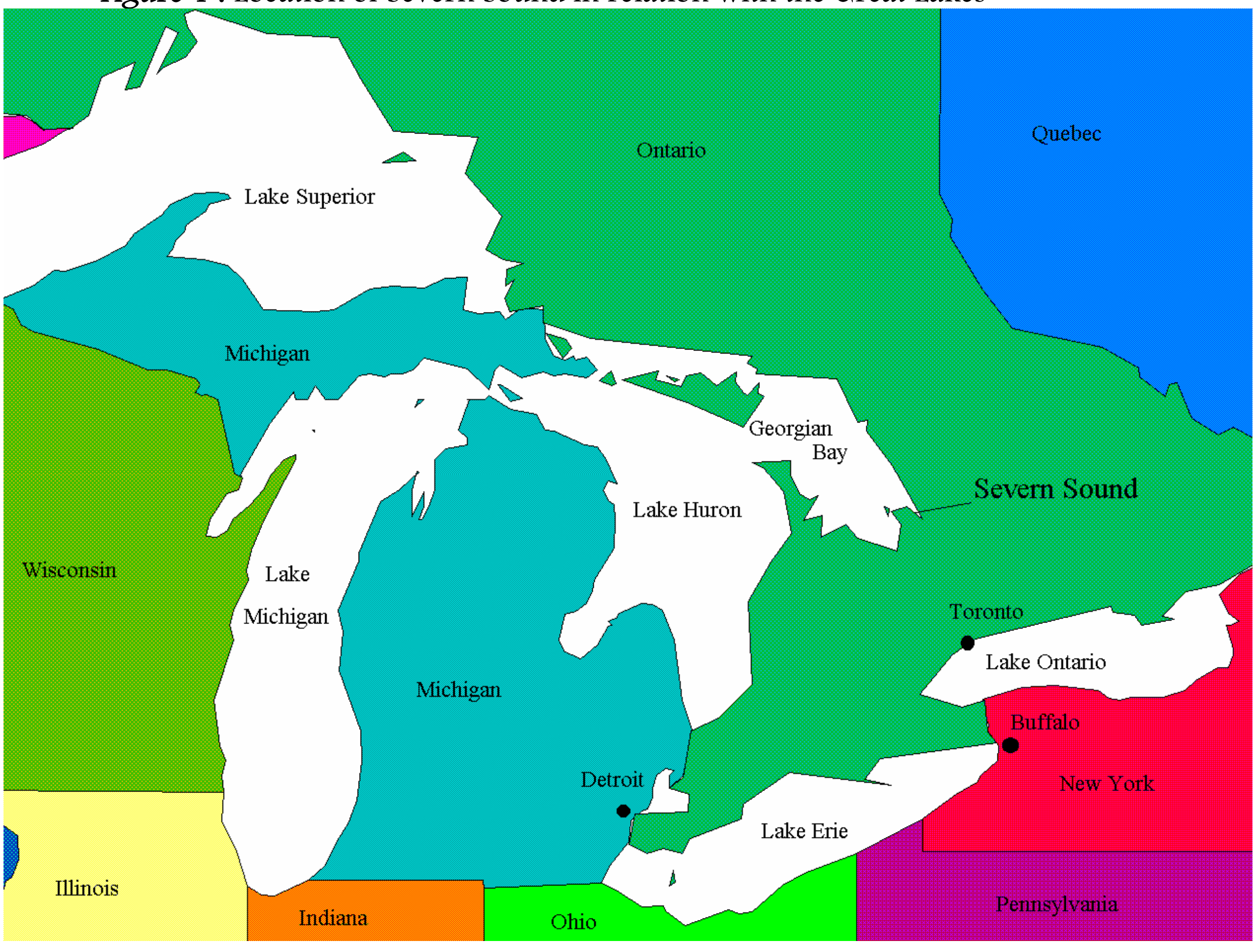
In early 1994, partnership was established between the Town of Penetanguishene, the Severn Sound Remedial Action Plan and Environment Canada's Great Lakes 2000 Cleanup Fund through the Remediation Technologies Program in order to provide funding and expertise to help restore the valuable fish and wildlife habitat of a section of Penetang Bay. The project was divided into four phases : 1) borehole study and planning, 2) wood debris removal, 3) habitat restoration, and 4) monitoring and management.

Phase 2 of the project had two components. First, the removal of approximately 4,000 m^3 of wood wastes using conventional technologies and methodologies; the second component was to demonstrate an innovative sediment removal technology in order to assess its effectiveness in the removal of contaminated sediment in other AOCs throughout the Great Lakes basin.

In July 1994, a request for proposal document was sent to dredging companies and published in local newspapers. Proposals were received in August 1994 and the contract was awarded to Wayne Jones Construction for an amount not to exceed $122,500.

The objectives of this report are to : 1) describe the dredging project undertaken in October 1994 at Penetanguishene's waterfront, 2) evaluate the effectiveness of the Visor Grab bucket - an innovative sediment removal technology, and 3) provide other project managers with a guidance tool to remediate similar areas where wood wastes (or other debris) impair the bed of nearshore areas.

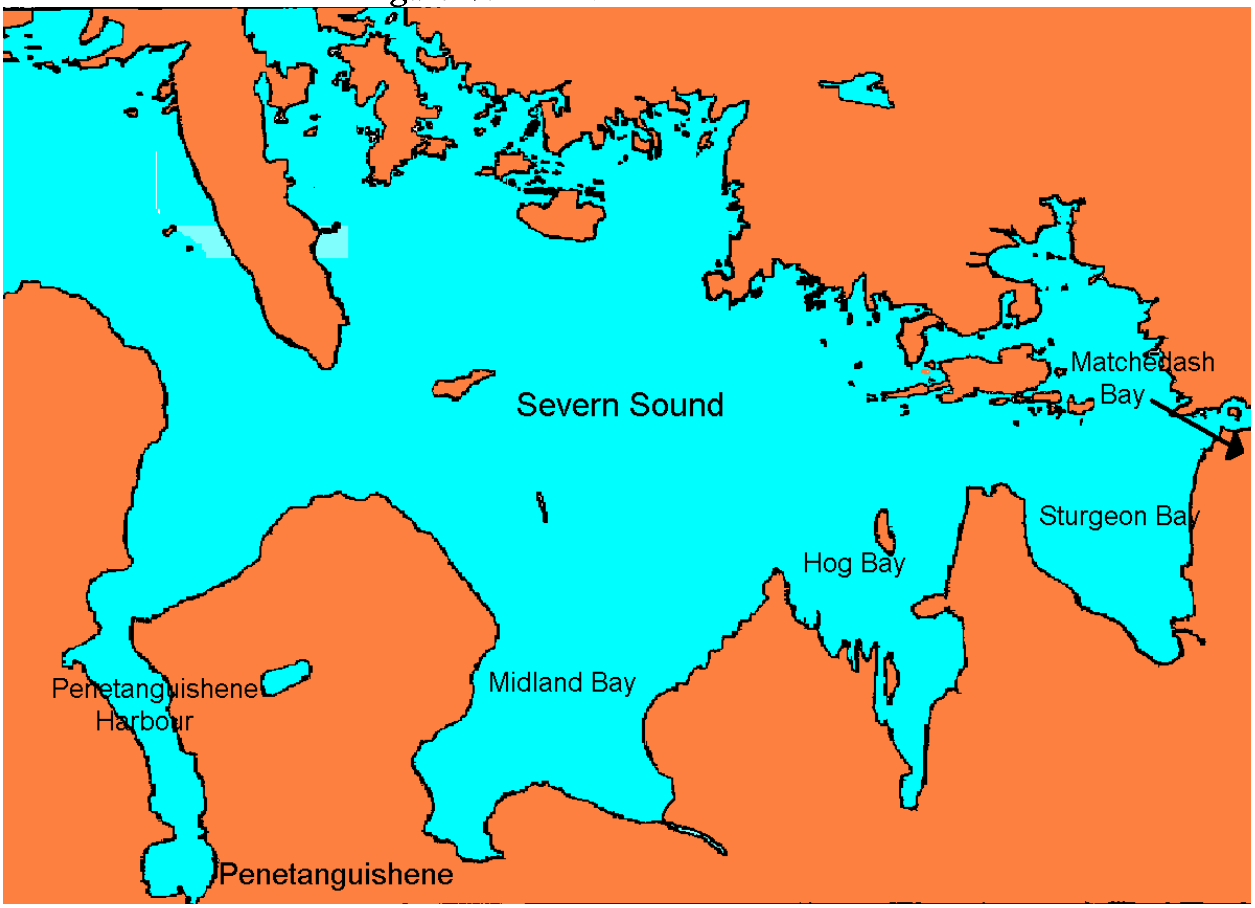
Figure 1 : Location of Severn Sound in relation with the Great Lakes



1.1) Site Degradation History

The first lumber mill in Penetanguishene was built at the mouth of Copeland Creek and was probably commissioned in 1829 in order to provide cut lumber for the government building and the officer's quarters. The second mill was built in 1864 on what is known today as McGibbon's point (study area). This mill closed in 1960. At that time, the sawdust and wood wastes located on the McGibbon's property were used to fill the existing wetland located at the bay shoreline (personal communication with former employees of McGibbon's sawmill).

Figure 2 : The Severn Sound Area of Concern



Another mill of importance in Penetanguishene was the Firstbrook Box Company which was established in 1867 and covered 68 acres of property on the land presently occupied by Beacon Bay Marina. This company was sold in 1910 and became the first general hospital in Penetanguishene. The International Fibreboard Company used the pulp and scraps from the Firstbrook mill to produce their fibreboard. A fire in 1923 forced both companies to close their businesses.

A small shingle production mill was established in 1900 at the foot of Centre Street, covering approximately ten acres of land. This company produced lath and building supplies as well as shingles.

Penetang Mill (formerly called "Red Mill") was built in 1863 on what is called today "Beck's Point". During the same year, a box factory was established at the corner of Chatham and Sheridan Streets and manufactured wooden pails and tubs. The sawmill closed in 1929 while the box factory terminated its operations in 1969.

The operation of these sawmills and factories contributed to the degradation of the bay shoreline, aquatic habitats and sediment quality through the years. Sawdust, wood chips, wood slabs, and logs have accumulated on the bottom sediment for over a century.

2) State of the Environment

The state of the environment before the removal project is discussed in many reports such as the Severn Sound Remedial Action Plan Stage 2 report (1993), Gemza (1995), and Krantzberg and Sherman (1995). A summary of the sediment and water quality of the study area follows.

2.1) Water Quality

The main concern related to water quality in Penetang Bay and the entire Severn Sound is nutrient enrichment. Very few contaminants have been found to exceed either provincial or federal guidelines.

