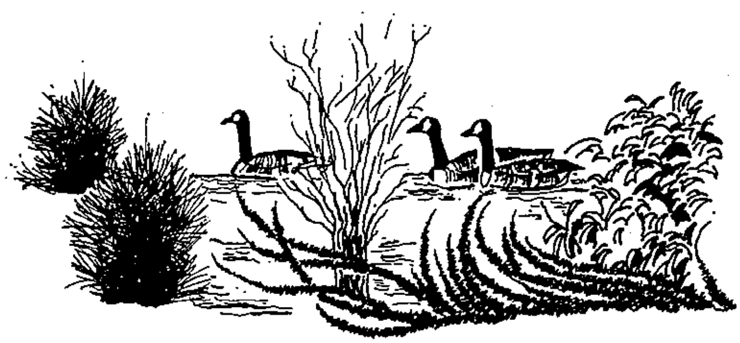
Tommy Thompson Park

Master Plan
and Environmental Assessment
Addendum



Appendix B - Cell 1 Capping Proposal

December 1992

Capping Proposal

For

Cell 1 at Tommy Thompson Park

submitted to

The Ontario Ministry of the Environment

The Metropolitan Toronto and Region Conservation Authority
Water Resources Division

January 1992

Acknowledgments

The MTRCA would like to thank the following people and organizations for their contribution and assistance with the Capping Proposal for Cell 1 Tommy Thompson Park. The staff of the Toronto Harbour Commissioners for providing technical assistance in developing the three capping options. Mr. Donald Speller and staff of Tarandus Associates Limited for conducting the Wetland Literature review, assisting in the development and documentation of the capping proposal. Members of the Technical Advisory Committee and the Natural Area Advisory Committee for their assistance and comments with the proposal. Mr. Robert Dalziel of Ministry of Natural Resources for the safe and efficient operation of the MNR SR20 Electrofishing boat.

Executive Summary

For several years, Tommy Thompson Park has been a repository for sediments dredged from the Keating Channel and other locations in the vicinity of Toronto Harbour. These operations were approved under Section 14 of the Environmental Assessment Act by the Provincial Minister of the Environment on September 17, 1986, subject to a number of terms and conditions. Condition number five states:

Cell 1 shall be topped off and capped no later than December 31, 1992, in a manner which restricts biological uptake and mobility of contaminants.

Disposal of dredgeate in Cell 1 at Tommy Thompson Park was completed in 1987; and as required by the Environmental Assessment decision, capping options have been developed by the MTRCA. The three capping alternatives evaluated by the MTRCA are: a dry clean-fill cap; a wetland cap established directly on dredgeate; and the placement of clean-fill cap over the dredgeate, followed by the creation of a wetland ecosystem on the clean fill. After extensive studies of the existing environment at Cell 1 and after evaluation of the economic and engineering considerations of the project, MTRCA is proposing the use of a clean-fill cap and the subsequent establishment of a wetland at the site.

The preferred capping alternative will be completed in phases to facilitate de-watering operations and to improve the management and control of construction. A minimum of 0.5 metres of clean fill will be placed over the dredgeate, and the quality of all fill will meet open-water disposal criteria. An estimated 203,754 m^3 of fill will be required for the capping.

Construction will begin immediately upon project approval. The length of the construction period will depend on the availability of fill, but at an expected average of 120 truck loads per day, the capping will be completed in approximately 11 months. At this rate of construction, the project is estimated to cost $493,000.

After the placement of the clean-fill cap over the dredgeate in Cell 1, a wetland ecosystem will be established at the site. The wetland will provide fish and wildlife habitat as well as recreational and interpretive opportunities. In addition, the wetland ecosystem will satisfy the policy objectives of various regulatory agencies.

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1.0 INTRODUCTION

For several years, Tommy Thompson Park has been a repository for sediments dredged from the Keating Channel and other locations in the vicinity of Toronto Harbour (Figure 1). These operations were approved under Section 14 of the Environmental Assessment Act by the Provincial Minister of the Environment on September 17, 1986, subject to a number of terms and conditions. Condition 5 is of particular relevance to this proposal:

> *Cell 1 shall be topped off and capped no later than December 31, 1992, in a manner which restricts biological uptake and mobility of contaminants.*

Disposal operations at Cell 1 at Tommy Thompson Park were completed in 1987, and as required by the Environmental Assessment decision, various capping options have been considered by the MTRCA. Three capping alternatives evaluated by the MTRCA are: a clean-fill dry cap; a wetland cap established directly on dredgeate; and the placement of a clean-fill cap over the dredgeate (below lake level), followed by the creation of a wetland ecosystem on the clean fill. After extensive studies of the existing environment at Cell 1 and literature on the subject, and after evaluation of the economic and engineering considerations of the project, the MTRCA is proposing the use of the third option of a clean-fill cap and the subsequent establishment of a wetland.

It is estimated that Ontario has lost at least 70% of its pre-settlement wetlands (Snell, 1982); and that 1 to 2 percent of southern Ontario's wetlands are disappearing each year (Reid, 1981). In southwestern Ontario, over 90% of the original wetlands are estimated to have been converted to other uses such as agricultural and cottage development (Rump, 1987). A study of changes in marsh area along the Canadian shore of Lake Ontario (Whillans 1982), found that the greatest losses of marsh area have occurred in the area between Hamilton and Toronto. Virtually 100% of Toronto's former 1500 acres of marsh have disappeared (McCullough, 1981).

Although the use of a clean-fill/wetland cap at Cell 1 will not alter the history or trend of wetland disappearance in Ontario, it would offer opportunities for public education, recreational benefits, wildlife-habitat improvement, ecosystem diversity and other environmental enhancements. In addition, the construction of a Clean-fill/Wetland may be useful as a demonstration of what can be achieved in the way of wetland creation along the shores of the Great Lakes.

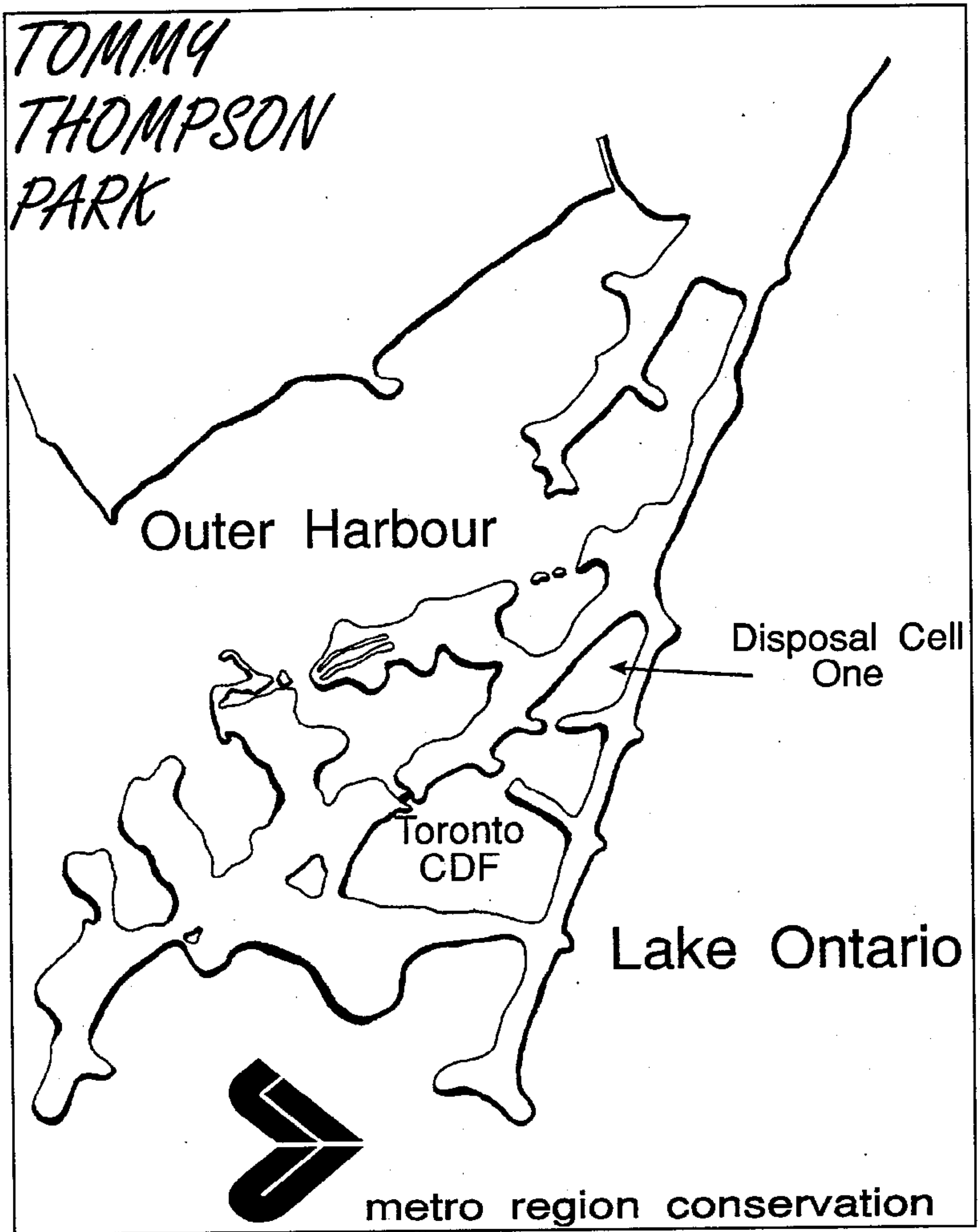

Fig. 1. Tommy Thompson Park, the Toronto CDF and Disposal Cell One.

2.0 BACKGROUND

The Keating Channel was constructed from 1890 to 1899 and attained its present configuration in 1922 when the cut was closed and connected to the lower Don River. Periodic routine dredging of the Keating Channel to navigational depth was conducted between 1920 and 1974. During this period, dredgeate was deposited in the open lake or in advance of the east headland lake filling (Tommy Thompson Park). Options for the disposal of Keating Channel dredgeate were restricted as a result of an agreement concluded in 1972 between Canada and the United States. The agreement prohibits the open-water disposal of unacceptably contaminated dredged materials (THC 1987).

The Keating Channel east of the Cherry Street Bridge was not dredged between 1974 and 1987. During this time, the deposition of sediments in the channel reduced the flow capacity of the watercourse, and as a result, created a flood hazard. Sediments from the Keating Channel also encroached in the north east corner of the Inner Harbour, a situation which necessitated interim dredging to maintain navigational depths. The Toronto Harbour Commission conducted occasional maintenance dredging in the harbour from 1977 to 1986. Dredgeate from these operations was deposited in Tommy Thompson Park within the confined-disposal facility at Cell 1.

