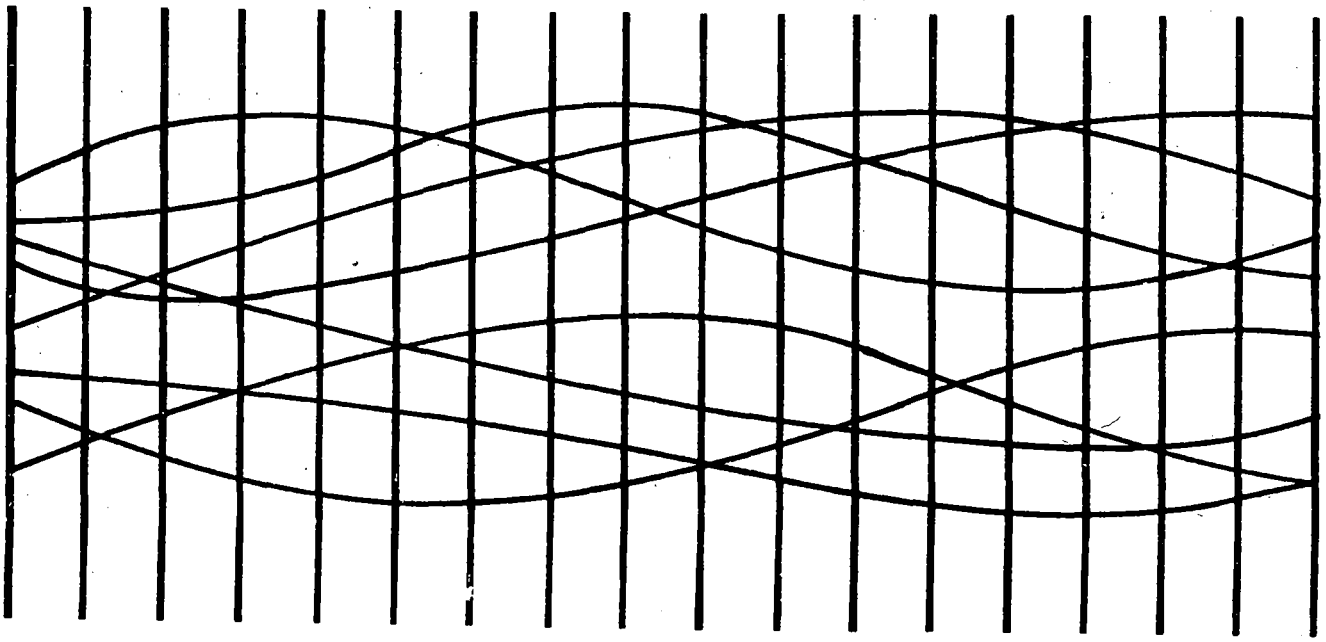
FINAL REPORT

Preliminary Field Investigation of Abandoned Waste Disposal Sites In Ontario: Phase II, for

ENVIRONMENT CANADA

ENVIRONMENTAL PROTECTION SERVICE



MORRISON BEATTY LIMITED
PROCTOR & REDFERN LIMITED

STUDY OF ABANDONED WASTE DISPOSAL SITES (LAND)

FOR SELECTED FEDERAL AGENCIES IN ONTARIO

PREPARED FOR

ENVIRONMENT CANADA

BY

MORRISON BEATTY LIMITED

AND

PROCTOR & REDFERN LIMITED

This project was carried out under contract to Environment Canada (EPS - Ontario Region). The statements, conclusions and recommendations expressed are thos of the Consultant and do not necessarily reflect the views and policies of Environment Canada

May 1984

morrison beatty limited
consulting engineers and hydrogeologists
4500 dixie road, unit 12a, mississauga, ontario L4W 1V7 (416-624-9308)

May 10, 1984

Mr. J. Smith
A/Manager, Federal Programs Division
Environmental Protection Service
7th Floor
25 St. Clair Avenue East
Toronto, Ontario
M4T 1M2

Dear Sir:

re: Study of Abandoned Waste
Sites (Land) for Selected
Federal Agencies in Ontario
DSS File No. 02SE.KE403-3-0262

We are pleased to submit our Final Report for the above noted study. Twenty copies of the report have been included as specified in the Terms of Reference.