The phosphorus levels near the study area have decreased by 50% since 1969 (Gemza, 1995). This decrease is presumed to be due to improved operating efficiency at the Penetang Water Pollution Control Plant (WPCP) and to detergent phosphorus control. Results from one water quality station located near the study area have indicated that the mean total nitrogen concentrations were at one of the highest levels within Severn Sound. In recent years, Total Inorganic Nitrogen (TIN) levels have been higher suggesting less demand for nitrogen by the algal and plant communities. That station had the most important shift from organic to inorganic forms of nitrogen. This is probably due to partial nitrogen removal at the WPCP and to an increase in nitrate occurring throughout the Great Lakes.

Copper, mercury, aluminum and iron were found to exceed the provincial water quality objectives in Penetang Bay, outside the study area. All the organic contaminant concentrations were below the detection levels. No results were available for the immediate study area.

2.2) Sediment Quality

In early 1994, the Severn Sound RAP secured pre-funding from the Great Lakes 2000 Cleanup Fund for a borehole study at the Penetanguishene waterfront in order to assess the vertical extent of the wood wastes problem. On February 28, 1994 a crew using a hand held sonic vibrator rig took samples from 10 boreholes. In order to determine quality of sediment to be uncovered, samples of sediment underlaying the wood wastes were taken to a depth averaging 1.5 m and were sent for chemical analyses. As shown in Table 1, from all the parameters measured, only cadmium, total phosphorus, copper, iron and nickel marginally exceeded the Ontario Ministry of the Environment and Energy sediment quality guidelines' lowest effect level (LEL). Although elevated, the concentrations of those parameters were similar to or lower than ambient levels measured at other stations in the bay.

Two other surveys were performed in the proposed removal area in May 1994. The first one consisted mainly of a remotely operated vehicle (ROV) video survey of the wood pile and observations of localized sediment accumulation and plant growth.

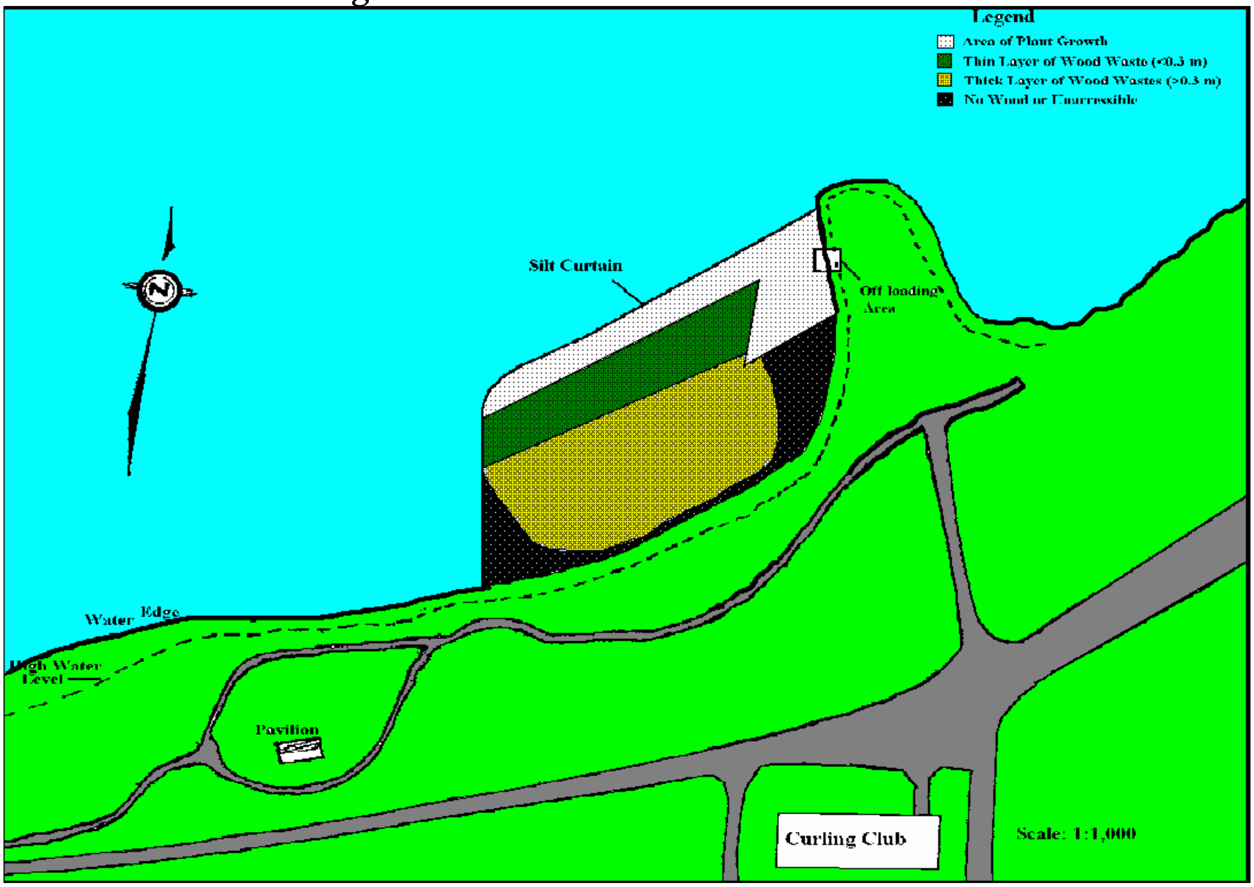
Table 1 : Conc.of parameters in sediment samples from Penetang Bay (February, 1994).

Parameter	Units	MOE LEL-Guideline	MDL	Sample BH-16	Sample BH-18	Sample BH-6
Moisture	%	N/A	----	31.02	16.32	29.41
Dry Matter	%	N/A	----	68.98	83.68	70.59
O&G	ppm	1500	10	270.7	589.4	645.8
Arsenic	ppm	6	0.5	<0.5	<0.5	<0.5
Cadmium	ppm	0.6	0.01	0.83	<0.01	<0.01
Lead	ppm	31	0.2	27.16	12.6	21.19
Mercury	ppm	0.2	0.01	<0.01	<0.01	<0.01
TP	ppm	600	0.5	621.61	680.79	593.09
Vol.Sol.	ppm	N/A	----	23245	5234	22257
Ammonia	ppm	100	0.1	3.27	<0.1	<0.1
Copper	ppm	16	0.02	24.11	8.86	18.77
Cobalt	ppm	50	0.2	19.68	8.27	15.54
Chromium	ppm	26	0.05	24.94	17.52	24.62
Iron	ppm	20000	0.04	23916.79	11070.26	20543.17
Nickel	ppm	16	0.1	19.4	9.45	20.18
Silver	ppm	0.5	0.09	<0.09	<0.09	<0.09
Zinc	ppm	120	0.2	69.56	23.03	51.06
TKN	ppm	550	10	400	200	400
Mo	ppm	N/A	0.1	<0.1	<0.1	<0.1
Selenium	ppm	N/A	0.1	<0.1	<0.1	<0.1
Cyanide	ppm	0.1	0.01	<0.01	<0.01	<0.01

Source : Terraprobe Limited, 1994.
LEL: Lowest Effect Level Guideline, MDL : Method Detection Limit, N/A: Value not available,
O&G: Oil and Grease, TP: Total Phosphorus, Vol. Sol.: Volatile Solids, TKN: Total Kjeldahl Nitrogen,
Mo: Molybdenum.

The second survey consisted of the use of an ROV video survey and manual sounding/probing of the wood pile area. This survey allowed better definition of the area requiring wood removal (Figure 3). Using those results, it was estimated that between 4,000 and 5,000 m^3 of wood waste required removal.

Figure 3 : Location of wood wastes removal area



3) Project Schedule Description

This section will highlight the chronological steps used by the project management team to perform the site remediation at Penetanguishene's waterfront.

3.1) Initial Problem Definition

In order to carry out any projects, the problem and its extent must be carefully defined through historical research and field work. The Town of Penetanguishene owns pictures and other documentation illustrating the activities of different sawmills along the waterfront. Personal communications with former sawmill employees and other residents of Penetanguishene proved to be extremely valuable in defining the the nature of the wood waste problem at the waterfront. From the documents and the personal communications, the horizontal extent of the "wood pile" was roughly defined, however the vertical extent was more of a challenge since some residents estimated anywhere from a few feet to two storeys!

The wind-induced water level fluctuation of 1992 indicated that the visible wood (surface) was composed mainly of slabs and logs. This drop in water level also provided a unique indication of the horizontal extent of the wood pile.

In February 1994, a borehole study was performed by Terraprobe Limited in order to estimate the vertical extent of the wood pile. The cores obtained from this survey indicated that the vertical extent of the wood wastes was fluctuating around the waterfront from 0.3 m to a maximum depth of 1 m. Those cores also indicated the presence of large volumes of sawdust and wood chips located underneath the larger pieces of wood with a thickness varying from 0.1 to 0.5 m.

3.2) Workshop

Once the horizontal and vertical extent of the wood pile was estimated, a workshop was held in Penetanguishene in March 1994. In attendance were members of the Ontario Ministry of Natural Resources, Canadian Wildlife Service, Severn Sound RAP & Public Advisory Committee (PAC), Town of Penetanguishene's council and staff, Environment Canada's Remediation Technologies Program, Town of Penetanguishene's consulting engineers, habitat biologist consultants, Town of Penetanguishene's waterfront development committee, and other interested members of the public.

During the workshop, the problem and its extent were explained. Funding partners were identified, and a remediation as well as public consultation strategy for the project were established.

3.3) Second Field Survey

The main objective of the second field survey was to identify areas near the proposed project site where aquatic vegetation, therefore fish habitat, was still present, delineating more closely the remediation area. Two remotely operated vehicle surveys were performed in May 1994. In addition, manual sounding/probing was performed to identify the nature of the substrate/extent of the wood pile. Coordinates were defined for each point using a theodolite. Those coordinates allowed the creation of a map showing the extent of the wood. The volume of wood wastes was then estimated at 4,000 m^3.

3.4) Environmental Assessment and Approval Requirements

In order to carry out the remediation project, the federal Environmental Assessment and Review Process (EARP) was initiated because federal funding was provided for this project and because Penetang Bay is a federal harbour. The Federal Fisheries Act also applied to this project for the same above-noted reasons. Provincial approvals were also required since all the removed wood wastes would placed on Town of Penetanguishene land.