Cell 1 was created as part of the Endykement Project initiated by the Toronto Harbour Commission. This project was intended to extend the eastern-headland breakwater concurrent with the construction of containment cells for use as dredgeate-disposal sites.

3.0 EXISTING ENVIRONMENTAL CONDITIONS

3.1 Existing Sediment Conditions

A total of 28 sediment samples were collected in Cells 1 and 2 during the summer of 1989 for the use in evaluating the environmental quality of the existing substrates in these embayments. Sediments were collected with the use of a KB corer at 13 stations in each cell (Figure 2); and the surficial 5 cm of each sample was retained for analyses. The sediment materials at most stations were generally well consolidated and the corer often penetrated the substrate with difficulty. As a result, the samples retained at most stations were homogenized composites of multiple cores.

The sediment analyses were completed by Enviroclean, a subsidiary of McLaren Plansearch. The parameters selected for analyses were those listed in several guidelines available for use in assessing the environmental quality of sediments and/or soils. These include: The Lakefill Quality Guidelines for Open Water Disposal and for Restricted Land Use (Trow 1988), and the Decommissioning Guidelines (MOE 1989). Some additional parameters were selected from the Dredged Material Model Classification Criteria, along with a series of organochlorine pesticides. Table 1. contains a complete list of parameters analyzed from collected sediments from disposal cell 1.

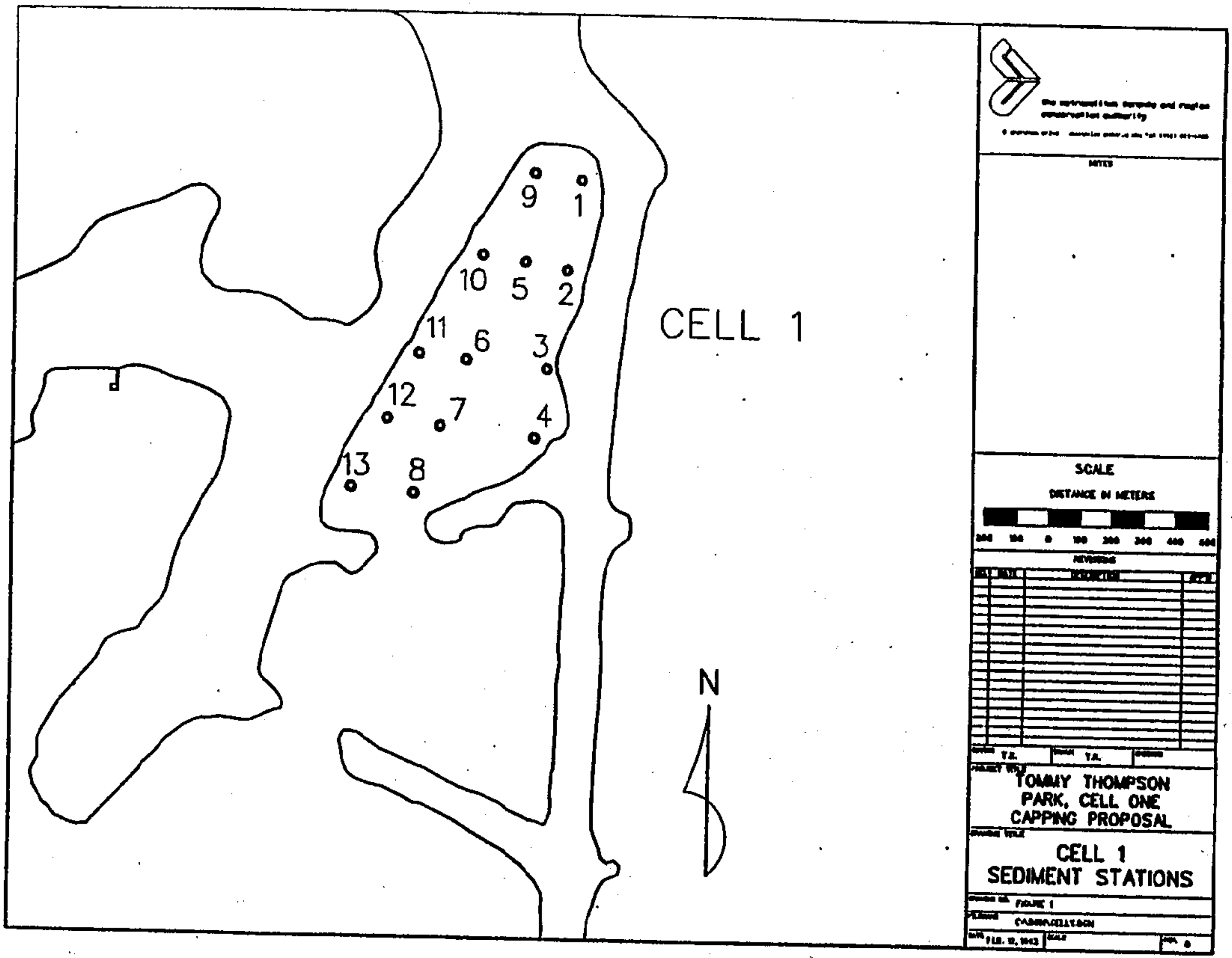

Figure 2. Cell 1 Sediment Stations

Table 1: Parameters Used to Evaluate Sediment Quality in Disposal Cell 1.

Total P	Antimony	Iron	TKN
Barium	Molybdenum	Oil and Grease	Beryllium
Nickel	Conductivity	Chromium	Selenium
SAR	Cobalt	Silver	Zinc
Loss on Ignition	Copper	Vanadium	PCB
Arsenic	Cadmium	Lead	Mercury
HCB	Aldrin	Heptachlor	p,p' DDE
beta BHC	Mirex	alpha	Chlordane
beta Chlordane	gamma BHC	gama Chlordane	p,p' DDD
alpha BHC	p,p' DDT	Dieldrin	Methoxychlor
Heptachlor Epoxide	alpha Endosulphan	Oxychlordane	beta Endosulphan
Endosulphan Sulphate	Endrin		

At present, the most stringent sediment-quality guidelines are those which are used for assessing materials proposed for open-water disposal. After the analyses of sediments from Cell 1, it was apparent that a number of parameters were present in very low concentrations or were below the existing detection limits. Table 2 contains a list of the parameters in this category:

Table 2: Parameters For Which Results Did Not Exceed The Open-Water Disposal Guidelines.

Total P	Chromium
TKN	Cobalt
Oil and Grease	Iron
Conductivity	Molybdenum
SAR	Selenium
Antimony	Silver
Barium	Vanadium
Beryllium	

Because the parameters listed in Table 2 meet the most-stringent existing guideline, they were omitted from further consideration in the evaluation of sediment quality in Cell 1. Table 3. presents a list of those organochlorine pesticides which were not detected in the sediments of Cell 1. These parameters were also omitted from further consideration.

Table 3: Organochlorine Pesticides Below Detection Limits in Cell 1 Sediments.

Parameter	Detection Limit (μg/g)
Heptachlor	0.001
Mirex	0.005
alpha-BHC	0.001
gamma-BHC	0.001
Oxychlordane	0.002
Methoxychlor	0.005
Heptachlor Epoxide	0.001
alpha-Endosulphan	0.002
Endrin	0.004
beta-Endosulphan	0.004
Endosulphan Sulphate	0.004

Table 4 presents a summary of the levels of selected metal and organic parameters. Summaries of organochlorine pesticide concentrations, and grain-size distributions in the Cell 1 sediments are given in Appendices A-1 and A-2.

Although certain sediment parameters at various sampling sites in Cell 1 do not meet Open Water Disposal criteria, most values met the sediment guidelines for confined disposal (Table 4). The exceptions were two samples for which cadmium levels and two for which mercury concentrations were elevated. All sediment metal and PCB concentrations meet the Decommissioning Guidelines for Parkland, Residential, and Agricultural soils.

There are presently no guidelines in Ontario for use in evaluating pesticide concentrations in sediments. Concentrations of detectable organochlorine pesticides are generally within the ranges found in sediments at other Toronto waterfront locations including Humber Bay, Ashbridge's Bay, and the mouth of Mimico Creek Appendix A-13. At these locations, the most-frequently detected organochlorine pesticides were DDE, Chlordane, and dieldrin.

The sediments in Cell 1 are dominated by silt, sand, and clay (Appendix A-2). The silt fraction contributed approximately 47% to 59% of the sediments, with sand ranging from 18 to 34%, and silt from 14 to 23 %. The sand fraction is mainly composed of fine sand to very-fine sand.

Table 4: Statistical Summary of Cell-1 Sediments (All values are given as ug/g unless otherwise specified)

	Station	Sample No.	As	Cd	Pb	Hg	Zn	Loss on Ignition (%)	PCB	Cu	Ni
Cell-1	1	1	3.0	0.7	110	0.15	110	2.4	0.11	30	15
	2	2	5.0	1.6	170	0.20	200	3.6	0.17	45	15
	3	3	5.4	1.8	160	0.20	210	4.3	0.14	55	20
	4	4,5*	16.9	3.4	250	0.60	255	5.6	0.32	70	25
	5	6	10.3	2.7	190	0.26	240	4.6	0.22	50	25
	6	7	9.5	2.9	150	0.22	220	5.0	0.23	70	25
	7	8	6.0	1.4	170	0.23	200	4.3	0.10	55	20
	8	9	8.5	1.3	180	0.19	220	6.2	0.15	60	25
	9	10	11.2	3.7	240	0.30	280	5.5	0.47	95	30
	10	11	8.1	1.7	200	0.25	230	4.2	0.11	55	20
	11	12	7.1	1.9	190	0.19	220	4.2	0.15	60	15
	12	13	9.9	1.7	220	0.34	250	4.4	0.19	60	20
	13	14,15*	7.1	1.6	165	0.81	225	4.6	0.29	53	20
Minimum			3.0	0.7	110	0.15	110	2.4	0.10	30	15
Maximum			16.9	3.7	250	0.81	280	6.2	0.47	95	30
Mean			8.3	2.0	184	0.30	220	4.5	0.20	58	21
Standard Deviation			3.4	0.8	36	0.18	38	0.9	0.10	15	4
Variance			11.2	0.7	1315	0.03	1481	0.8	0.01	211	20
Decommissioning Guideline For Parkland/Residential			25	4	500	1	800	-	-	200	200

* Duplicate Samples

A review of contaminant concentrations in sediments found at wetland sites in Lake Ontario and other Great Lakes was conducted for the purposes of comparing Cell 1 conditions with those at other wetlands and with various sediment-quality criteria. Table 5 presents a summary of the sediment concentrations for arsenic, cadmium, lead, mercury, zinc, and chromium.