The report includes the preliminary field study findings and identified impacts for the five Ontario sites. Our study did not identify any significant impacts. We have presented recommendations for on-going monitoring programs and supplemental studies at some of the sites.

Thank you for the opportunity of working with you on this project.

Yours very truly,
MORRISON BEATTY LIMITED

Nancy J. Rennie

NJR/lf

Nancy J. Rennie, B.E.S.
Environmental Geomorphologist

TABLE OF CONTENTS

EXECUTIVE SUMMARY . . . . . (i)

1.0 INTRODUCTION 1

2.0 STUDY OBJECTIVES AND TERMS OF REFERENCE 5

3.0 METHODOLOGY 6

3.1 Background Preparation 6
3.2 Field Studies 7

4.0 CFS LOWTHER: SITE NO. D-75 12

4.1 Introduction 12
4.2 Site-Specific Studies 15
4.3 Study Results 17
4.3.1 Hydrogeologic Setting 17
4.3.2 Water Budget 23
4.3.3 Groundwater Quality and Leachate Impacts 25
4.3.4 Methane Impacts 29
4.3.5 Potential Hydrogeologic Impacts 29
4.4 Future Land Use Plans 30
4.5 Conclusions 30
4.6 Recommendations 31

continued.....

5.0 CFB KINGSTON: SITE NO. D-81 32

5.1 Introduction 32
5.2 Site-Specific Studies 34
5.3 Study Results 36
5.3.1 Hydrogeologic Setting 36
5.3.2 Water Budget 42
5.3.3 Groundwater Quality and Leachate Impacts 45
5.3.4 Methane Impacts 48
5.3.5 Potential Hydrogeologic Impacts. 49
5.4 Future Land Use Plans 49
5.5 Conclusions 50
5.6 Recommendations 50

6.0 ST. REGIS RESERVE: SITE NO. I-21 51

6.1 Introduction 51
6.2 Site-Specific Studies 54
6.3 Study Results 56
6.3.1 Hydrogeologic Setting 56
6.3.2 Water Budget 61
6.3.3 Groundwater Quality and Leachate Impacts 62
6.3.4 Methane Impacts 67
6.3.5 Potential Hydrogeologic Impacts 67
6.4 Future Land Use Plans 68
6.5 Conclusions 68
6.6 Recommendations 68

continued.....

7.0 RIDEAU CANAL (SMITHS FALLS): SITE NO. P-103 69

7.1 Introduction 69
7.2 Site-Specific Studies 69
7.3 Study Results 73
7.3.1 Hydrogeologic Setting 73
7.3.2 Water Budget 77
7.3.3 Groundwater Quality and Leachate Impacts 78
7.3.4 Methane Impacts 82
7.3.5 Potential Hydrogeologic Impacts 83
7.4 Future Land Use Plans 83
7.5 Conclusions 83
7.6 Recommendations 84

8.0 POINT PELEE: SITE NO. P-105 85

8.1 Introduction 85
8.2 Site-Specific Studies 88
8.3 Study Results 90
8.3.1 Hydrogeologic Setting 90
8.3.2 Water Budget 97
8.3.3 Groundwater Quality and Leachate Impacts 99
8.3.4 Methane Impacts 102
8.3.5 Potential Hydrogeologic Impacts 103
8.4 Future Land Use Plans 104
8.5 Conclusions 104
8.6 Recommendations 105

EXECUTIVE SUMMARY

A. INTRODUCTION AND OBJECTIVES

Morrison Beatty Limited and Proctor & Redfern Limited were retained by Environment Canada's Environmental Protection Service to carry out a preliminary Phase II assessment of five selected abandoned waste disposal sites in Ontario. The five sites were identified during the Phase I study as requiring further study.

The objective of the Phase II study was to assess the sites for hazards which could be detrimental to public health and safety or the environment and to determine the direction of further studies. The Phase II field program was conducted during the winter and spring of 1984.