Information on the site and the project (site history, existing environmental conditions, public involvement, expected effects of the project and the appropriate mitigation measures, description of the project, etc.) was compiled and an Environmental Screening Document was produced to fulfill the requirements of EARP. This document was forwarded to the federal Environmental Assessment Coordinating Committee (EACC) for federal review. This document was also used as a tool to obtain approvals from the Canadian Coast Guard, the Department of Fisheries and Oceans, and the Ontario Ministries of Environment & Energy and Natural Resources. A letter of concurrence was also requested from the only affected property owner : the Town of Penetanguishene. The following is a listing of approval requirements for the project :

<u>Federal Government</u>

- Canadian Coast Guard, Department of Transport
    a) Approval to "Dredge in a Navigable Waterway under Section 5(2) of the Navigable Waters Protection Act (NWPA), RSC 1985, Chapter N-22".
- Department of Fisheries and Oceans (DFO)
    a) Approval under Section 33 of the Fisheries Act.
- Federal Environmental Assessment and Review Office
    a) Initial Screening of the proposal undertaking in keeping with the requirements of EARP.

<u>Provincial Approvals</u>

-Ministry of Natural Resources (MNR)
    -Public Lands Act (not required for removal operations)
    -Lakes & River Improvements Act (not required since the water is federal)
-Ministry of the Environment and Energy
    -Environmental Protection Act

<u>Affected Property Owner</u>

- Town of Penetanguishene

3.5) Request for Proposal

In June 1994, the management team decided that the selection of a dredging contractor should be performed based on proposals from companies. A request for proposal (RFP) document was produced and sent to known dredging companies. Advertisement of this RFP document was published in community papers. A bidders' meeting was held in Penetanguishene in order to provide the bidders with site specific information.

Three responses to the RFP were received. Each proposal was evaluated based on : qualification of the company, the methodology to be used, the resources, the cost, the project management experience and the type of equipment to be used. Wayne Jones Construction's proposal was selected for a total cost not to exceed $122,500.

3.6) Public Consultation

Public consultation has been an on going process in the municipality of Penetanguishene for many years. Once a month, the public and the press is invited to a Council members' open session when projects are presented to the public for discussion. Since the Town has approached the Severn Sound RAP for remediation options, the public has been actively involved in the decision process.

An open workshop was held in Penetanguishene on March 29, 1994 when the removal project was first presented to the those member of the public in the attendance. Only positive responses were received.

The Severn Sound RAP's public involvement process includes media releases, displays and presentations at special events, and a monthly meeting of the Public Advisory Committee (PAC) which is announced in the local news media as open to the public. The PAC has been kept informed on the planning process with regard to this project, and PAC members' participation has included collaboration on the design of the on-shore restoration and on the debris handling and recycling aspects of the project.

The removal and transport technology and procedures were explained and presentation of the project by the RAP team, the Remediation Technologies Program and the Town of Penetanguishene was performed during an open house in Penetanguishene on September 13, 1994. The public was invited to attend, ask questions and raise any concerns they had. The questions and answers were provided in the final ESD. Members of Penetanguishene's Waterfront Development sub-committee, Council Members, the Severn Sound Remedial Action Plan Technical Committee and Public Advisory Committee and the Remediation Technologies Program were also in attendance.

A review period of 15 days was allowed to the public to respond to the project presented during the open house. Very strong support for the wood removal project was received from the community during and after this open house.

3.7) Remediation Project

Mobilization of the equipment started on Friday, 30 September 1994 and ended on Monday, 03 October 1994. The removal operations started on Monday, 03 October 1994 and ended on Monday, 24 October 1994. Section 5 provides more details on the dredging operations.

4) Operational and Performance Standards

The following standards were provided to the contractor and used by the scientific authority to evaluate the efficiency of the removal technology and methodology used to carry out the wood wastes removal operations.

REMOVAL

Turbidity and Suspended Solids

Since very little contamination has been detected in the bottom material, turbidity was not strictly controlled inside the confined area, but was outside. Turbidity and total suspended solids measurements were performed inside the confined area in order to audit the removal technology. All provisions were taken to ensure that the turbidity level is not increased outside the silt curtained area.

No Overflow or Leaks

A minimum freeboard of half (½) a metre must be maintained in the holding facility for the excavated material.

Removal Efficiency

The solids to liquids ratio in the excavated material should be at least 30% by volume.

Production Rate

The production rate of the sediment removal equipment should be at least 40 m^3/hr; the daily production should be close to 400 m^3.

TRANSPORT

No Overflow or Leaks

No overflow or leaks of excavated material shall be allowed during transport to the storage area.

Transport Rate

The rate of material being transported must be adjusted to meet the handling capacity of the off-loading methodology.

5) Project Description

The removal project can be separated in five (5) phases : mobilization of the equipment, removal of the larger wood debris, removal of the finer wood wastes using the Visor Grab, mechanical screening of material and demobilization. Every phase will be presented and discussed in this section. Section 6 will present and discuss the results obtained during the wood removal phases.

5.1) Mobilization

Mobilization of the equipment started on Friday, 30 September 1994. The equipment brought by the contractor for the project included :

- One Caterpillar 235 excavator
- One crane
- Two grapple forks, one dragline bucket and one clamshell bucket
- One transport barge with spuds
- Two containment barges (one with spuds)
- Two tugboats
- Two tandem trucks
- One Visor Grab, and
- One 200 m X 2 m silt curtain.

In addition to the above-noted equipment, the Town of Penetanguishene provided trucks, a front-end loader, storage site, site coordination, on-land siltation control and security equipment.

A silt curtain was deployed by the dredging contrator to cover the entire working area. Wooden poles were hammered in place in order to minimize movement of the silt curtain. Heavy chains were secured at the bottom of the curtain to ensure anchorage to the bottom of the bay, while styrofoam buoys were placed at the top portion of the curtain to act as a flotation measure. The curtain was secured on shore at both ends.

Using logs and rocks, an off-loading platform was created to facilitate the discharge of the loading barges. Sitting on the platform, the backhoe was used to off-load the barges into dump trucks.

Town of Penetanguishene Public Works' Department prepared the storage area. Snow fences were placed around the storage area as a safety measure in order to minimize public exposure to heavy machinery (trucks, bulldozer, backhoe, etc) movement. Hay bales were also placed on the bay side of the storage area in order to capture most of the suspended matter in the excess water brought to the storage site that could re-enter the bay.

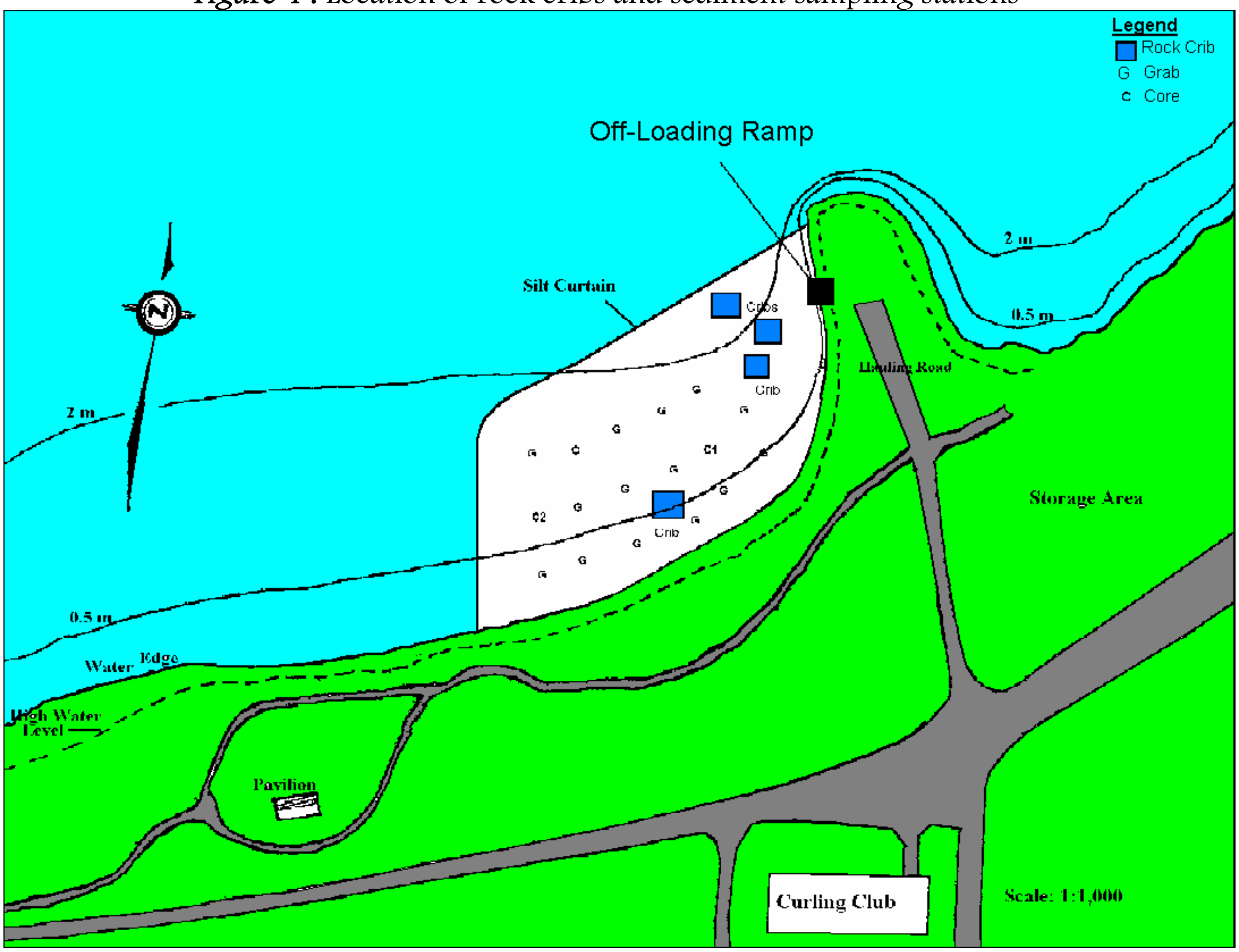
5.2) Removal of Larger Wood Wastes

The removal component of the project started on Monday, 03 October 1994, at approximately 13:00. During mobilization, the presence of rock cribs (remnants of an old dock) was noted in the removal area. Figure 4 shows the location of those cribs. The first duty performed on 03 October was to remove one crib located near the silt curtain in order to allow more efficient movement of the loading barges, therefore increasing productivity. Once that crib was removed, removal of wood wastes started using the grapple fork.

Many factors influenced the volume of wood to be removed and the productivity of the removal plant. The primary objective of the project was to remove the wood wastes obstructing the growth of aquatic vegetation. During mobilization, areas of aquatic plant growth were delineated in the removal zone in order to minimize disruption of existing fish habitat, therefore reducing the removal zone and the volume of wood wastes requiring removal. Figure 3 shows the location of this vegetation growth area.