With the exception of lead and cadmium, Cell 1 sediment parameters were generally found at concentrations within the ranges of those reported at other wetlands. All other Cell 1 parameters examined were within the ranges of those found at other sites.

Table 6 presents a summary of Cell 1 sediment concentrations of arsenic, cadmium, lead, mercury, zinc, and chromium compared with surface and background sediments in Lake Ontario and other Great Lakes. All Cell 1 parameters were found to be within the ranges of existing surface sediments elsewhere in the Lake Ontario and other Great Lakes. Certain arsenic and cadmium levels, and all lead concentrations from Cell 1 sediment metals were elevated in comparison to the ranges of background sediments at other Great Lakes locations.

3.2 Plants and Soil at other Great Lakes Locations

In the summer of 1989, composite soil samples were collected at the artificial island in Cell 1 (see Section 4.0) and at two nearby wetlands Second Marsh at Oshawa and the marshes at the mouth of the Rouge River. Specimens of cattails (*Typha latifolia)* were also collected at all three sites, and samples of other wetland flora were collected from Cell 1. These soils and plant materials were analyzed for PCBs and heavy metals and the results are presented in Table 7.

All Cell 1-island sediment parameters, with the exception of nickel, were found at concentrations within the range of values found at Rouge Beach Park and Oshawa Second Marsh. The levels of lead, chromium, zinc and mercury were significantly lower in the cattails than in the associated soils for all areas. The concentrations of lead, zinc and arsenic were higher in the *Myriophyllum spicatum* tissue from Cell 1 than island soil concentrations while concentrations of all parameters were well below soil levels in *P. cordata* tissues.

A comparison of vegetation contamination found slightly higher levels of zinc, chromium and nickel in cattails from Cell 1. PCB's, arsenic, mercury lead and cadmium levels were similar in cattails from all three areas. Analysis of other plant species from Cell 1 indicated increased concentrations of all metal parameters in *M. spicatum, Potamogeton richardsoni* and *Elodea canadensis.* The *M. Spicatum* tissues had the highest concentration of metal parameters of the six species tested. The variation in tissue levels of the various contaminants in the different species identifies the variability in contaminant uptake associated with various vegetation types. Variation also exists within species in terms of where specific contaminants may accumulate (ie leaf, stem or root tissues).

Table 5: Comparison of Study-Area Sediments With Those of Selected Marshes In The Great Lakes And With Existing Guidelines/Criteria

	Parameter Range (μg/g)					
Sample Location	As	Cd	Pb	Hg	Zn	Cr
Big Creek Marsh[1] (6)	0-112	-	36-86	0.08-0.93	88-383	42-119
Dover Marsh[1] (4)	2-15	-	20-78	0.10-0.13	0.10-118	9-21
Cootes Paradise[1] (5)	5-10	-	40-45	0.06-0.13	130-190	9-75
Balmoral[1] (1)	1	-	70	0.15	105	25
St Lukes[1] (2)	2	-	35-79	0.21-0.3	65-150	10-20
Second Marsh[2] (24)	-	0.7	44	-	198	-
(Non-Vegetated Sites)						
Rattray Marsh[2]	-	1.0	81	-	118	-
Disposal Cell 1	3-23.4	0.7-4.1	110-260	0.15-0.89	110-330	15-45
Disposal Cell 2	2.5-14.6	0.9-4.2	110-470	0.12-0.53	170-400	25-45
Open Water Disposal Guideline	8	1	50	0.3	100	25
Lakefill Quality Restricted	20	3	375	0.5	500	120
Decom. Guideline Parkland	25	4	500	1	800	1000
Decom. Guideline Industrial	50	8	1000	2	800	1000

( ) - Number of stations sampled
1 - Mudroch, 1981
2 - Glooschenko, 1982

Table 6: Comparison of Study-Area Sediments with Great Lakes Sediments and with Existing Guidelines/Criteria (All values expressed as ug/g unless otherwise stated).

Sample Location		As	Cd	Pb	Hg	Zn	Cr
Lake Ontario[1]	Surface	0.2-24.0	0.1-22.0	1.0-1600	0.01-7.76	5-3507	0.3-500
Background		NA	0.9-3.7	18-32	0.03-0.7	83-210	34-100
All Great Lakes[1]	Surface	0.2-54.0	0.05-22.0	0.3-1600	0.01-10.28	2.4-3507	0.1-1295
	Background	0.16-15	0.1-3.7	8-93	0.01-7.00	8-500	9-250
Disposal Cell 1		3-23.4	0.7-4.1	110-260	0.15-0.89	110-330	15-45
Open Water Disposal Guideline		8	1	50	0.3	100	25
Lakefill Quality Restricted		20	3	375	0.5	500	120
Decommissioning Guideline Parkland		25	4	500	800	1000	
Decommissioning Guideline Industrial		50	8	1000	2	800	1000

1 - Mudroch et al., 1988

Table 7: Analytical Results of Soils and Macrophytes Collected at Tommy Thompson Park, Rouge Beach Park, and Oshawa Second Marsh (All values expressed as ug/g unless otherwise stated)

Test Medium	Location	Cd	Pb	Zn	Cr	Ni	Hg	As	PCB
Soil	Disposal Cell 1	<0.5	37	74	28	21	0.08/0.08	<0.5	<0.5
Soil	Rouge Beach Park	<0.5/<1	32/32	101/97	30/31	18/18	0.10	<0.5/<1	<0.5
Soil	Oshawa Second Marsh	<0.5	51	115	26	15	0.08	<0.5	<0.5
T. latifolia	Disposal Cell 1	<0.1	6	32	3.2	2.2	<0.2	<0.5	<0.5
T. latifolia	Rouge Beach Park	0.1	5	22	2.0	1.6	<0.2	<0.5	<0.5
T. latifolia	Oshawa Second Marsh	<0.1	6	25	2.4	2.0	<0.2	<0.5	<0.5
E. canadensis	Disposal Cell 1	0.9	132	210	19.6	26	<0.2/<0.4	1.0/1	<0.5
P. richardsoni	Disposal Cell 1	0.6	51	140	9.2	11.7	<0.2	1.0	<0.5
M. spicatum	Disposal Cell 1	1.0/0.9	162/176	250/260	30/31	26/26	<0.2	3.5	<0.5
Juncus sp.	Disposal Cell 1	2.1	14	143	2.7	2.1	<0.2	<0.5	<0.5
P. cordata	Disposal Cell 1	0.1	6	46	1.6	2.4	<0.2	<0.5	<0.5

MTRCA unpublished data (Enviroclean 1990)

3.3 Existing Biota

3.3.1 Fish Community

The fish community of Cell 1 at Tommy Thompson Park was sampled with the use of a Smith Root SR20 electrofishing boat, on July 25 and September 25, 1989. A list of fish species found at the site is presented in Appendix A-3.

During the summer, the fish community was dominated in numbers by alewife and young-of-the-year pumpkinseed. The abundance of alewife in Cell 1 is thought to be the result the nocturnal near-shore orientation of this species during the summer. The presence and abundance of young-of-the-year pumpkinseed is considered evidence that this species is spawning in Cell 1. The confined nature of Cell 1 offers extensive shallow areas and thermal habitat which is typical of the spawning habitat of pumpkinseed. Cyprinids were also collected within Cell 1. Although not prolific in numbers, they constitute a valuable component of the available forage fish. The large adult northern pike which were collected at the site were probably attracted by the resident abundant forage population coupled with suitable shallow-water habitat. Because of the abundance and diversity of fish species found at Cell 1 during the summer, the fish community was ranked second in quality among the 15 locations sampled across the Toronto waterfront.

The fish community present during the fall sampling period exhibited an overall reduction in the number of species and individuals relative to those captured during the summer. Based on other studies and sampling programs, such seasonal fluctuations are not unexpected (MTRCA 1984, Dalziel 1988 ,MTRCA 1989). Although abundance and diversity were lower in the fall, the total collected biomass was higher due to the capture of two large chinook salmon. The two salmon were tagged and released, and were subsequently caught by anglers four weeks later in the Humber River. Gizzard shad composed a large percentage (70%) of the fish community in the autumn.

The species composition within Cell 1 reflects a well-balanced community of prey and predator species, particularly during the summer. This high-quality fish community is probably the result of the stable thermal habitat provided by the embayment of Cell 1 and the combination of suitable depth and substrate present at the site. The apparent decline in the fish community in the fall may reflect the reduced importance of thermal habitat late in the year, as well as other factors such as seasonal migration.

3.3.2 Benthic Invertebrates

Annual collections of benthic invertebrates have been ongoing in Cell 1 since 1987 as part of the Keating Channel Environmental Monitoring Program. Triplicate samples are collected in the fall of each year with the use of a ponar grab sampler from the Cell 1 station. A summary of the benthos collections is presented in Appendix A-4.

To date, 28 species of benthic invertebrates have been identified in Cell 1. The macro-benthic community appears unstable, with a high degree of variability evident in the densities and species compositions. This situation may reflect the fact that Cell 1 is a recently created ecosystem, and as a result biota have not yet fully colonized the site.

The community is composed of the most tolerant species of tubificids and larval midges, with tubificids generally the dominate invertebrate. The most common identifiable species included *Limnodrilus hoffmeistreri*, *L. claparedianus*, *L. cervix*, *Potamothrix moldaviensis*, *P. vejdovskyi*, and *Quistadrilus multisetosus.*

3.3.3 Avian Fauna

Annual monitoring of the avian communities at Tommy Thompson Park have been completed by members of the public as part of the Interim Management Program. In addition, MTRCA has completed various studies of the bird populations at the site, including the surveys conducted for the Environmentally Significant Area Study (MTRCA, 1982b) and the Aquatic Park Environmental Study (MTRCA, 1982a)

More than 260 bird species have been observed at Tommy Thompson Park (Appendix A-5), although most of these species are seasonal migrants or uncommon visitors. Tommy Thompson Park is considered a significant migratory stopover point and staging area. Approximately 29 species have been known to breed successfully at the site.

Cell 1 provides foraging habitat for numerous duck species, herons, gulls and some shore birds. The enclosure of Cell 1 provides a sheltered resting area for ducks and geese, but the shoreline habitat is not particularly suitable for shorebirds or breeding waterfowl. To date, Cell 1 has been used for breeding purposes by Canada Geese, Killdeer, Ring-Billed Gull, and Herring Gulls. Most nesting is concentrated on the points of land which separate the disposal cells or on the artificial nesting structures which have been placed at the site.