B. STUDY RESULTS

The following is a summary of the study's findings and recommendations for the five abandoned waste sites.

CFS Lowther

Field studies indicate leachate has migrated away from the site and has probably entered the bedrock aquifer. Two production wells on the Lowther CFS may be impacted. Methane will not pose a problem if building is restricted close to the site.

A follow-up monitoring program is recommended which includes sampling of the two production wells. Further observation wells may be required if contaminants are identified in the bedrock aquifer. Private water supplies in the vicinity of the site rely on the bedrock aquifer.

CFB Kingston

There is a lack of documentation and some uncertainty about the type and quantity of waste disposed of at this site. The actual disposal area appears to be small - less than 15 m^2.

The public is protected from direct exposure to the waste by a security fence. No significant impact was detected in bedrock observation wells outside the site enclosure.

A follow-up monitoring program is recommended to confirm the Phase II results. There appears to be no threat to public health and safety, providing it is restricted from public access; however, if the site is developed for other uses, the waste should be examined to identify their condition, state of decay and impact.

St. Regis Reserve

The St. Regis site is not a threat to public health and safety. Groundwater flow is northward to the St. Lawrence River. Domestic wells located south of the site will not be impacted.

Leachate migrating from this landfill is dilute and is not expected to have any significant impact on the St. Lawrence River. Small surface streams may be impacted seasonally; however this can be remedied if a proper closure plan is developed for the site.

Smiths Falls

This site does not pose a threat to public health and safety. It will have no impact on local groundwater resources. The leachate produced in this landfill is weak. The impact on the river and canal is expected to be insignificant due to dilution in the streamflow. Methane will not pose a public safety risk unless building development takes place on the site.

The study recommends that sampling take place at localized leachate seepages to the watercourse. If contaminants are found along the shore areas, remedial measures should be taken. The gas probes installed at the site should be monitored if building development is proposed.

Point Pelee

There were no public health and safety hazards identified at the Point Pelee site; however, shore erosion could eventually expose the wastes.

No further hydrogeologic impact studies were recommended.

Respectfully submitted,
MORRISON BEATTY LIMITED

Brian W. Beatty, P.Eng.

Study Members

Morrison Beatty Limited:
- B.W. Beatty - Project manager and report preparation
- N.J. Rennie - Study co-ordination and report preparation
- J.W. Wilson - Field studies
- C.A. Hawke - Field studies

Proctor & Redfern Limited:
- J.A. Hiraishi - Land use studies and report preparation

1.0 INTRODUCTION

This study is part of a three-phase program developed by Environment Canada to determine the public and environmental hazard potential of abandoned waste disposal sites on federal land. The three phases are listed below as described by Environment Canada.

Phase I: Identification - identification and verification of closed or abandoned land disposal site locations together with available data on the nature and quality of the materials deposited therein.

Phase II: Preliminary Assessment - preliminary assessment of the manifested or potential impact of each site on human health or the environment.

Phase III: Detailed Study - detailed examination of candidate sites to verify preliminary assessment and recommend alternative remedial measures.

The Phase I study was carried out in 1983. This study produced an inventory of known disposal sites on federal land in Ontario. A ranking system was developed to evaluate the potential hazard of the site to the public and the environment based on available information. Each site was given a rating and placed in one of the following classifications.

Priority I: Sites which could present a high risk potential to health and the environment, which should be immediately assessed.

Priority II: Sites which could present a medium risk potential which should be assessed at a future date.

Priority III: Sites which should not present a danger to human health or the environment but which may require occasional monitoring in the future.

Environment Canada selected five sites to be examined in greater detail for the Phase II program. This report presents the findings of the Phase II study.