Other factors such as the thickness of wood wastes and the water level greatly influenced the productivity of the removal plant. When the layer of wood is thin, more movement of the removal plant and loading barges is required. The water level also greatly affected the productivity. Between Wednesday, 12 October 1994 and Thursday, 13 October 1994, the water level dropped by more than 60 cm. Shallower portions of the removal zone were therefore unreachable by the crane equipped with the grapple. A dragline bucket was then installed on the crane to drag the material from the shallower area to points reachable with the grapple fork.

Figure 4 : Location of rock cribs and sediment sampling stations



The material removed during this phase was composed mainly of logs, wood slabs and composted sawdust. The material dredged using the grapple fork was placed into loading barges. Once a barge was filled, it was then towed to the off-loading area where the excavator moved the material from the barge into dump trucks. The trucks then took the wood wastes to the storage area. A total volume of this mixture of wood wastes of 3,595 m^3 was removed from Monday, 03 October 1994 to Wednesday, 19 October 1994.

5.3) Visor Grab Demonstration

The Visor Grab bucket has been developed by VOW, a division of Hollandsche Aanneming Maatchapij (HAM) Dredging (a large international dredging and maritime construction company from Holland), to remove contaminated sediment.

The Visor Grab consists of a standard type backhoe bucket with a controlled visor operated by hydraulic cylinders located on each side. This bucket can be used on standard excavators such as a Caterpillar 235 (or greater) and Hitachi 300 (or greater). The bucket has a capacity of 1.5 m^3 with a cycle time dependent on the driving machine, the operator and the water depth. The visor closes the grab by moving around the material contained within the bucket.

The Visor Grab bucket was air-freighted from the Netherlands on 15 October 1994 to Toronto's Lester B. Pearson International Airport. It was transported from the airport to Penetanguishene and installed on Wayne Jones Construction's excavator on Thursday, 20 October 1994. Once the installation of the Visor Grab was completed, the backhoe was then placed on a flat deck spud barge.

The Visor Grab was used to remove the remaining thin layer of sawdust overlaying the clayey sediment that the grapple fork was unable to remove. The demonstration lasted three (3) days and served to remove approximately 375 m^3 of a mixture of sawdust, wood chips, silt and clay.

5.4) Mechanical Screening of Material

Once the material was placed in the storage area, options were considered for disposal of the wood wastes. As the project evolved, the management team realized that more sediment was mixed with the wood wastes than expected. Therefore, one option was considered : mechanical screening of the wood wastes into two piles. The first pile would be composed of the larger pieces of wood that could be reused as firewood (once dried) or a wood chip source, etc. Another option was to dispose of this wood in a landfill site. The second pile would be composed of the fine material, a mixture of small pieces of wood, sawdust and sediment (silty-clay). This mixture will be used as compost on the Town of Penetanguishene's properties, or given/sold to the public.

5.5) Demobilization

Demobilization was mainly composed of the restoration of the site and removal of the silt curtain. As part of the restoration of the site, it was noted that the two remaining rock cribs could be a hazard to navigation due to the low water level above the rocks (approximately 30 cm). It was then decided to add rocks on top of one crib in order to make it visible to boaters and to create habitat for waterfowl and other wildlife.

The silt curtain was removed after water quality samples indicated that the turbidity inside the confined area was equal to the ambient turbidity of the bay (approximately one (1) week after completion of operations).

6) Results and Discussion

Production and water quality was measured throughout the wood wastes removal project. Sediment core samples were also taken at one occasion during the project. This section will present and discuss the results from the site audit and the environmental monitoring performed during the project.

6.1) Production

Figure 5 presents the daily volume of wood removed during the entire project. This figure indicates that the maximum volume of wood removed in one day was 630 m^3, while the minimum was 0 m^3. The daily average was approximately 300 m^3. Zero cubic metre volume removed was due to statutory holiday (Thanksgiving, Monday, 10 October 1994), use of dragline (Monday, 17 October 1994) and the fact that no removal work was performed on that day (Saturday, 22 October 1994, Tuesday, 25 October 1994 to Friday, 28 October 1994).

Figure 5 : Daily volume of wood removed

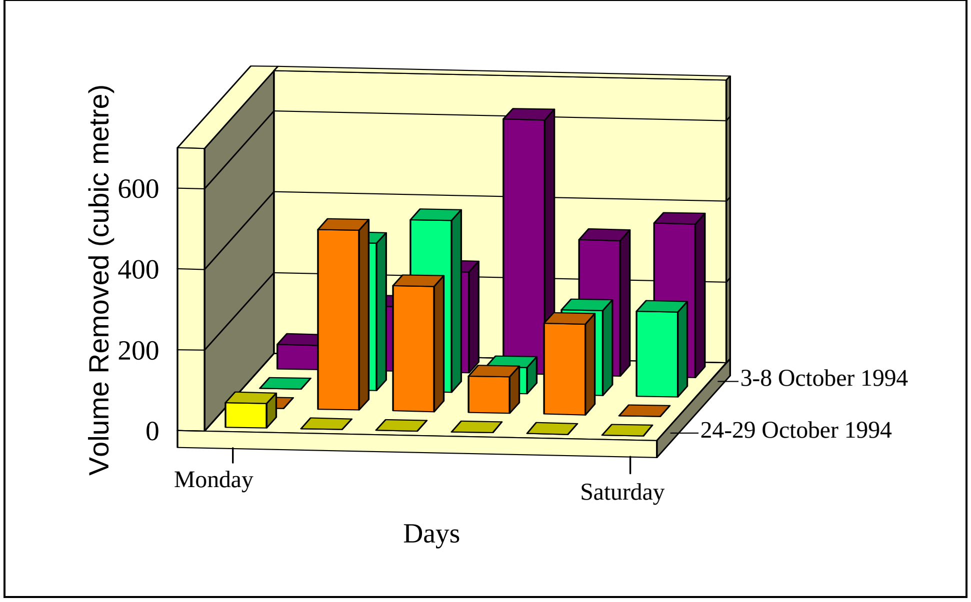
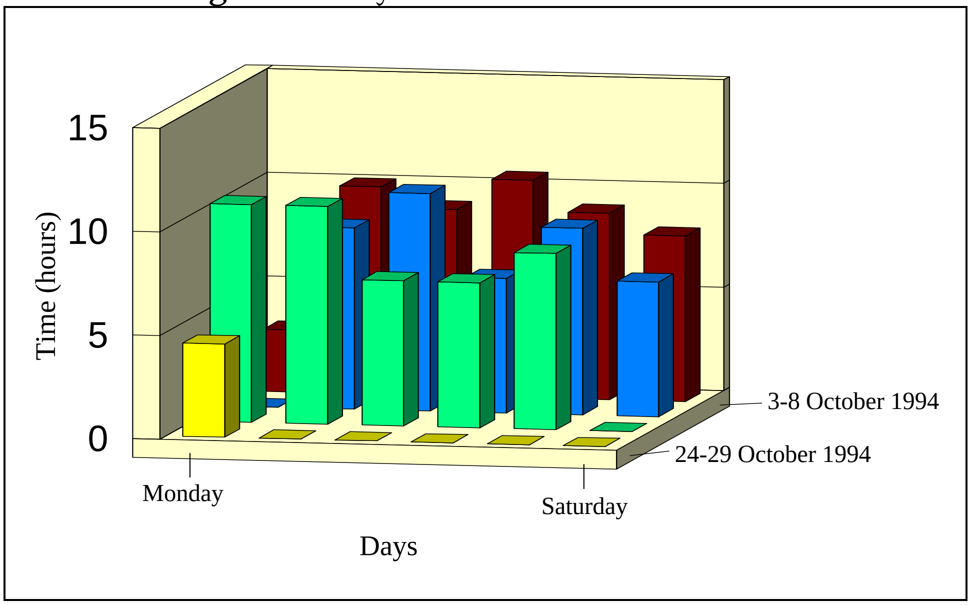


Figure 6 shows the daily time devoted to the removal of the above noted volume. It can be seen that the longest days lasted 10.5 hours, but averaged 9 hours.

Figure 6 : Daily time devoted to wood removal



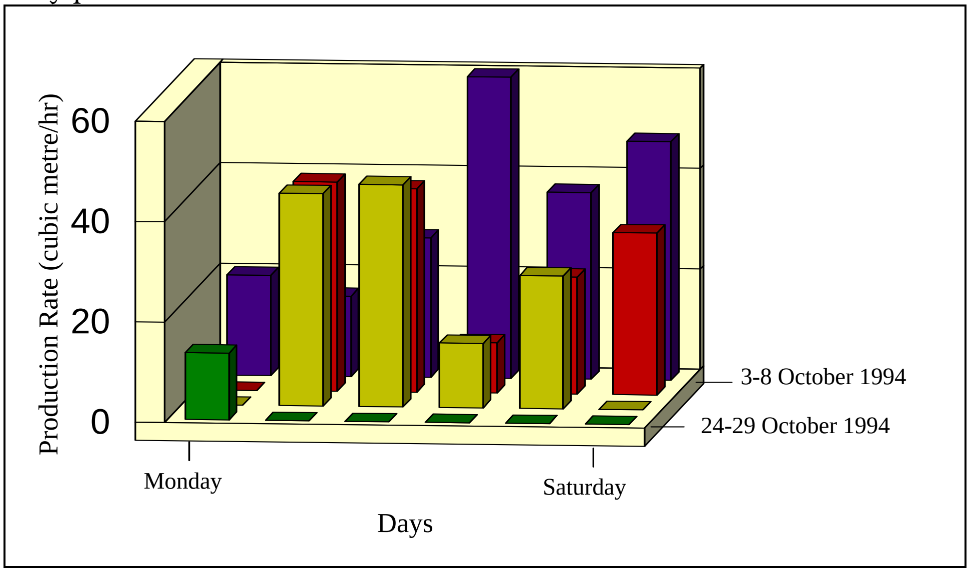
From those two figures, daily production rate was calculated and Figure 7 was produced. This figure indicates that the daily maximum production rate achieved was 60 m^3/hr, with and average of approximately 30 m^3/hr. Downtimes happened on:

Wednesday, 05 October 1994 (2 hours): Breakdown and change of a crane hose
Saturday, 08 October 1994 (0.5 hour): Crane cable stuck
Tuesday, 11 October 1994 (2 hours): Verification of water depth in navigation channel
Wednesday, 12 October 1994 (1 hour): Repair of a crane cable
Thursday, 13 October 1994 (6 hours): Break of main pole of grapple fork and barges stuck on bottom
Saturday, 15 October 1994 (1 hour): Breakdown of small tugboat and barges stuck on bottom

A total of 12.5 hours was devoted to equipment repair. From this 12.5 hours of downtime, 8.5 hours were paid by the management team, while the other 4 hours were the contractor's responsibility.