Tern nesting platforms were deployed at Tommy Thompson Park as part of the Interim Management Program to assess the feasibility of artificial nesting habitat. Nesting platforms were 5-metre square rafts decorated with sand and driftwood, and anchored within a protected areas, including Cell 1. During the 1990 breeding season, the tern raft supported 26 active nests containing a total of 81 eggs, 62 of which successfully hatched chicks. In total, 35 chicks were fledged.

3.3.4 Mammals

During various surveys and monitoring programs at Tommy Thompson Park, a total of 17 mammal species have been identified (Appendix A-6). Eleven species have been known to breed successfully at the site (MTRCA, 1982a; MTRCA, 1982b).

The most abundant mammals in Tommy Thompson Park are the small varieties which include members of the mice, shrew, and vole families. The absence of useful habitat is believed to be the major factor restricting the colonization of this area by larger animals.

3.2.5 Reptiles and Amphibians

A total of seven species of reptile and amphibian (Appendix A-7) have been found to date at Tommy Thompson Park (MTRCA, 1979; MTRCA, 1982). The only herptile observed in Cell 1 to date is the Eastern Garter Snake. The steep sides and stony substrate at this site provide ideal habitat for this species.

3.4 Laboratory Bioassays

At the request of MTRCA, the Ontario Ministry of the Environment conducted a series of laboratory bioassays with Cell 1 sediments and several test organisms including mayflies (*Hexagenia limbata*), midge larvae (*Chironomus tentans*), and fathead minnows (*Pimephales promelas*). The purpose of these bioassays was to assess the lethal and sublethal effects and bioaccumulation of Cell 1 sediments and contaminants on the test biota (Bedard and Petros, 1990).

Composite sediment samples from Cell 1 and Cell 2 were collected on November 23, 1989, with the use of a ponar, and laboratory bioassays were initiated between 29 November and 01 December, 1989. Details of the laboratory and analytical methods are described in the an MOE draft report (Bedard and Petro, 1990).

With the exception of aluminum, iron, and manganese, metal concentrations in Cell 1 sediments were generally higher than in the control sediments collected at Balsam Lake (Lat. 43°35'00" Long. 78°50'00"). Cell 1 metal concentrations were above the "lowest effect level" described in MOE's proposed Sediment Quality Guidelines, for the following parameters; copper, lead, zinc, cadmium and chromium.

Mortality was low for all test organisms for both the control and Cell 1 sediments. Growth of test chironomids and mayflies were not significantly different between control and test sediments. Metal concentrations in sediments and fathead minnows are presented in Appendix A-8.

3.5 In-Situ Biomonitoring

As part of the environmental monitoring associated with the Keating Channel Environmental Assessment approval, MTRCA has conducted biomonitoring studies at Tommy Thompson Park and other sites on the waterfront since 1988. One of the purposes of this program has been to monitor the effectiveness of dredgeate containment in Tommy Thompson Park. This data is expected to provide a benchmark of contaminant uptake at the site. The biomonitoring studies involved the placement of caged clams and the subsequent analyses of clam tissues following a six-week exposure period. Methods used during these studies have followed the procedures developed and used by MOE for similar monitoring projects.

Freshwater clams (*Eliptio complanata*) measuring 65mm to 70 mm in total length were collected from Balsam Lake. Collected clams were retained in buckets lined with food-grade plastic bags, and were deployed within 48 hours of collection. Biomonitoring stations have included disposal cells 1, 2, and 3 at Tommy Thompson Park, embayment "C", the Outer Harbour, and several additional sites along the Toronto waterfront.

Three cages of five clams each were deployed at each site. Fifteen clams from Balsam lake were immediately processed and preserved as a control set. In 1988 and 1989, the clams were deployed in July. After a six-week exposure, the clams were retrieved and the soft tissues removed and processed appropriately prior to analysis.

The results of the metal analyses are summarized in Appendix A-9. With the exception of lead in 1988 and copper in 1989, uptake of all other metals was lower in Cell 1 clams than at other sites in the vicinity of Tommy Thompson Park. In addition, metal levels in the Cell 1 clams were not appreciably different from those found in Balsam Lake clams in both years.

The results of PAH analyses are presented in Appendix A-10. Pyrene, flouranthene, and crysene were detected at all stations during both years, however there appears to be a significant decrease in the concentrations of these parameters in 1989. A total of 9 PAHs were detected in Cell 1 clams in 1988, and 3 were detected in 1989. This variability in parameter detections and concentrations between years may be due to several factors, including differences in water circulation, climatology, point-source influences, and normal experimental variability.

The results of PCB and pesticide analyses are summarized in Appendix A-11. As with the metal and PAH results, the pesticide data is variable from year to year. As a generality, however, clam uptake of pesticides appears higher in cells 1 and 2 than at other sites in the study area. Forms of chlordane and DDD were the only pesticides to be detected in Cells 1 and 2 during both years.

4.0 ADDITIONAL SUPPORTING STUDIES

4.1 Construction of Experimental Island

A small test island was constructed in the southwest corner of Cell 1 (Figure 3) for the purpose of evaluating the ability of typical wetland flora to survive on Cell 1 dredgeate, and as a preliminary test of methods for wetland contouring and plant cultivation. The island was constructed with the use of a derrick normally used during dredging operations in Toronto Harbour. Over a two-day period, the derrick used existing Cell 1 dredgeate to form a small test plot approximately 100 m^2 in size. During construction, efforts were made to contour the island to provide gradual slopes for wetland plant growth, and to accommodate the relatively large water-level fluctuations typical of Lake Ontario.

The test island was completed by late May, 1989, and was periodically inspected by MTRCA personnel during 1989 and 1990. Although the island substrate became more consolidated and dry following construction, no substantial changes in the shape or elevation were observed.

4.2 Experimental Planting

At the time of island design and construction, mature wetland-plant specimens were procured from a commercial supplier in Port Stanley, Ontario. Species selection was based on a desire to use common, native varieties which grow in a range of wetland conditions. Five species were selected, including: cattail (*Typha latifolia* and *Typha angustifolia*), soft rush (*Juncus effusis*), arrowhead (*Sagittaria latifolia*), pickerel weed (*Pontedaria cordata*), and marsh marigold (*Caltha palustris*).

A total of 125 specimens were manually planted on the test island during a one-day period in mid June. Three planting locations on the test island were selected to take advantage of a range of water depths, slope, and wave protection, and fencing was placed to exclude carp. The botanical colonization of the experimental island has been documented by site investigations conducted in the fall of 1989 and 1990 (Appendix A-13). Marsh marigold and arrowhead failed to survive due to transplant shock and poor habitat suitability. The other species survived well during the first growing season and also reproduced vegetatively. The test island also became populated with a wide variety of vascular plants including the bushy cinquefoil (*Potentilla paradoxa*), a provincially rare species.

Figure 3. Experimental Island in Cell 1

4.3 Literature Review

In September, 1989, Tarandus Associates Limited was contracted by the Metropolitan Toronto and Region Conservation Authority to complete a review of wetland literature. The main goal of this review was to summarize relevant technical information regarding the concept of utilizing wetlands as dredgeate caps.

A wide range of information sources were consulted during the literature review including, journals, consultant reports, government publications, and conference proceedings. Several government agencies and public-interest groups were contacted during the review, and a search of two electronic databases was also completed. More than 1,000 citations were provided by the electronic databases, and over 400 literature sources were reviewed during this survey. A copy of each wetland reference obtained during the project was delivered to MTRCA. Following is a summary of the relevant information compiled as a result of the review:

- Wetlands provide a wide range of essential ecological functions and important public benefits. For example, approximately one third of the species identified by the Committee on the Status of Endangered Wildlife in Canada as rare, endangered, or threatened, are found in wetland habitat. In addition, 12 of the 14 species regulated by the Ontario Endangered Species Act (RSO/1980 c. 138) require wetland environments during at least part of their life cycles. Wetlands can also provide several useful hydrologic and water-quality functions. The public benefits of wetlands include their role in various recreational activities and educational pursuits.

- Contaminant uptake by wetland biota is influenced by a wide range of factors. Among these are: the concentration of contaminants in the sediments and water; pH; the affinity of a particular species for a given contaminant; the characteristics, form, and availability of the contaminant; and the nature of the sediments at the site.

- In this review of more than 400 wetland articles, no example was found in which a cap or barrier of any sort was deployed as a restriction to dredgeate-contaminant mobility in wetland ecosystems. At several locations, wetlands have naturally become established or have been artificially cultivated directly on dredged materials, and no reported efforts have been made to cover or isolate the dredgeate before colonization by wetland species.

- In laboratory experiments, a 50-cm layer of clean sediment has been shown to be sufficient to prevent contaminant migration from the underlying dredged materials. This thickness is reportedly adequate even when the cap consists of relatively porous materials such as sand, and even when bio-turbating invertebrates penetrate the 50-cm clean cover (Brannon *et al.*, 1985).

- Many wetlands have been constructed in North America with the use of dredged material. The final elevation of the wetland has been noted as one of the most important factors in site design; and freshwater marshes have been found to be most productive at a depth range of 0.1 to 1 metres. During construction, marsh substrates can be placed with the use of mechanical or hydraulic techniques, although the hydraulic pipeline is apparently the most common method.

- In the selection and cultivation of wetland flora, several factors should be considered including: the project goal; water-level fluctuations; soil characteristics; wind and wave action; tolerance to contaminants; availability; and cost. The best results have usually to occurred at those sites where plant diversity is highest. Cultivation of wetland flora should generally be completed in the early to mid spring. Fertilization is rarely needed. Natural plant invasion can be a low-cost alternative to cultivation if an acceptable source of propagules is available.

- Water-level fluctuation is essential to the maintenance of healthy wetlands, particularly those in coastal locations. Water-level control can be achieved with the use of several methods such as dykes, weirs, control gates, and pumps. A preferred alternative, however, may be to use a community/multi-species approach in which the wetland is dyked but is allowed to fluctuate with lake water levels. With such a system, the water-control structure would only be closed when essential to regulate the wetland water level.

- Purple loosestrife and carp are two undesirable species commonly found in the coastal marshes of Lake Ontario. Assuming no barrier would be constructed between a Cell 1 wetland and Lake Ontario, there is presently no practical method to exclude carp. Although several experimental methods are being evaluated, manual removal is currently the only technique which presently appears feasible for the control of purple loosestrife.

5.0 CONSULTATION

Since the beginning of the project, MTRCA recognized the need to involve other agencies in the process of evaluating the capping alternatives, and representatives from relevant organizations were invited to participate in an Technical Advisory Committee. Membership in this committee has included the Ministry of the Environment, the Ministry of Natural Resources, The Department of Fisheries and Oceans, Environment Canada, Metro Toronto, Public Works Canada, and the Federation of Ontario Naturalists. The Technical Advisory Committee was intended to provide a vehicle through which the interests and expertise of each organization could be expressed and through which direction and guidance be offered to the MTRCA.

The Technical Advisory Committee has met on three occasions since April, 1989. A smaller group of members of the Technical Advisory Committee has met for the purpose of addressing specific scientific questions about the capping proposal. In addition, there have been numerous informal meetings with selected non-government organizations.

As part of the public review of the Tommy Thompson Park Master Plan, MTRCA organized the Natural Area Advisory Committee, the purpose of which was to provide a vehicle for input from relevant public-interest groups. This committee was re-convened in January, 1991, at which time MTRCA presented the details of the preferred option for capping Cell 1. The preferred capping option was also presented to the Technical Advisory Committee. The MTRCA we will be contacting members of the advisory groups and interested organizations to set up a series of design workshops. The objectives of these workshops will be directed towards developing specific habitat design and components within Cell One. Through these workshops we hope to further address botanical, fisheries, wildlife, environmental, and other wetland management concerns. It is expected that the Technical Advisory Committee and the Natural Area Advisory Committee will be involved on an on-going basis, with the capping considerations at Cell 1. Members of the Technical Advisory Committee and Natural Area Advisory Committee are listed in Appendix A-14.

6.0 CAPPING OPTIONS

A total of three capping options have been evaluated by MTRCA: 1) a dry clean-fill cap; 2) a wetland cap established directly on the dredgeate; and 3) the placement of a clean-fill cap over the dredgeate, followed by the creation of a wetland ecosystem on the clean fill. Although Option 3 is the preferred alternative, a summary of each option is presented below, including details regarding construction techniques, costs, and timing. The advantages and disadvantages of each capping option are also summarized.

6.1 Dry Cap

The dry-cap option involves filling Cell 1 to an elevation of 77.0 meters. This elevation is approximately 2.5 metres higher than the existing mean lake elevation and would establish a dry upland type of environment. The resulting terrestrial characteristics would be similar to those presently existing at Tommy Thompson Park. The total volume of fill-material required is estimated at 365,900 m^3 or 45,737 truckloads. Two construction alternatives are possible at the site and are outlined below.

6.1.1 Alternative 1

Alternative 1, illustrated in Figure 4 below, consists of a dry cap constructed with the use of imported fill.

For this alternative, fill meeting open-water disposal quality guidelines will be end-dumped by truck and the final grading will be completed with the use of a bulldozer.

Construction can begin immediately after project approval, however the length of the construction period will depend on the availability of suitable fill. A summary of timing and cost estimates based on three fill-scenarios are presented below in Table 8. It is expected that an average of 120 truckloads of fill would be available per day, giving a total construction cost of $570,000.

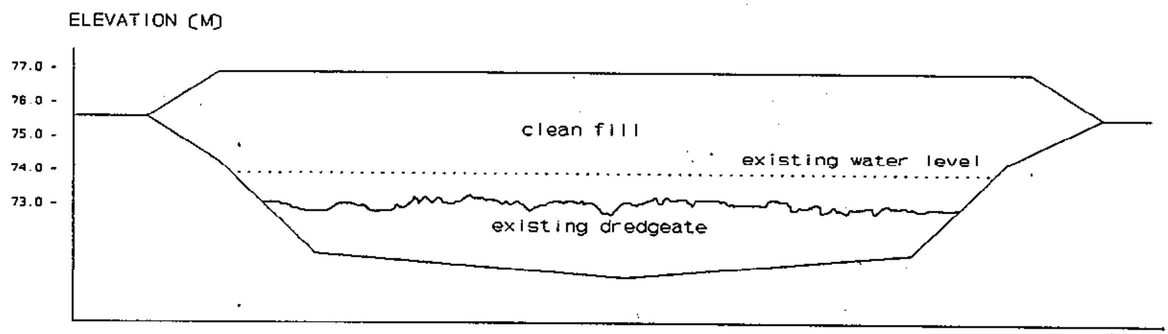

Figure 4. Dry-Cap Option, Alternative 1 Using Imported Fill (not to scale).

Table 8: Summary of Timing and Cost Estimates for the Dry-Cap Alternative 1 option Based on Three Scenarios.

Assumption (truckloads/day)	Time	Cost
60	720 days (2.93 yrs)	$1,080,000
120	381 days (1.46 yrs)	$570,000
200	228 days (10.5 mos)	$343,000

6.1.2 Alternative 2

Alternative 2, illustrated in Figure 5, proposes that the cap be constructed using dredgeate from Cell 2, covered by a minimum 1-metre layer of clean fill.

For this alternative, existing material from Cell 2 would be hydraulically dredged into Cell 1 to an elevation of 76.0 meters. The final elevation of 77.0 meters will be achieved using clean fill which would be graded to the elevation of surrounding features. The 1-metre cap will ensure that an appropriate thickness would be retained after dredgeate consolidation. The estimated volumes of Cell-2 sediment and clean fill is 291,000 m^3 and 73,570 m^3 (9,200 truckloads), respectively.

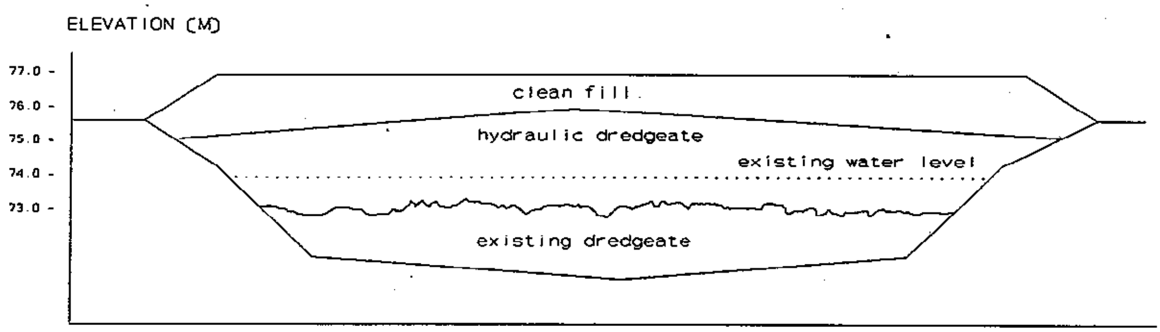

Figure 5. Dry-Cap Option, Alternative 2 Using Cell 2 Dredgeate and a one Meter Clean-Fill Cap (not to scale).

Construction can begin immediately after project approval. It is estimated that the hydraulic dredging can be completed in approximately 4.8 months based on a dredging rate of 3000 m^3 of material per day. The total cost for the dredging operation is estimated at $1,600,000.

The length of the construction period for the clean cap would depend on the availability of suitable fill. Timing and cost estimates for the one-meter cap based on three fill-scenarios are presented in Table 9. It is expected that an average of 120 truckloads of fill would be available per day, giving a total construction cost, including hydraulic dredging, of $1,714,000.

Table 9: Timing and Cost Estimates for Alternative 2, Based on Three Scenarios

Assumption (truckloads/day)	Time	Cost
60	153 days (7.6 mos.)	$229,000
120	76 days (3.8 mos.)	$114,000
200	46 days (2.3 mos)	$66,000

The hydraulic dredging, although costly ($5.5/m³), would provide additional CDF space in cell 2. One disadvantage of hydraulic dredging, however, is the anticipated production of turbid effluent, particularly when dredgeate is placed above existing water levels. An outflow structure would be necessary to contain and control dredgeate effluent.

The end-dumping and grading techniques proposed for alternative 1 are simple and have been used very successfully at other waterfront development projects. The end-dumping required to construct the clean cap for alternative 2 may be difficult due to the unconsolidated nature of the recently dredged material from Cell 2. A six-month period would be required to allow for dredgeate consolidation before final capping activities could begin.

The dry-cap option would ensure that the dredgeate is well contained and that the mobility of contaminants is restricted. This technique could also provide a potential area for inland disposal of fill which meets the quality guidelines for Restricted Land Use.
One of the major disadvantages of a dry cap is that it involves the permanent loss of aquatic habitat in Cell 1. Cell 1 is known to support a diverse fish community, and the loss of fish habitat would be in violation of the Department of Fisheries and Ocean's (DFO) No-Net-Loss Policy (Federal Fisheries Act).

6.2 Wetland Cap Directly on Dredgeate

This option would involve the hydraulic dredging of existing dredgeate sediments from Cell 2 into Cell 1 to an elevation which would support a wetland ecosystem. The imported sediments would be graded and shaped to the desired contours with the use of bucket dredging and side casting. It is estimated that 203,754 m³ of dredgeate would be required, of which approximately 160,926 m³ would be handled by the bucket dredge.

Construction could begin immediately after project approval. It is estimated that the hydraulic dredging could be completed in approximately 67 days, based on an anticipated dredging rate of 3,000 m³ of material per day. The total cost for the hydraulic-dredging operation is estimated at $1,120,000.

Shaping and contouring of the material to the final configuration would be completed following the consolidation of the hydraulically dredged material. The final grading by bucket dredging and side casting would be completed in about 210 days, based on an expected daily dredging rate of 764 m³. The total construction cost for final grading procedures is estimated at $1,100,000.

The total construction cost of $2,200,000 for this option is extremely high due to the high proportion of equipment costs.

This alternative provides numerous advantages, including the creation of fish and wildlife habitat. The wetland construction would also provide an opportunity for restoration of lost coastal wetlands which could provide various opportunities for education, interpretation, and recreation. This option is also expected to meet the requirements of the Department of

Fisheries and Oceans no-net-loss policy. The hydraulic dredging of Cell 2 would also provide more confined-disposal storage space.

One of the major disadvantages of this option is the high cost. Another potential disadvantage is that this option may not meet the intent of the Environmental Assessment condition regarding contaminant mobility and cell capping. The hydraulic dredging would also require effluent control measures, and it may be a technical challenge to manipulate the dredgeate to the desired contours.

6.3 Clean-Fill/Wetland Cap - The Preferred Option

This capping option is the preferred alternative. It involves the phased placement of a clean-fill layer on top of the existing dredgeate and the subsequent development of a wetland ecosystem as an integral part of the clean-fill cap. This concept is illustrated in Figure 6.