A total of 139.25 hours were required to remove 3,970 m^3 of wood wastes, of which 120.5 were devoted to the removal of 3,595 m^3 of larger wood wastes and 19 hours were devoted to the Visor Grab demonstration. This total duration leads to a dredging efficiency of over 90 %, with an average production rate during the removal of larger wood wastes of approximately 30 m^3/hr. Cycle times fluctuated between 55 seconds to 1 minute and 30 seconds during removal of larger debris. The percentage of solids was estimated to be near 80 % during the large debris removal phase.

Figure 7 : Daily production rate



6.2) Water quality monitoring

The water quality was monitored throughout the project. Since very little contamination was found in both the water and the sediment, it was decided that water sampling would be performed once a week only. The sampling program focussed mainly on the quantity of re-suspended material that could enter the bay from the confined area.

Seven sampling stations were used during this program. Station 1 was located at mid-bay, and served as the ambient level indicator. Stations 2, 3 & 4 were located 10 m outside the silt curtain, while stations 5, 6 & 7 were located inside the confined area. Figure 8 shows the location of these sampling stations in relation to the harbour.

Samples were collected at mid-depth and were analyzed for the following parameters : chloride, calcium, magnesium, sodium, potassium, hardness, conductivity, pH, turbidity, ammonia, nitrite, nitrate, phosphate, suspended solids, total phosphorus, total Kjeldahl nitrogen, dissolved organic carbon, dissolved inorganic carbon and reactive silicate.

Figure 8 : Location of water sampling stations

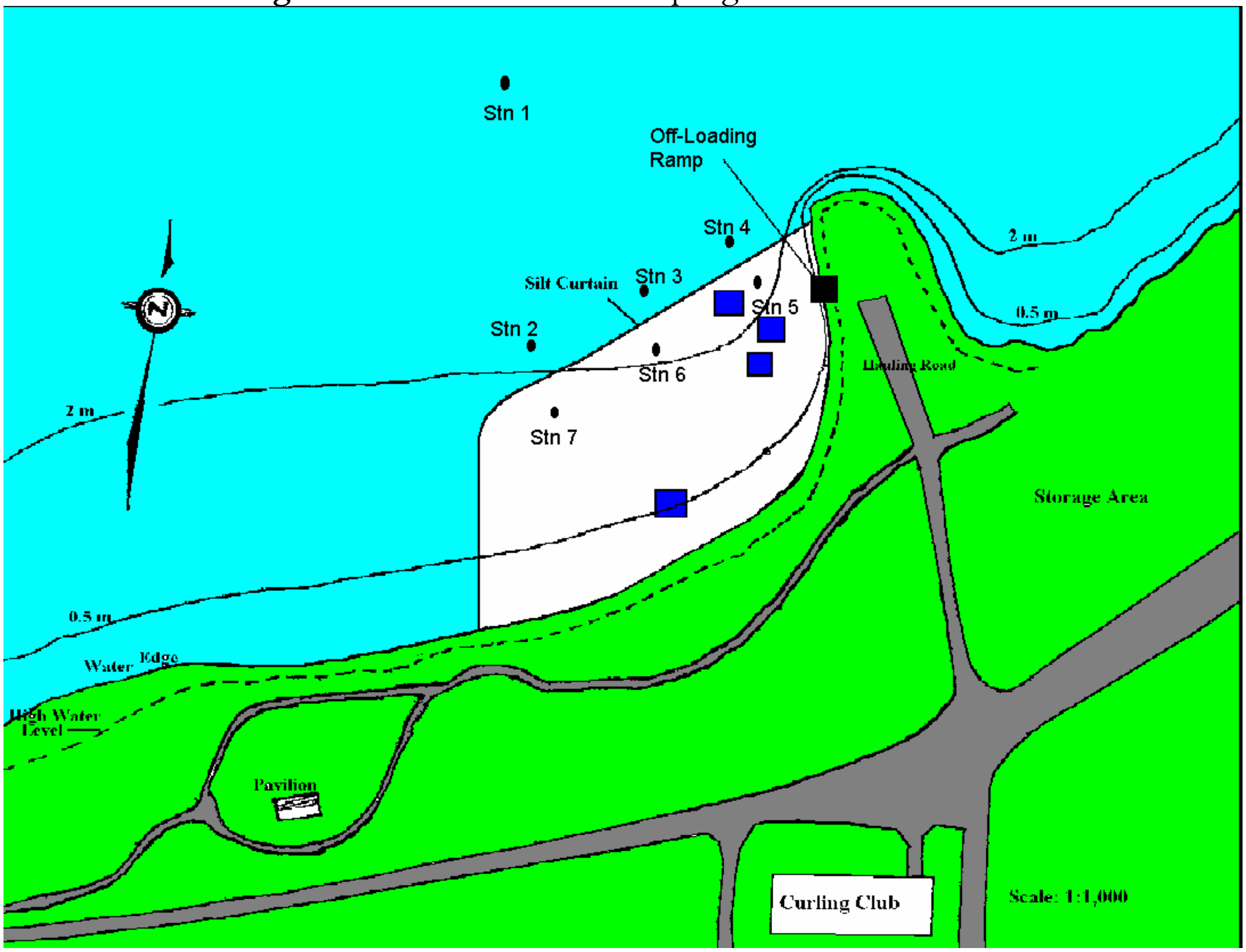


Figure 9 was produced using the turbidity results. These results indicate that the turbidity gradually increased in the confined area, which is related to the nature and the particle sizes of the dredged material. Sawdust and fine particles such as clay tend to re-suspend easily, and stay in this re-suspended state longer than large particles such as sand and gravel. An accumulation of easily re-suspended material occurred in the confined area throughout the duration of the project. These results also indicate that this re-suspended material took approximately one week to settle.

Figure 9 : Turbidity less ambient levels

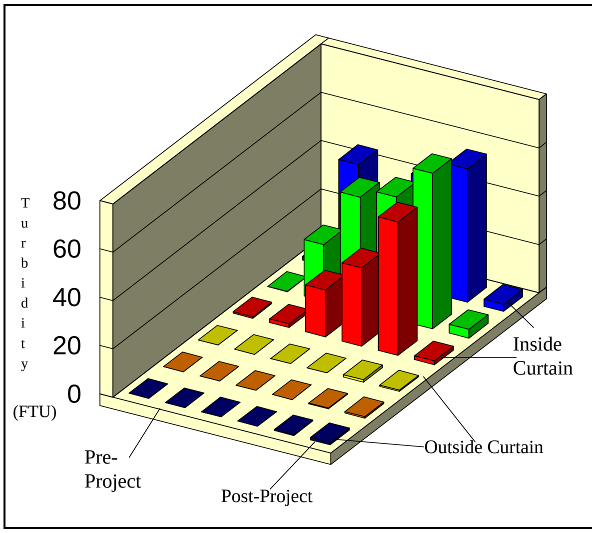
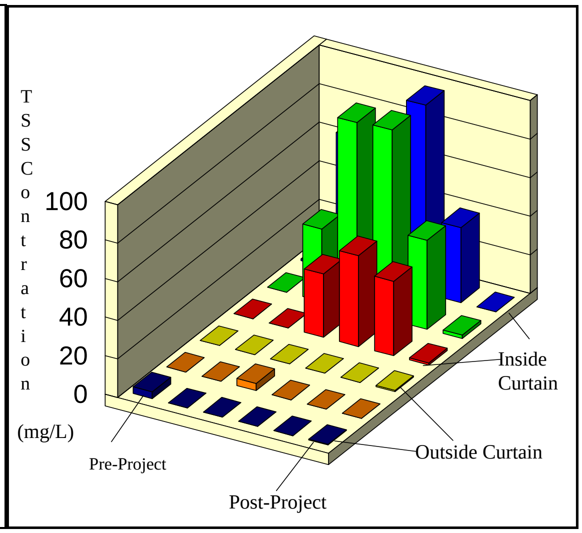


Figure 10 : TSS concentration less ambient levels



The results from Figure 9 also indicate that very little material exited the confined area since the turbidity immediately outside the silt curtain is always comparable to the turbidity at mid-bay (ambient level). Figure 10 was also generated using the total suspended solids concentrations results. These numbers indicate the same trend as for those for turbidity.

Tables 2a, b & c show the concentration of all other parameters analyzed during the water quality monitoring program.

Table 2a : Concentration of various parameters prior to dredging operations

Station and Date	Cl^-	Cond.	pH	$NH_3 + NH_4^+$	nitrite	NItrate + Nitrite	PO_4^{-3}	Total phosphorus	TKN	DOC	DIC	SiO_2
	mg/L	uS/cm		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
27/09/94												
Station 1	na	na	na	na	na	na	na	na	na	na	na	na
Station 2	8.6	208	8.17	0.034	0.006	0.01	0.002	0.01	0.3	3.5	18.2	1.02
Station 3	9	213	8.18	0.34	0.002	0.005	0.001	0.01	0.32	3.2	19.2	1.06
Station 4	8.9	215	8.2	0.68	0.003	0.005	0.005	0.016	0.34	3.2	19	1.04
Station 5	9.1	217	8.16	0.066	0.004	0.01	0.005	0.022	0.38	3.3	19.2	1.04
Station 6	8.7	210	8.18	0.064	0.004	0.02	0.002	0.016	0.34	3	18.2	1.02
Station 7	8.4	209	8.18	0.056	0.003	0.005	0.001	0.014	0.34	3.3	18.6	1.14

Note: Cond.: Conductivity, TKN: Total Kjeldahl Nitrogen, DOC: Dissolved Organic Carbon, DIC: Dissolved Inorganic Carbon, na: not analyzed