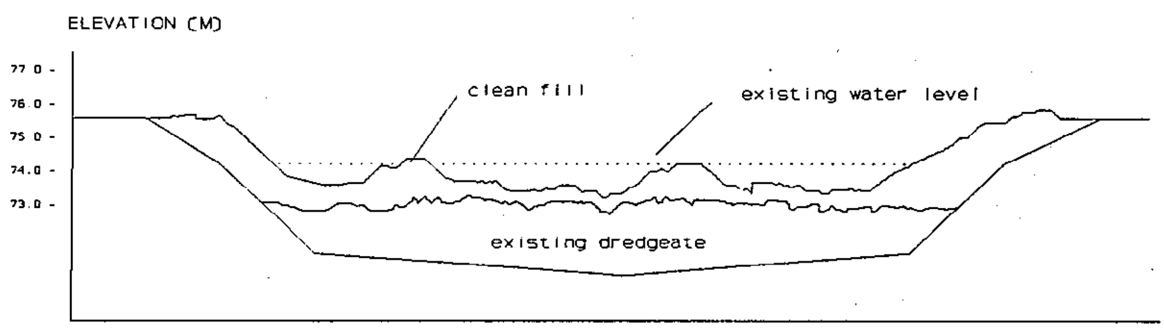

Figure 6. Clean Fill/Wetland Cap (not to scale).

The estimated volumes of clean fill required and the associated dewatering volumes are presented in Table 10. The construction will be completed in three phases to minimize the cost of dewatering and to improve control over the construction procedures. The Phased construction will also help to minimize the duration of environmental disturbance at the site.

Table 10: Estimated Fill and Dewatering Volumes for the Three Phases of Construction.

Phase	Volume of Clean Fill	Total Truckloads	Volume of Dewatering	Surface Area (ha)**
I	48,023 m^3	6,002	35,033 m^3	2.42
II	70,198 m^3	8,774	57,926 m^3	2.50
III	85,533 m^3	10,691	67,967 m^3	3.14
Total	203,754 m^3	25,467	160,926 m^3	8.06

The construction will commence in the following sequence for each phase. The perimeter of each phase will be filled to control water seepage during the dewatering process. Peninsulas will then be built into the cell during perimeter construction to allow access of construction equipment. The first phase and subsequent phases will be dyked off from the remainder of the cell by the extension of the peninsula. The perimeter filling and dyking should displace a large percentage of the water and account for a reduction in the amount of dewatering required. Before dewatering commences, any fish left in the remaining standing water will be removed. Dewatering will take place using portable high capacity pumps. Following dewatering during each phase, a minimum of 0.5 meter of clean fill will be placed over the exposed existing dredgeate. Depending on the nature of the exposed dredgeate, clean fill may be pushed directly over firm dredgeate or, if required, rubble roads and/or geotechnical material may be placed over softer dredgeate. As an alternative, clean fill may be back-filled to conditions outlined in the Dry Cap Option (alternative 1). As the filling advances conventional construction excavation, grading, and relocation techniques would be utilized to develop the proper cap depth and contour design.

The clean fill will be manipulated into contours compatible with the establishment of a healthy wetland, and elements of fish and wildlife habitat will be incorporated where appropriate. Soil conditioning may be required to ensure the viability of the soil and sediments. This conditioning may be in the form of manipulation or augmentation of the soil using compost or other suitable materials. A concept plan for the final configuration of the prefrerred Cell 1 capping option is displayed in Figure 7. The final configuration will have a water/land ratio of 50:50 at the mean water level. The water/land ratio may range from a maximum of 65:35 during high water conditions to a low of 35/65 during low water conditions. The low water ratio will be maintained by a water regulation structure during periods of low water conditions. This ratio allows for a maximum of 30% of the area be intermittently flooded on a seasonal basis.

Construction depends on the availability of suitable fill. Timing estimates for each of the three construction phases based on three fill-scenarios are presented in Table 11.

The estimated cost for dewatering the 160,000 M^3 of water is $100,000. The costs associated with dyke excavation and final contouring are estimated at $75,000. Total fill costs will depend upon the number of truckloads of material available per day. Based on construction times ranging from 1.7 years to 5.7 months, the fill costs are expected to total between $612,000 and $171,000, respectively. It is expected that an average of 120 truckloads of fill will be available each day. This estimate results in an anticipated total construction cost, including dewatering, dyke construction, and final contouring, of $493,000.

Although this option will result in the loss of some existing aquatic habitat and will cause temporary disturbances during construction, the advantages appear to significantly outweigh the disadvantages. The clean-fill/wetland capping option will meet the intent of the Environmental Assessment condition regarding the restriction of contaminant mobility, and it is expected that the project can be completed within the required time limit. It is also highly cost efficient, and makes use of technically sound construction methods. This option also provides opportunities to increase habitat quality and diversity at the site, and will help to compensate for the historical loss of coastal wetlands. The wetland creation aspect of this capping option will be the subject of a series of design workshops. The objectives of these workshops will be directed towards developing specific habitat design and components within Cell One. Through these workshops we hope to further address botanical, fisheries, wildlife, environmental, and other wetland management concerns.

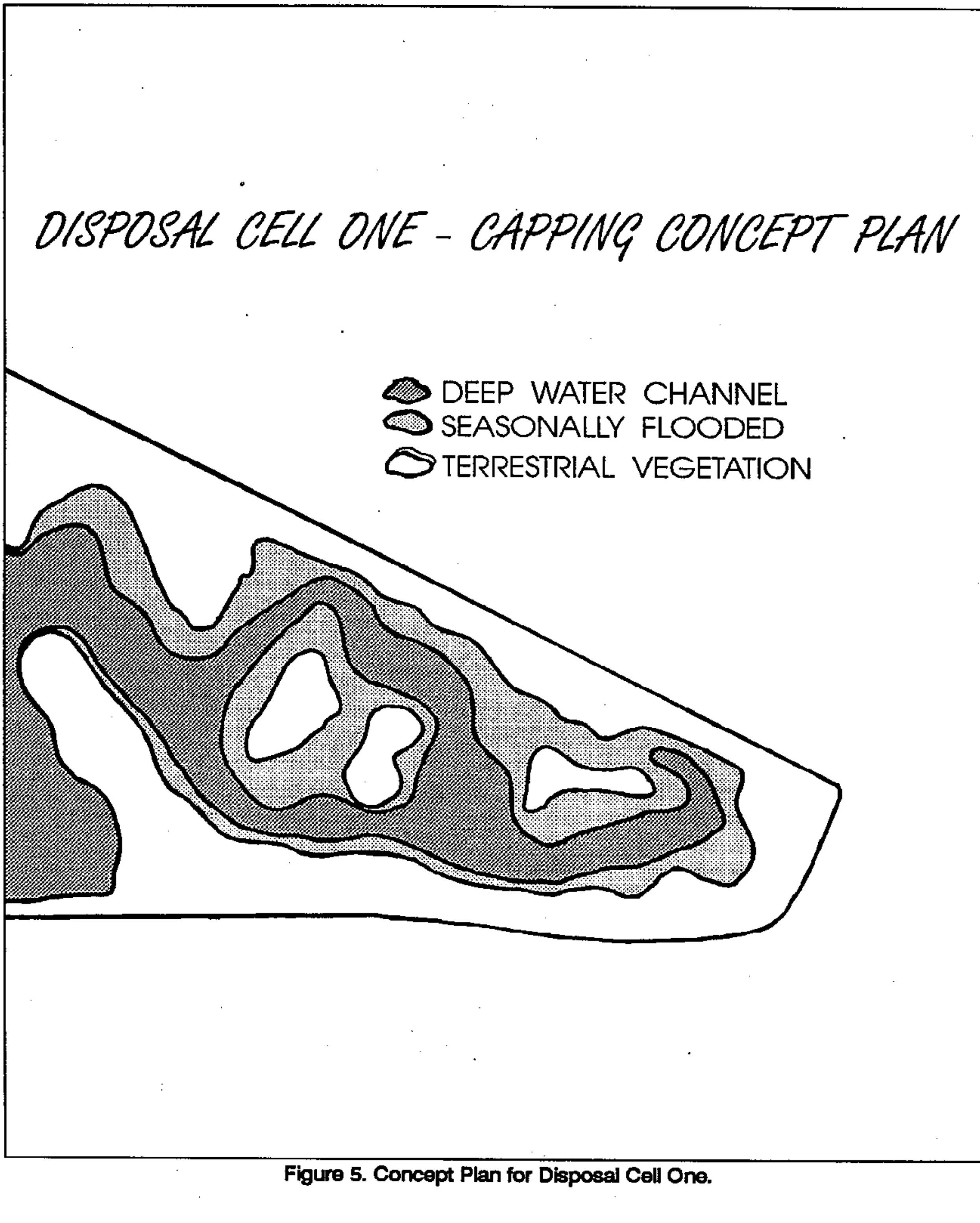

Figure 5. Concept Plan for Disposal Cell One.

Table 11: Summary of the 3 Construction Phases, Based on 3 Fill-Availability Scenarios.

Phase	Truckloads/day	Time
I	60	100 days (5.0 mos.)
	120	50 days (2.5 mos.)
	220	27 days (1.4 mos.)
II	60	146 days (7.3 mos.)
	120	73 days (3.6 mos.)
	220	39 days (1.9 mos.)
III	60	178 days (8.9 mos.)
	120	89 days (4.4 mos.)
	220	39 days (2.4 mos.)
TOTAL	60	454 days (1.7 yrs.)
	120	212 days (10.6 mos.)
	220	115 days (5.7 mos.)

One of the most important benefits of this option is that it will meet the requirements of the Department of Fisheries and Ocean's "no-net-loss" policy by providing the opportunity to compensating for lost fish habitat. In addition, it appears compatible with the objectives of various agencies such as the Ministry of Natural Resources, MTRCA, and the federal Department of Fisheries and Oceans.

7.0 SUMMARY

Based on the existing nature of the site, the Environmental Assessment requirement, and MTRCA's evaluation of the three capping alternatives, the preferred capping option is the Clean-Fill/Wetland cap. A summary of all the proposed capping options, including the advantages and disadvantages of each, are presented in Table 12.

The preferred option appears to meet the requirements of the Environmental Assessment condition by effectively restricting the potential for the release of dredgeate contaminants to the environment. In addition, it allows for the creation of fish, wildlife, and wetland habitat offsetting any construction disturbances. The Clean-Fill/Wetland capping option also has the lowest construction costs. The MTRCA hopes to continue the three party agreement between the Authority, The Toronto Harbour Commissioners , and the Department of Transport for the capital costs of this proposal. Tentative funding of $34,000 has been approved under the provincial Clean Sweep Lottery pending project approval. This funding requires matching capital and is to be utilized for the creation of the wetland component of the preferred option.