Table 2b : Concentration of various parameters during dredging operations

Station and Date	Cl^-	Cond.	pH	NH_3 + NH_4^+	nitrite	NItrate + Nitrite	PO_4^{-3}	Total phosphorus	TKN	DOC	DIC	SiO_2
	mg/L	uS/cm		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
05/10/94												
Station 1	8.7	na	na	0.136	0.004	0.04	0.005	0.022	0.48	3.2	5.8	1.26
Station 2	8.6	na	na	0.084	0.025	0.075	0.004	0.038	0.54	3.1	17.2	1.24
Station 3	8.5	na	na	0.108	0.012	0.035	0.003	0.028	0.48	3.3	8.2	1.32
Station 4	8.9	na	na	0.206	0.003	0.02	0.012	0.032	0.54	3	17.8	1.22
Station 5	9.9	na	na	0.332	0.003	0.06	0.015	0.118	1	3.3	4.4	2.1
Station 6	10	na	na	0.414	0.003	0.035	0.005	0.08	1.06	3.3	21	1.56
Station 7	10	na	na	0.188	0.003	0.025	0.011	0.04	0.6	3.3	7.2	1.46
6/10/94(AM)												
Station 1	8.8	218	7.92	0.12	0.004	0.06	0.005	0.03	0.52	2.9	17.6	1.2
Station 2	8.7	218	8.09	0.136	0.005	0.025	0.005	0.03	0.54	3.1	17.8	1.24
Station 3	8.9	221	8.29	0.136	0.005	0.015	0.005	0.056	0.68	3.2	18.6	1.2
Station 4	8.9	227	8.04	0.18	0.003	0.01	0.008	0.026	0.54	3.3	19	1.26
Station 5	10.3	247	8.23	0.362	0.004	0.05	0.19	0.098	0.98	3.3	21.8	1.68
Station 6	10.3	251	7.88	0.364	0.002	0.05	0.01	0.14	1.26	3.2	22	1.72
Station 7	10.1	246	7.99	0.238	0.004	0.045	0.008	0.068	0.74	3.3	21.4	1.62
6/10/94(PM)												
Station 1	8.7	216	8.19	0.106	0.004	0.04	0.005	0.022	0.46	3.1	17.6	1.2
Station 2	8.7	222	8.22	0.174	0.002	0.005	0.008	0.028	0.52	3.1	18.2	1.22
Station 3	8.6	229	8.04	0.196	0.003	0.02	0.013	0.022	0.52	3.1	19.2	1.38
Station 4	8.5	224	8.13	0.168	0.002	0.005	0.009	0.024	0.48	3.1	18.6	1.26
Station 5	10.2	251	7.87	0.286	0.002	0.05	0.01	0.146	1.24	3.1	22.2	1.7
Station 6	10.2	250	7.87	0.316	0.002	0.05	0.012	0.148	1.22	3	22.4	1.72
Station 7	na	na	na	na	na	na	na	na	na	3.1	21.6	1.74
13/10/94												
Station 1	9	224	8.2	0.146	0.007	0.09	0.007	0.018	0.38	3	18.4	1.18
Station 2	10.5	241	8.21	0.142	0.006	0.47	0.013	0.024	0.4	3.1	18.8	1.28
Station 3	10.5	241	8.23	0.138	0.005	0.465	0.011	0.026	0.42	3	18.8	1.28
Station 4	9.8	236	8.14	0.11	0.008	0.33	0.006	0.02	0.38	3	18.8	1.26
Station 5	10.6	267	7.95	0.218	0.022	0.2	0.021	0.088	0.66	2.9	23.8	2.02
Station 6	10.6	267	8.27	0.218	0.021	0.19	0.021	0.09	0.64	2.8	23.8	2.04
Station 7	10.4	267	8.07	0.32	0.009	0.155	0.03	0.116	0.86	2.8	24.2	2

Note : Cond.: Conductivity, TKN: Total Kjeldahl Nitrogen, DOC: Dissolved Organic Carbon, DIC : Dissolved Inorganic Carbon, na : not analyzed

The results presented in Tables 2a show that all analyzed parameters had a uniform concentration throughout the sampled area, indicating very little effects of mobilization operations on the water column. Those presented in Tables 2b show an increase of the concentration of most parameters in the silt curtained area during dredging. As suggested by the turbidity, TSS and SiO_2 analytical results, this increase is related to the increase in suspended particles.

Table 2c : Concentration of various parameters after dredging operations

Station and Date	Cl^-	Cond.	pH	NH_3 + NH_4^+	nitrite	NItrate + Nitrite	PO_4^{-3}	Total phosphorus	TKN	DOC	DIC	SiO_2
	mg/L	uS/cm		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
3/11/94												
Station 1	8.7	232	7.96	0.076	0.013	0.145	0.003	0.02	0.44	2.8	21.4	1.42
Station 2	9.3	236	7.95	0.094	0.015	0.18	0.004	0.024	0.44	2.8	21.6	1.46
Station 3	8.7	240	8.04	0.106	0.011	0.15	0.004	0.022	0.44	2.8	22.8	1.68
Station 4	8.8	263	8.17	0.08	0.01	0.2	0.003	0.022	0.44	2.9	25.8	2.34
Station 5	10.1	251	7.95	0.08	0.015	0.235	0.002	0.24	0.44	2.7	23.2	1.7
Station 6	9.6	255	8.14	0.088	0.008	0.19	0.002	0.022	0.44	2.7	24.2	1.92
Station 7	9.2	257	7.97	0.108	0.009	0.185	0.004	0.026	0.46	2.8	24.6	2.06

Note : Cond.: Conductivity, TKN: Total Kjeldahl Nitrogen, DOC: Dissolved Organic Carbon, DIC : Dissolved Inorganic Carbon, na : not analyzed

The results presented in Tables 2c show that the suspended particles settled down to the bottom since there are no more differences between the concentration of all parameters inside and outside the silt curtain.

6.3) Sediment Quality

On Wednesday, 19 October 1994, a sampling survey was conducted in order to determine the remaining quantities of fine wood wastes that was left to be removed using the Visor Grab bucket. Both grab and core samples were collected. In those areas where grab samples indicated the presence of fine wood wastes, core samples were collected. In total, six core samples were collected, four for visual analyses only, and two were sent to the MOEE's laboratory for chemical analyses.

Figure 11 to 15 show the results for chemical analyses of sediment from core #1. These results indicate that the concentration of trace metals (Cu, Cr, Ni), aluminum and manganese greatly increase at a depth of 15 cm to levels above their OMOEE lowest effect level guideline, while heavy metals (Pb, As, Cd) except for mercury, have significant increases at 25 cm, again to levels above their OMOEE lowest effect level guideline. The concentration of organic indicators (TOC & LOI) and total Kjeldahl nitrogen significantly decreases with depth. The concentration of phosphorus tends to increase with depth. Although the concentration of most parameters tends to increase with depth, the results indicate that all chemical parameters for the newly exposed sediment are all below their respective OMOEE lowest effect level guideline.

Figure 11 : Conc.of metals with depth

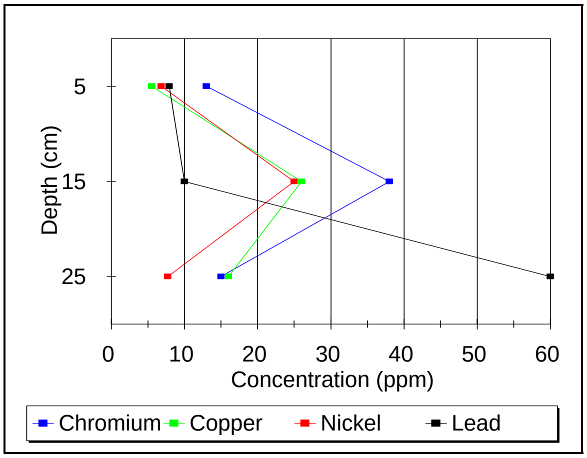


Figure 12 : Conc. of metals with depth

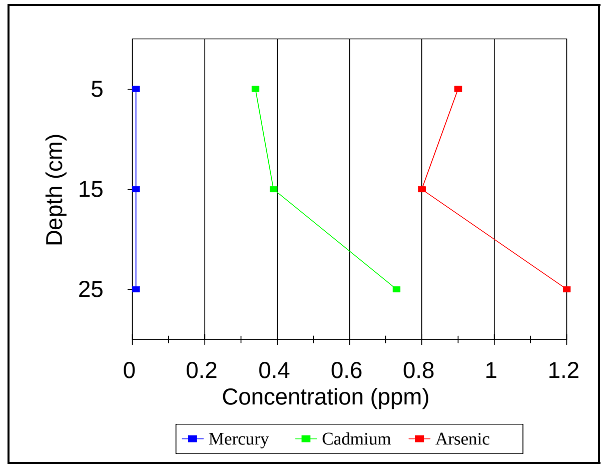


Figure 13 : Conc. of metals with depth

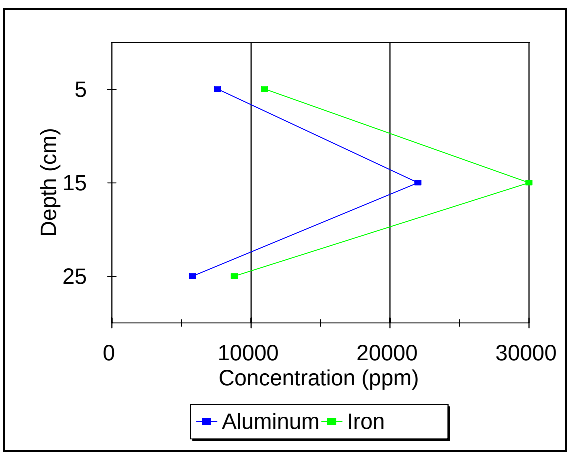


Figure 14 : Conc. of organic indicators with depth

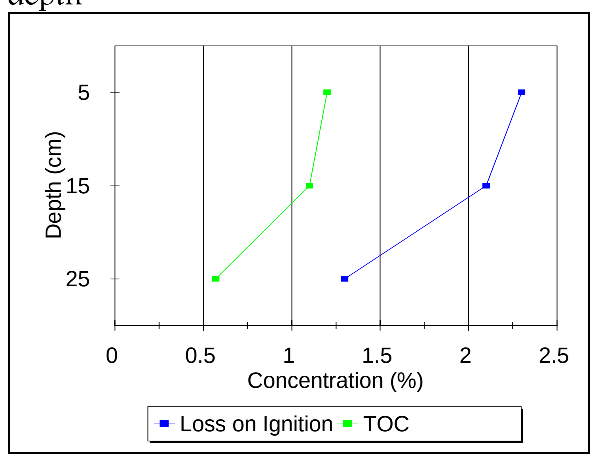


Figure 15 : Conc. of some nutrients with depth

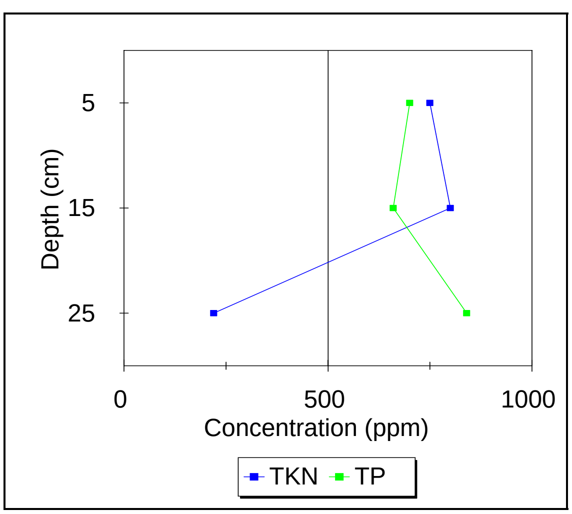


Figure 16 to 21 show the results of chemical analyses performed on the sediment from core sample # 2. The results indicate that the concentration of most trace metals (except for Fe) increase at a depth of 42 cm. Although this increase is significant, the final concentration is still lower than the OMOEE lowest effect level guideline. The concentration of heavy metals (except for arsenic) does not show any significant fluctuation with depth. The concentration of arsenic increases significantly at a depth of 42 cm to a level above the OMOEE lowest effect guideline of 6 ppm. The concentrations of organic indicators (LOI & TOC) and conventional parameters (TKN & TP) decreases with depth. The results also indicate that the surficial concentration of TKN (0-10 cm) is very close to the OMOEE severe effect guideline of 4,800 ppm (surficial concentration = 4,600 ppm).

Figure 16 : Conc. of some heavy metals with depth

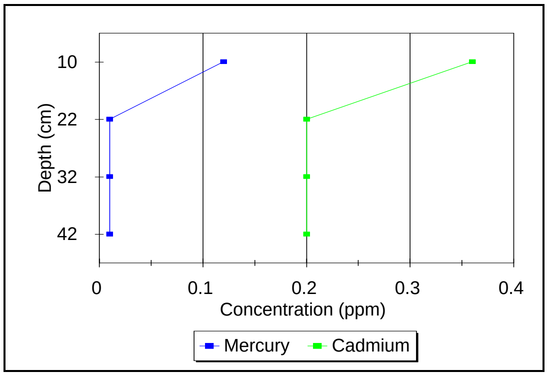


Figure 18 : Conc. of various metals with depth

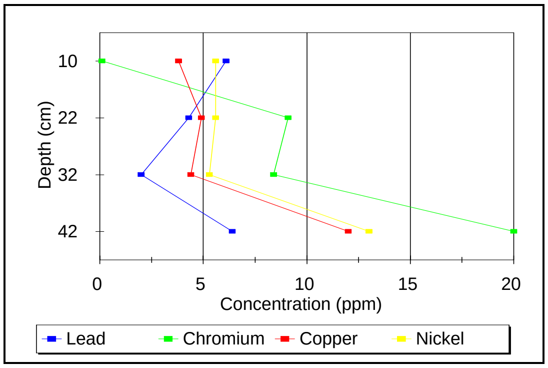


Figure 17: Conc. of various metals with depth

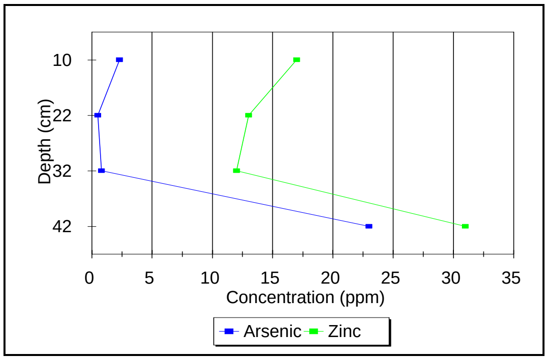


Figure 19 : Conc. of Al & Zn with depth

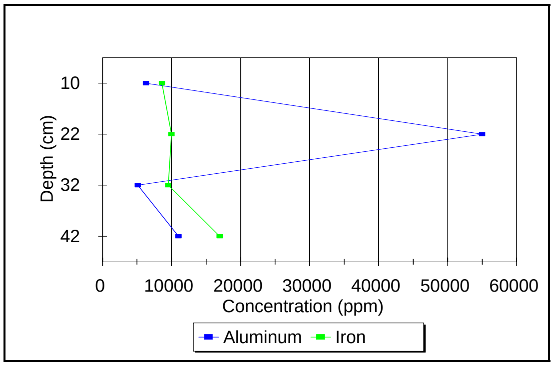


Figure 20 : Conc. of some nutrients with depth

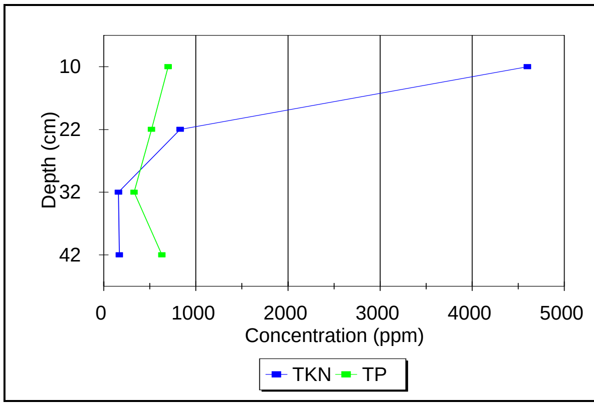
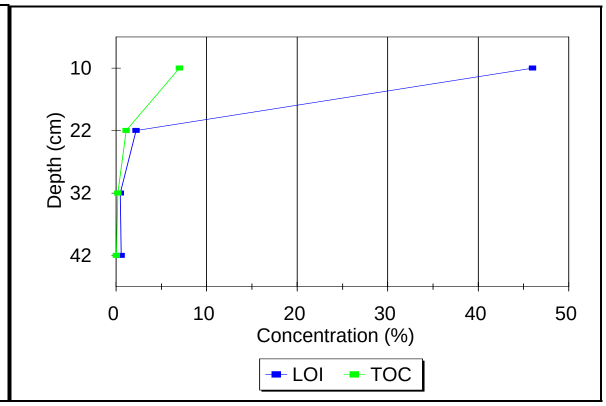


Figure 21: Conc. of organic indicators with depth



Of most importance is the comparison of the results from Figure 11 to 15 with the concentration of surficial sediment for the entire harbour. Table 3 shows the maximum, the minimum and the mean concentrations of surficial sediment from samples taken between 1988 and 1990 (Krantzberg and Sherman, 1995). The comparison indicates that only the concentrations of aluminum, cadmium and total phosphorus are above the minimum concentration recorded in samples from the entire Penetang Bay.

Table 3 : Penetang Bay chemical concentrations of surficial sediment (based on 19 sampling stations)

Parameter	Unit	OMOEE-LEL	Min. Conc.	Max. Conc.	Mean
Al	ug/g	na	2,100	230,000	14,916
As	ug/g	6	2.0	5.9	3.8
Cd	ug/g	0.6	0.13	1.30	0.83
Cr	ug/g	26	42	180	74
Cu	ug/g	16	18	61	36
Fe	ug/g	20,000	12,150	34,000	23,028
Hg	ug/g	0.2	0.03	0.52	0.21
Mn	ug/g	460	310	670	454
Ni	ug/g	16	16	40	26
Pb	ug/g	31	36	140	70
Zn	ug/g	120	75	190	140
TKN	ug/g	550	2,400	8,220	5,240
TP	ug/g	600	660	5,180	1,380
LOI	%	na	5.2	48	14.8
TOC	%	1	2.4	24	7.1

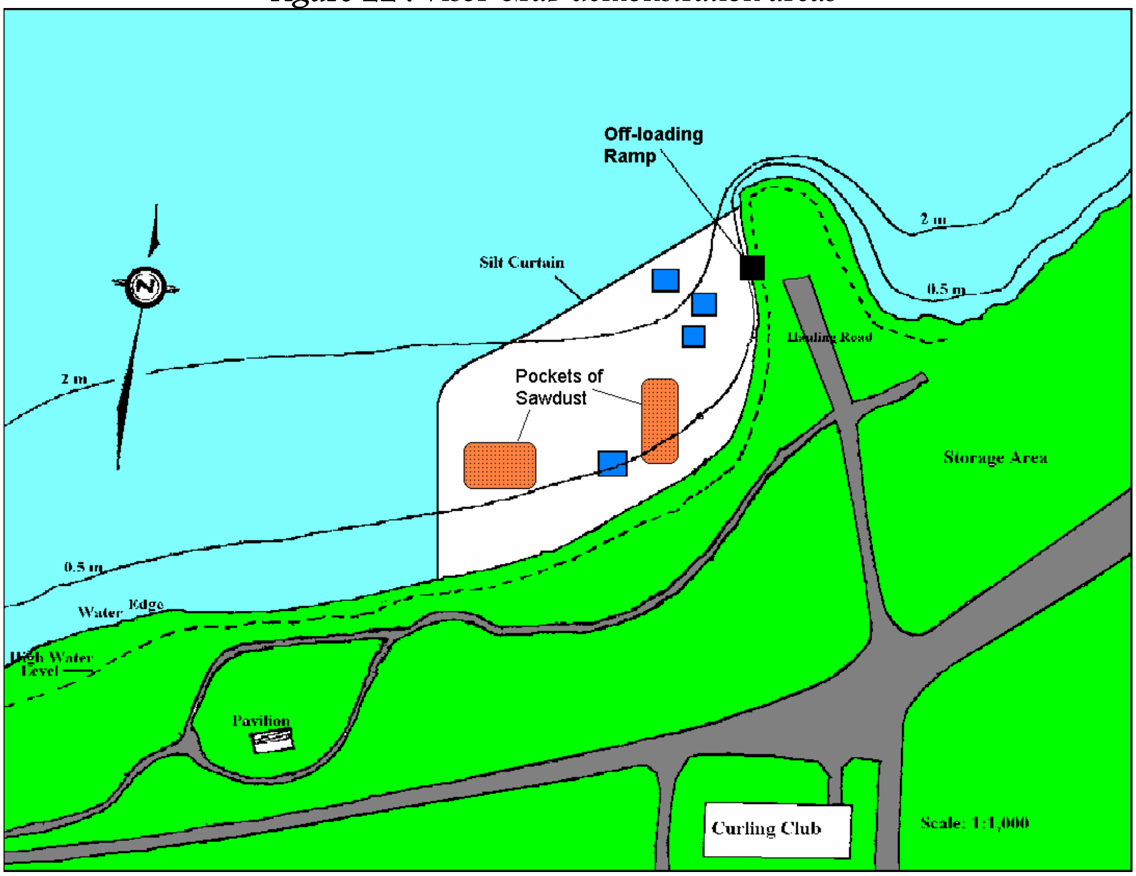
The comparison of the results presented in Figures16 to 21 with those showed in Table 3 indicate that the concentrations of aluminum, cadmium, total Kjeldahl nitrogen, loss on ignition and total organic carbon are above the minimum concentrations recorded in samples for the entirebay.