Table 12: Summary of Capping Options

Option	Fill Vol. (m^3)	Time	Total Cost	Advantages	Disadvantages
Dry Cap (Alt. #1)	365,900	381 days	$570,000	- end-dumping and grading easy construction technique - ensures containment of contaminants - provides potential area for disposal of fill of restricted land use quality	- destroys aquatic community in Cell 1 - loss of fish habitat - violates DFO's No-Net Loss policy
Dry Cap (Alt. #2)	291,000 (Dredgeate) 73,570 (Clean-Fill)	8.65 months.	$1,714,000	- ensures containment of contaminants - provides potential area for disposal of fill of restricted land use quality	- destroys aquatic community in Cell 1 - loss of fish habitat - violates DFO's No-Net Loss policy - hydraulic dredging costly - hydraulic dredging creates an effluent - end-dumping may be difficult due to unconsolidated nature of dredgeate - 6 mo. period required for the consolidation of dredgeate

Table 12 (Continued): **Summary of Capping Options**

Option	Fill Vol. (m^3)	Time	Total Cost	Advantages	Disadvantages
Wetland on Cell-2 Dredgeate	203,754	277 days	$2,220,000	- creation of fish, wildlife, and wetland habitat - increases habitat diversity - meets DFO's No-Net Loss policy - restoration of lost coastal wetlands - social advantages for education, interpretation, and recreation - creates more CDF storage space	- loss of some aquatic habitat - temporary disruption to aquatic habitat during construction - high cost - construction techniques difficult - may not meet Environmental Assessment condition for contaminant mobility - hydraulic dredging creates an effluent - extensive monitoring due to rehandling of Cell-2 sediments - pilot project

Table 12 (Continued): **Summary of Capping Options**

Option	Fill Vol. (m^3)	Time	Total Cost	Advantages	Disadvantages
Wetland/ Clean-Fill	203,754	10.6 months.	$493,000	- meets the Environmental Assessment condition - ensures containment of contaminants - creation of fish, wildlife, and wetland habitat - increases habitat diversity - meets DFO's No-Net Loss policy - restoration of lost coastal wetlands - social advantages for education, interpretation, and recreation - cost efficient - easily constructed - timing fits Environmental Assessment condition - appears to support several objectives of MNR, MTRCA, and DFO - has public support	- loss of some aquatic habitat - temporary disruption to aquatic habitat during construction - pilot project

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Appendix
Supplementary Data

The Appendices contain various data intended to supplement the text of the capping proposal. Following is a summary of the contents of this material:

Appendix

Appendix A-1: Statistical Summary of Organochlorine Pesticides in Cell-1 Sediments (All values are given as ug/g dry weight unless otherwise specified)

Station Number	Sample Number	HCB	Aldrin	p,p' DDE	Beta BHC	alpha Chlordane	gamma Chlordane	p,p' DDD	p,p' DDT	Dieldrin
1	1	ND	ND	0.0035	ND	0.012	0.0105	0.0025	ND	ND
2	2	ND	ND	0.006	ND	0.017	0.015	ND	ND	0.003
3	3	0.002	0.002	0.008	0.002	0.031	0.033	0.012	ND	0.097
4	4,5**	ND	ND	0.013	0.0025	0.012	0.013	0.0105	0.0065	0.009
5	6	ND	ND	0.007	0.002	0.015	0.015	0.061	ND	0.004
6	7	0.002	ND	0.009	0.003	0.009	0.009	ND	ND	0.008
7	8	ND	ND	0.005	ND	0.009	0.008	0.003	ND	0.003
8	9	0.002	ND	0.006	ND	0.015	0.014	0.008	ND	0.006
9	10	ND	ND	0.025	ND	0.008	0.008	0.016	0.009	0.017
10	11	ND	ND	0.005	ND	0.012	0.012	ND	0.005	0.004
11	12	0.002	ND	0.009	ND	0.015	0.015	ND	ND	0.006
12	13	ND	ND	0.010	ND	0.014	0.015	0.005	ND	0.005
3	14,15**	0.0025	ND	0.012	ND	0.0185	0.017	0.0115	0.0085	0.0125
	Minimum	ND	ND	0.005	ND	0.009	0.008	ND	ND	ND
	Maximum	0.0025	0.002	0.025	0.003	0.031	0.033	0.061	0.009	0.097
	Mean	-	-	0.0091	-	0.0133	0.0142	-	-	-

** duplicate samples -results reported are average values

Appendix A-2: Grain Size Analysis of Cell-1 Sediments.

	Station	Percent Gravel	Percent Sand	Percent Silt	Percent Clay	Very Coarse Sand	Coarse Sand	Medium Sand	Fine Sand	Very Fine Sand
Cell-1	1	<0.1	30.8	54.6	14.6	<0.10	0.20	1.10	17.7	11.80
	2	<0.1	25.0	59.5	15.5	0.10	0.30	1.40	14.3	8.90
	3	0.2	31.0	51.2	17.6	0.20	0.70	3.90	19.9	6.30
	4*	<0.1	18.4	59.7	21.9	0.15	0.50	2.15	11.7	3.90
	5	0.3	23.7	54.5	21.5	0.30	0.50	1.80	15.6	5.50
	6	0.4	28.3	55.5	15.8	0.70	0.80	3.10	18.5	5.20
	7	<0.1	30.7	54.2	15.1	0.10	0.20	1.30	15.7	13.40
	8	<0.1	22.8	54.1	23.1	0.10	0.30	1.10	11.6	9.70
	9	0.3	20.0	59.3	20.4	0.20	0.40	1.10	12.4	5.90
	10	0.5	31.5	46.9	21.1	0.50	0.40	2.20	19.0	9.40
	11	<0.1	30.8	54.6	14.6	<0.10	0.20	1.10	17.7	11.80
	12	<0.1	25.0	59.5	15.5	0.10	0.30	1.40	14.3	8.90
	13*	0.1	34.6	49.8	15.8	0.25	1.05	4.85	19.7	8.45

* Values at these stations are means of two sample results.

Appendix A-3: Fish Species Found in Cell 1 During the 1989 Electrofishing Survey

SPECIES	SCIENTIFIC NAME
alewife	*Alosa Pseudoharengus*
gizzard shad	*Dorosoma cepedianum*
chinook salmon	*Oncorhynchus tshawyscha*
northern pike	*Esox lucius*
white sucker	*Catostomus commersoni*
common carp	*Cyprinus carpio*
golden shiner	*Notemigonus crysoleucas*
emerald shiner	*Notropis atherinoides*
spottail shiner	*Notropis hudsonius*
bluntnose minnow	*Promelas notatus*
creek chub	*Semotilus atromaculatus*
white perch	*Morone americana*
white bass	*Morone chrysops*
rock bass	*Ambloplites rupestris*
pumpkinseed	*Lepomis gibbous*
bluegill	*Lepomis macrochirus*
largemouth bass	*Micropterus salmoides*
yellow perch	*Perca flavescens*

Appendix A-4: Summary of Benthos Results From Cell 1, 1987 to 1989

ORDER	FAMILY	GENUS/SPECIES	1987	1988	1989
Platyhelminthes	Turbellariacae	*Turbellaria sp.*		6	
Oligochaeta	Naididae	*Nais variabilis*		16	
	Tubificidae	*Limnodrilus sp.*	6		
		L. cervix	12	11	
		L. hoffmeisteri	5	71	1
		L. udekemianus		8	
		L. claparedianus	1	27	
		L. profundicola	4		
		Potamothrix vejdovskyi	49		
		P. moldaviensis		26	
		Quistadrilus multisetosus	1	155	1
		Peloscolex sp.	11		
		P. ferox	2		
		Tubifex		49	
		immature with hair setae	49	39	
		immature without hair setae	167	237	3
Amphipoda	Gammaridae	*Gammarus sp.*	1		
		G. faciatus	3		
		G. pseudolimnaeus	3		
Arachnida		*Acarina sp.*		2	
Diptera	Chironomidae	*Chironomus sp.*	29	20	62
		Cryptochironomus sp.	34	2	1
		Polypedium sp.			1
		Procladius sp.	2	2	3
		unidentified sp.	10		
Mollusca	Sphaeriidae	*Pisidium sp.*		33	
		Sphaerium sp.		6	
	Valvatidae	*Valvata sincera*		2	
		Total Number	360	721	76
		Number of Species	19	19	9
		Number per M^2	7200	14420	1520

Appendix A-5: Birds Observed At Tommy Thompson Park

Birds Observed in Cell 1

- Double-crested Cormorant	*Phalacrocorax auritus*
- Great Blue Heron	*Ardea herodias*
- Green Heron	*Butorides striatus*
- Black-crowned Night Heron *	*Nycticorax nycticorax*
- Mute Swan *	*Cygnus olor*
- Canada Goose *	*Branta canadensis*
- American Black Duck *	*Anas rubripes*
- Mallard *	*Anas platyrhynchos*
- Northern Shoveler	*Anas clypeata*
- Gadwall *	*Anas strepera*
- Canvasback	*Aythya valisineria*
- Redhead	*Aythya americana*
- Ring-necked Duck	*Aythya collaris*
- Greater Scaup	*Aythya marila*
- Lesser Scaup	*Aythya affinis*
- Oldsquaw	*langula hyemalis*
- Common Goldeneye	*Bucephala clangula*
- Bufflehead	*Bucephala albeola*
- Hooded Merganser	*Lophodytes cucullatus*
- Common Merganser	*Mergus merganser*
- Killdeer	Charadrius vociferus
- Spotted Sandpiper *	*Actitis macularia*
- Ruddy Turnstone	*Arenaria interpres*
- Ring-billed Gull *	*Larus delawarensis*
- Herring Gull *	*Larus argentatus*
- Caspian Tern	*Sterna caspia*
- Common Tern *	*Sterna hirundo*
- Belted Kingfisher	*Ceryle alcyon*
- Great Crested Flycatcher	*Myiarchus crinitus*
- Red-winged Blackbird *	*Agelaius phoeniceus*

* species breed at TTP

Appendix A-6: Mammals Found at Tommy Thompson Park

- Eastern Cottontail	*Sylvilagus floridanus*
- European Hare	*Lepus europaeus*
- Deer Mouse	*Peromyscus maniculatus*
- White-footed Mouse	*Peromyscus leucopus*
- House Mouse	*Mus musculus*
- Star-nosed Mole	*Condylura cristata*
- Meadow Vole	*Microtus pennsylvanicus*
- Norway Rat	*Rattus norvegicus*
- Muskrat	*Ondatra zibethicus*
- Groundhog	*Marmota monax*
- Eastern Grey Squirrel	*Sciurus carolinensis*
- Red Fox	*Vulpes vulpes*
- Raccoon	*Procyon lotor*
- Striped Skunk	*Mephitis mephitis*
- Beaver	*Castor canadensis*
- Domestic Dog	*Canis familiaris*
- Domestic Cat	*Felis familiaris*

Appendix A-7: Reptiles and Amphibians Observed at Tommy Thompson Park

- Eastern Garter Snake	*Thamnophis sirtalis sirtalis*
- Northern Brown Snake	*Storeria dekayi dekayi*
- Eastern Milk Snake	*Lampropeltis triangulum triangulum*
- Midland Painted Turtle	*Chrysemys picta marginata*
- Snapping Turtle	*Chelydra serpentina*
- Blanding's Turtle	*Emydoidea blandingi*
- American Toad	*Bufo americanus americanus*
- Northern Leopard Frog	*Rana pipiens*

Appendix A-8: Metal Levels in Sediments and Fathead Minnows (Bedard and Petros, 1990)

Parameter	Medium	Control (ug/g)	Cell 1 (ug/g)
Copper	Sediment	12	42
	Minnows	0.4	1.31
Nickel	Sediment	17	17
	Minnows	0.55	0.66
Lead	Sediment	19	110
	Minnows	0.28	2.79
Zinc	Sediment	65	170
	Minnows	36.6	35.6
Aluminum	Sediment	11000	95000
	Minnows	62	63.3
Arsenic	Sediment	2.2	2.6
	Minnows	0.10	0.13
Cadmium	Sediment	0.5	1.3
	Minnows	0.02	0.04
Chromium	Sediment	25	33
	Minnows	0.77	0.97
Mercury	Sediment	0.03	0.14
	Minnows	0.04	0.04
Iron	Sediment	22000	17000
	Minnows	135	139
Manganese	Sediment	500	330
	Minnows	6.2	3.1

Appendix A-9: Results of The Clam-Tissue Metal Analyses for 1988 and 1989 at Selected Stations

Metals (mg/Kg)	BALSAM LAKE CONTROL	T.T.P. DISPOSAL CELL 1	T.T.P. DISPOSAL CELL 2	T.T.P. DISPOSAL CELL 3	T.T.P. EMBAYMENT "C"	OUTER HARBOUR
1988						
Cadmium	0.55	0.041	0.62	0.61	0.60	0.67
Copper	2.4	2.4	2.5	2.6	2.5	2.9
Lead	0.35	2.0	2.8	3.3	1.5	1.2
Mercury	0.014	0.012	0.023	0.014	0.018	0.022
Zinc	24	25	27	27	29	31
1989						
Cadmium	0.51	0.33(0.37)0.47	0.40(0.47)0.55	0.52	0.53	0.51
Copper	0.18	0.27(0.26)0.34	0.24(0.30)0.34	0.18	0.22	0.25
Lead	0.00	ND-0.5	ND	ND	ND	ND
Mercury	0.56	0.44(0.50)0.62	0.49(54.0)0.65	0.65	0.58	0.48
Zinc	23	23(25)27	25(25.5)26	22	26	23
Arsenic	0.00	ND-0.07	ND	0.08	0.05	ND

Appendix A-10: Results of PAH Analyses of Clams Deployed in the study area

PAH (µg/g)	BALSAM LAKE CONTROL	T.T.P. DISPOSAL CELL 1	T.T.P. DISPOSAL CELL 2	T.T.P. DISPOSAL CELL 3	T.T.P. EMBAYMENT "C"	OUTER HARBOUR
1988						
Pyrene	ND	0.54	0.48	0.15	0..07	0.10
Flouranthene	ND	0.33	0.36	0.10	0.06	0.09
Benz[a]anthracene	ND	0.08	0.10	0.03	ND	0.02
Crysene	ND	0.45	0.46	0.11	0.06	0.09
Benzo[b]fluoranthene	ND	0.21	0.15	ND	ND	ND
Benzo[k]fluoranthene	ND	0.09	0.08	ND	ND	ND
Benzo[a]pyrene	ND	0.09	ND	ND	ND	ND
Indeno[123cd]pyrene	ND	0.04	ND	ND	ND	ND
Benzo[ghi]perylene	ND	0.10	0.05	ND	ND	ND
1989						
Pyrene	ND	0.03(0.035)0.04	0.04(0.07)0.15	0.15	0..07	0.10
Flouranthene	ND	0.02(0.025)0.03	0.03(0.05)0.08	0.10	0.06	0.09
Benz[a]anthracene	ND	ND	ND-0.03	0.03	ND	0.02
Crysene	ND	0.02(0.23)0.03	0.03(0.065)0.10	0.11	0.06	0.09
Benzo[b]fluoranthene	ND	ND	ND-0.04	ND	ND	ND
Benzo[k]fluoranthene	ND	ND	ND-0.01	ND	ND	ND
Benzo[a]pyrene	ND	ND	ND-0.01	ND	ND	ND
Phenanthrene	ND	ND	ND-0.03	ND	ND	ND

Appendix A-11: Results of PCB and Pesticide Analyses for Clams Deployed in the Study Area

PCB's/Pesticides (ug/g)	BALSAM LAKE CONTROL	T.T.P. DISPOSAL CELL 1	T.T.P. DISPOSAL CELL 2	T.T.P. DISPOSAL CELL 3	T.T.P. EMBAYMENT "C"	OUTER HARBOUR
1988						
1,2,4-Trichlorobenzene	ND	0.030	0.010	ND	ND	ND
Beta-BHC	ND	0.001	ND	ND	ND	ND
alpha-chlordane	ND	0.004	0.003	ND	0.003	ND
gamma-chlordane	ND	0.005	0.010	0.002	0.005	0.003
p,p'-DDD	ND	ND	0.002	0.002	ND	ND
Methoxychlor	ND	0.017	ND	ND	ND	ND
beta-Endosulphan	ND	0.002	0.002	0.002	ND	ND
1989						
Hexachlorobenzene	ND	ND	ND-0.001	ND	ND	ND
Heptachlor	ND	ND	ND-0.001	ND	ND	ND
Aldrin	ND	ND-0.001	ND	ND	ND	ND
alpha-chlordane	ND	ND-0.001	ND(0.002)0.003	ND	ND	ND
gamma-chlordane	ND	0.001	0.001(0.0015)0.002	ND	ND	ND
p,p'-DDE	ND	ND-0.001	ND	ND	ND	ND
p,p'-DDD	ND	0.001(0.0018)0.003	0.001	0.001	ND	ND
Dieldrin	ND	ND-0.001	ND-0.001	ND	ND	ND
Total PCB	ND	0.025(0.0031)0.037	0.045(0.065)0.116	ND	ND	ND

A-12 PCB and Pesticide analyses from sediments from Ashbridge's Bay, Humber Bay Park East, and the Mouth of the Mimico Creek.

Detected PCB/Pesticide Parameter	Ashbridge's Bay (Coatsworth Cut)	Humber Bay Park East	Mouth of the Mimico Creek
HCB	0.001	ND	ND
Heptachlor	0.001	ND	0.001
Aldrin	0.013	ND	ND
p,p'-DDD	0.016	0.003	0.003
p,p'-DDT	0.014	ND	ND
p,p'-DDE	0.005	0.003	0.006
Mirex	0.005	ND	ND
beta-BHC	0.005	0.004	0.003
alhpa-Chlordane	0.026	0.004	ND
gamma-Chlordane	0.030	0.004	0.002
Methoxychlor	ND	0.008	ND
Heptachchlor Epoxide	0.002	0.002	ND
Dieldrin	0.029	0.002	ND
Total PCB	0.38	0.09	0.09

A-13 Summary of Plant Colinization on the Experimental Island, 1989-1990.

Woody Plants

		1989	1990
Eleagnus angustifolia	Russian olive		X
Populus deltoides	Eastern cottonwood		X
Populus x canadensis	Carolina poplar	?	
Salix amygdaloides	Peachleaf willow		X
Salix eriocephala	Rigid willow	X	X
Salix cf. bebbiana	Bebb's willow		X
Salix exigua	Sandbar willow		X

Non-woody Plants

		1989	1990
Artemesia biennis	Biennial wormwood	X	X
Bidens spp.	Beggar's ticks	X	
Bidens cf. tripartita	Beggar's ticks		X
Bidens cernua	Bur-marigold		X
Caltha palustris	Marsh marigold	X	
Carex sp.	Sedge		X
Chenopodium glaucum	Oak-leaf goosefoot	X	X
Cirsium arvensis	Creeping thistle		X
Daucus carota	Queen Anne's lace		X
Echinochloa crus-galli	Barnyard grass		X
Epilobium hirsutum	Hairy willow-herb		X
Erysimum cheiranthoides	Wormseed mustard	X	X
Juncus sp.	Rush		X
Juncus effusus	Soft rush	X	
Ludwigia palustris	Water purslane	X	
Lycopus europaeus	European bugleweed	X	X
Lytrhum salicaria	Purple loosestrife	X	X
Oenothera biennis	Evening primrose	X	X
Phalaris arundinacea	Canary reed grass		?
Plantago major	Plantain		X
Poa compressa	Flatstem bluegrass		X
Polygonum lapathifolium	Pale smartweed	X	X
Polygonum aviculare	Prostrate knotweed		X
Pontederia cordata	Pickerelweed	X	
Potentilla anserina	Silverweed	X	X
Potentilla paradoxa	Bushy cinquefoil	X	X
Ranunculus scleratus	Cursed buttercup	X	?
Rorippa islandica var. fernaldiana	Fernald's marsh cress		X
Senecio vulgaris	Common groundsel	X	X
Solanum dulcemara	Climbing nightshade	X	X
Solidago canadensis	Canada goldenrod		X

		1989	1990
Solidago canadensis ssp.scabra	Tall goldenrod		X
Solidago gigantea	Late goldenrod		X
Solidago graminifolia	Grassleaf goldenrod	X	X
Tanacetum vulgare	**Tansy**		X
Trifolium pratense	Red clover	X	?
Tussilago farfara	Coltsfoot	X	X
Typha angustifolia	Narrow cattail		X
Typha latifolia	Broad cattail		X
Urtica dioica	Stinging nettle	X	X
Verbena hastata	Blue vervain		X

A-14 Technical Advisory Committee Members, Natural Area Advisory Committee Members

TOMMY THOMPSON PARK
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