The results from the 1988-1990 surveys, have indicated that, although chromium exceeded the SEL and other parameters exceeded the LEL, little sublethal effects were measured on bioassays orginisms. Even though it is extremely difficult to reach a conclusion based on only 2 core samples, the results tend to indicate that, except for the concentration of TKN, the newly exposed sediment is of comparable quality with the less contaminated areas of Penetang Bay, and should therefore not pose any threat to the surrounding environment.

6.4) Visor Grab Evaluation

Following the sediment sampling survey, two areas requiring sawdust removal were identified. Figure 22 shows the location of these areas. These two pockets were used to demonstrate an innovative sealed bucket. The Visor Grab, owned and developed by HAM dredging, was brought from Holland to Penetanguishene for testing its applicability at removing sediment while minimizing sediment re-suspension.

Figure 22 : Visor Grab demonstration areas



The bucket was installed on Wayne Jones Construction's 235 Caterpillar excavator on Thursday, 20 October 1994. The demonstration started the same day and lasted until Monday, 24 October 1994.

In total, 19 hours were devoted to the removal of approximately 375 m^3 of a mixture of sawdust and clay. From those 19 hours, approximately 5 hours were devoted to transport and off-loading of material. Therefore, the total duration of the removal period was 14 hours, which leads to an average production rate of approximately 27 m^3/hr. The average cycle time was approximately 55 seconds, with a percentage of solids averaging approximately 40 %. It should be noted that performances related to the Visor Grab are related mostly to the excavator, the operator and the water depth. The above-noted performances could be totally different under other site specific conditions.

Even though most of the large debris was removed from the area with the grapple fork, some pieces of wood were still present on the sediment. These leftovers prevented the Visor Grab from sealing completely. In fact, approximately 70 % of the bucket loads were not sealed due to the presence of debris preventing complete closure.

Evaluation of sediment re-suspension related to the use of the Visor Grab only was impossible due to three main factors : 1) already extremely elevated levels of total suspended solids in the water column of the confined area, 2) effects of the current created by the tugboat propellers re-suspending a considerable amount of sediment, and 3) leaks from the holding barge.

6.5) Mechanical Screening of Wood Wastes

In October 1994, a portion of the wood wastes was separated into two fractions using a screen-all in order to determine the applicability of this commonly used process. The results indicated that, once totally dry, the wood wastes could be separated efficiently into a finer fraction and a wood fraction. The finer fraction, composed mainly of sawdust and sediment, could be re-used as compost. Options for the disposal of the wood portions were limited. It became obvious that this material could not be re-used as firewood, or even as wood chips since other debris (glass, metal, plastic, etc.) was mixed in.

In June 1995, the Town of Penetanguishene screened the remainder of the wood wastes. Two piles were generated. Approximately 1,500 m^3 of compost was generated, while another 1,500 m^3 of wood waste was trucked to a composting "stump dump".

7) Finance

7.1) The Costs

The expenses related to the project were mostly related to : 1) the removal of larger wood debris, 2) demonstration of the Visor Grab, and 3) the screening of the wood wastes.

7.1.1) Removal of Larger Wood Wastes

The total cost for dredging the larger wood debris was $113,500 and can be broken down as follows :

1) Mobilization of equipment : $15,000
2) Removal of wood wastes : ($530/hr) leading to a total of $83,500
3) Demobilization : $15,000

This total cost leads to a unit cost of $29.03/m³ (including mob-demob). The unit cost for dredging only was $21.36/m³.

7.1.2) The Visor Grab Demonstration

The Visor Grab demonstration had a total cost of $40,000. The breakdown is as follows :

1) Modifications of Visor Grab : $2,400
2) Preparation and transport to airport : $3,000
3) Rental : $5,000
4) Expert fees : $9,000
5) Overhead : $9,000

Additional costs totalling $8,600 were encountered by Wayne Jones Construction and the Town of Penetanguishene during the demonstration.

This total cost leads to a unit cost (including all items) of $106.67/m³. The unit cost for dredging only was $13.33/m³. The high cost associated with this demonstration is due to the Visor Grab being brought by plane from Holland and it was felt that, by bringing an expert from Holland, the demonstration would be more accurate to the Visor Grab real efficiency.

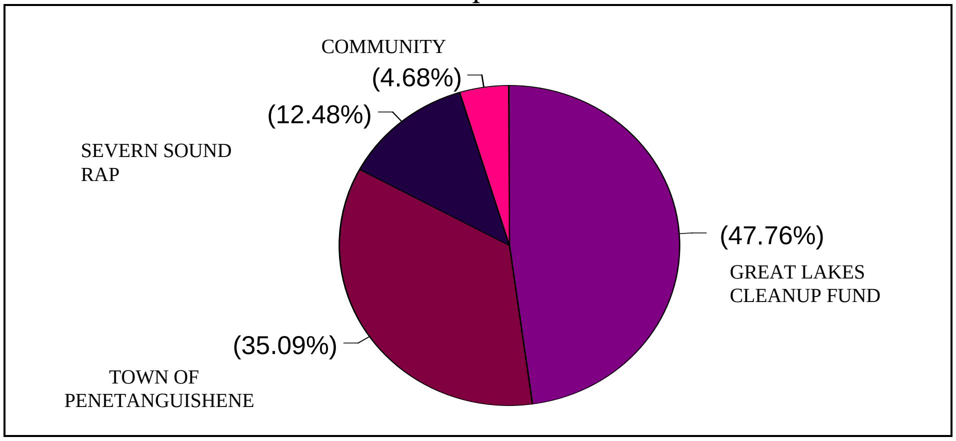
7.1.3) Mechanical Screening of Wood Wastes

The total cost related to mechanical screening of the wood wastes was $20,000, which leads to a unit cost of $5.12/m³.

7.2) Financial Contributions from Partners

Figure 23 shows the financial contributions from the different partners involved in the larger wood wastes removal portion and the mechanical screening portion of the project. As indicated in Figure 23, the Town of Penetanguishene contributed a total of $90,000, of which $70,000 was from in-kind support in the form of trucks, loader, backhoe, labour, meeting rooms, communication services, etc. and $20,000 for mechanical screening of the wood wastes. The Severn Sound RAP contributed for $32,000 in in-kind support in the form of sampling, technical services, sample analyses, communications, publicity, etc. The community provided services for a total value of $12,000. The Great Lakes Cleanup Fund (CuF) provided the bulk of the money with $122,500. In addition, the CuF covered the extra expenses related to the demonstration of the Visor Grab.

Figure 23 : Financial contribution from partners



8) Conclusion

The Penetanguishene wood pile removal project was successful for many reasons. Partnership was established in the early stage of the project. All partners had a well defined role that suited their capability. The Town of Penetanguishene provided equipment and labour through its Public Works and Parks Departments, administration, etc, the Severn Sound RAP provided technical support, sample analyses, communications, etc, the Remediation Technologies Program of Environment Canada provided expertise in the dredging field through site supervision, and the community participated in every event planned by the management team.

Another important factor in the success of this project was the strong support from the population of Penetanguishene. From day one, public support was granted to the management team for the wood removal project.

The demonstration of the Visor Grab proved that innovative technologies can be found and used to clean up contaminated areas of the Great Lakes. The Visor Grab itself, with some minor modifications, does have the potential to be used to clean up other AOCs.

The main purpose of this phase of the project was to remove wood wastes that were preventing the creation of valuable fish and wildlife habitat. This large volume of wood now being removed, plants can colonize the area and gamefish such as pike, bass, and even trout can use this new habitat and provide a renewed recreational use of the harbour for the population of Penetanguishene.

9) Recommendations

Overall

- Project scheduling should take into account disposed material drying time. When material is to be temporarily stored on land, the dredging component should start in the spring in order to allow the material to dry over the summer.

- Promotion of the Penetanguishene Wood Pile Removal Phase should be undertaken. Other areas throughout the Great Lakes basin and around the world could benefit from the unique partnership and procedures that were established for this project.

Removal of Wood Pile

- Close, on-site supervision is required during the removal phase of the projectto avoid overdredging or underdredging and additional costs.

- When the work area requires confinement (most cases), a remotely operated camera (or other means) should be used during the project to verify the integrity of the silt curtain.

- Precise sounding surveys should be performed prior to and after the project in order to determine the volume of material removed during the operations. For handling purposes, determination of the volume of material after removal and sorting is also necessary.

Visor Grab Demonstration

- When an innovative sediment removal demonstration is scheduled, the use of tugboats in a silt curtained area should be reconsidered. Tugboats disturb bottom sediment, therefore increasing the total amount of re-suspended material during and after removal operations. It is recommended that when the use of tugboats is essential, the demonstration should not take place until the turbidity levels inside the curtained area is equivalent to the ambient level. This would ensure an undisturbed environment and a better evaluation of the quantity of material re-suspended by the innovative removal technology only.

- A sensor indicating complete closure of the bucket should installed on the Visor Grab. This sensor would indicate to the operator that the bucket is sealed and that minimal leaks or spills will occur during lifting.

- A different bucket sealing system should be identified. The rubber seal on the Visor Grab is installed on the visor. The seal should be installed in a casing on the digging lip of the bucket with the visor closing on the rubber seal, in the casing. This would allow for a better longer-lasting seal.

- Hydraulic pressure guiding the visor closure should be increased. With increased hydraulic pressure, the visor would seal more tightly and small debris could be broken.

- A positioning system system indicating the position of the excavator and the bucket in relation with the dredging site should be added to the Visor Grab. This system would allow for more precision during dredging.

- During the demonstration, it was found that the excavator operator was improving with time, i.e. full bucket loads, less spillage, etc. It is recommended that, for future use of the Visor Grab bucket in more sensitive areas, that the operator be trained prior to the project commencement.

- Water samples should be taken more often and at different depth, when results are to be used for technology assessment. It is difficult with limited number of samples to determine whether or not the innovative dredging technology can reduce the impact on the surrounding harbour. The use of on-line monitors for turbdity (such as hydrolabs with logging capabilities) should be considered.

Monitoring

- Sediment assessment protocol should be followed : bulk chemical analyses of surficial sediment should be performed on newly exposed material six months to one year after dredging operations.

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Picture 1: Grapple Fork full of wood debris

Picture 2: Offloading ramp. Excavator used to transfer wastes from barges to trucks

Picture 3: Temporary storage area. Material is composed of sawdust, wood slabs and logs

Picture 4: Visor Grab Bucket open preparing for descent

Picture 5: Visor Grab Bucket full with minimal leakage

Picture 6: Mechanical screening of wastes by the Town of Penetanguishene