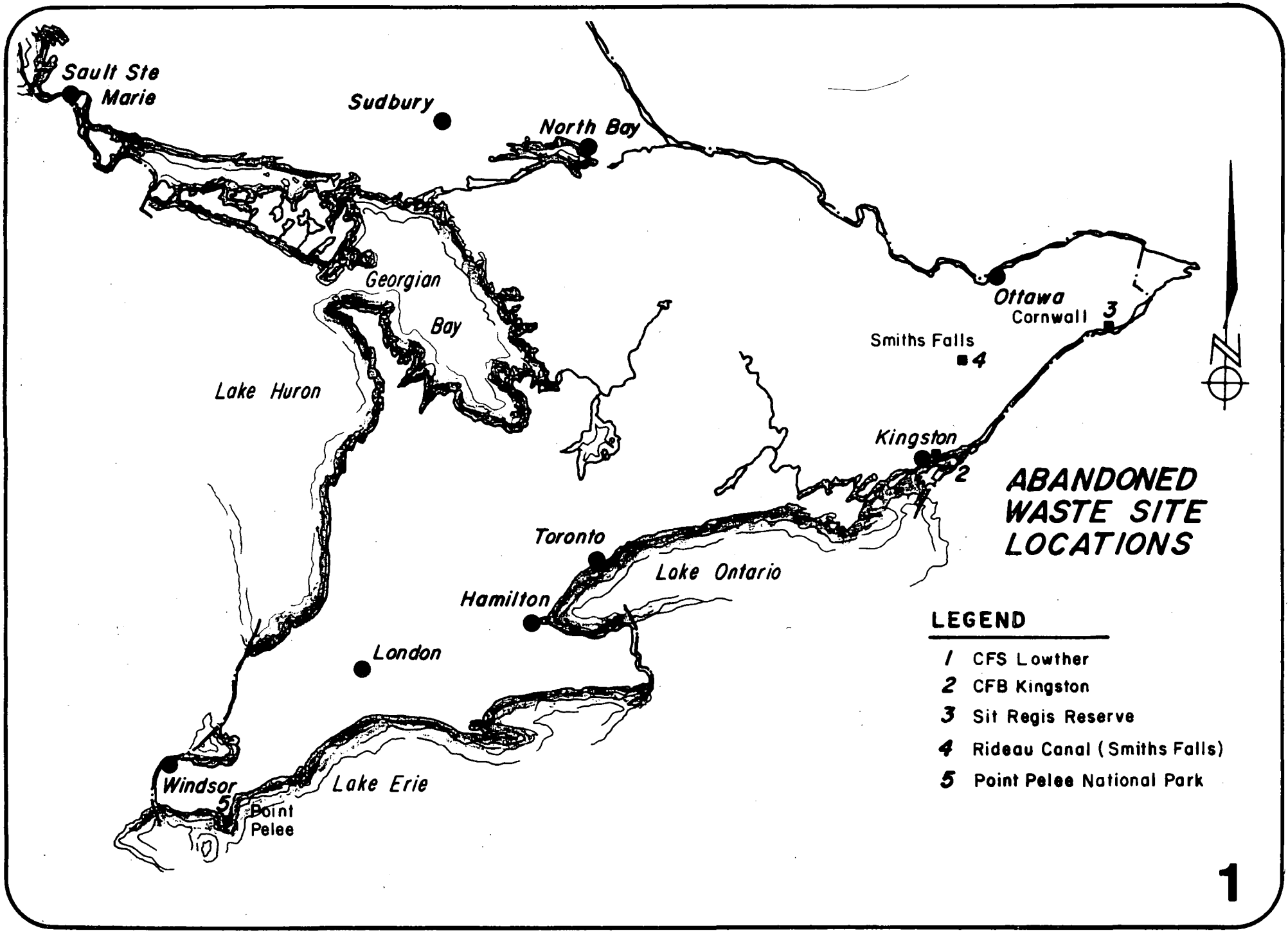
Morrison Beatty Limited and Proctor & Redfern Limited were retained by Environment Canada, under Contract No. 02SE.KE403-3-0262 with the Department of Supply and Services to investigate five abandoned waste disposal sites. The study comprised a Phase II evaluation of four Priority I waste disposal sites and one Priority II site within the Province of Ontario. The results of the investigation are presented in a dossier format for each site. Each dossier consists of a complete presentation of the study results, maps, interpretations, conclusions and recommendations.

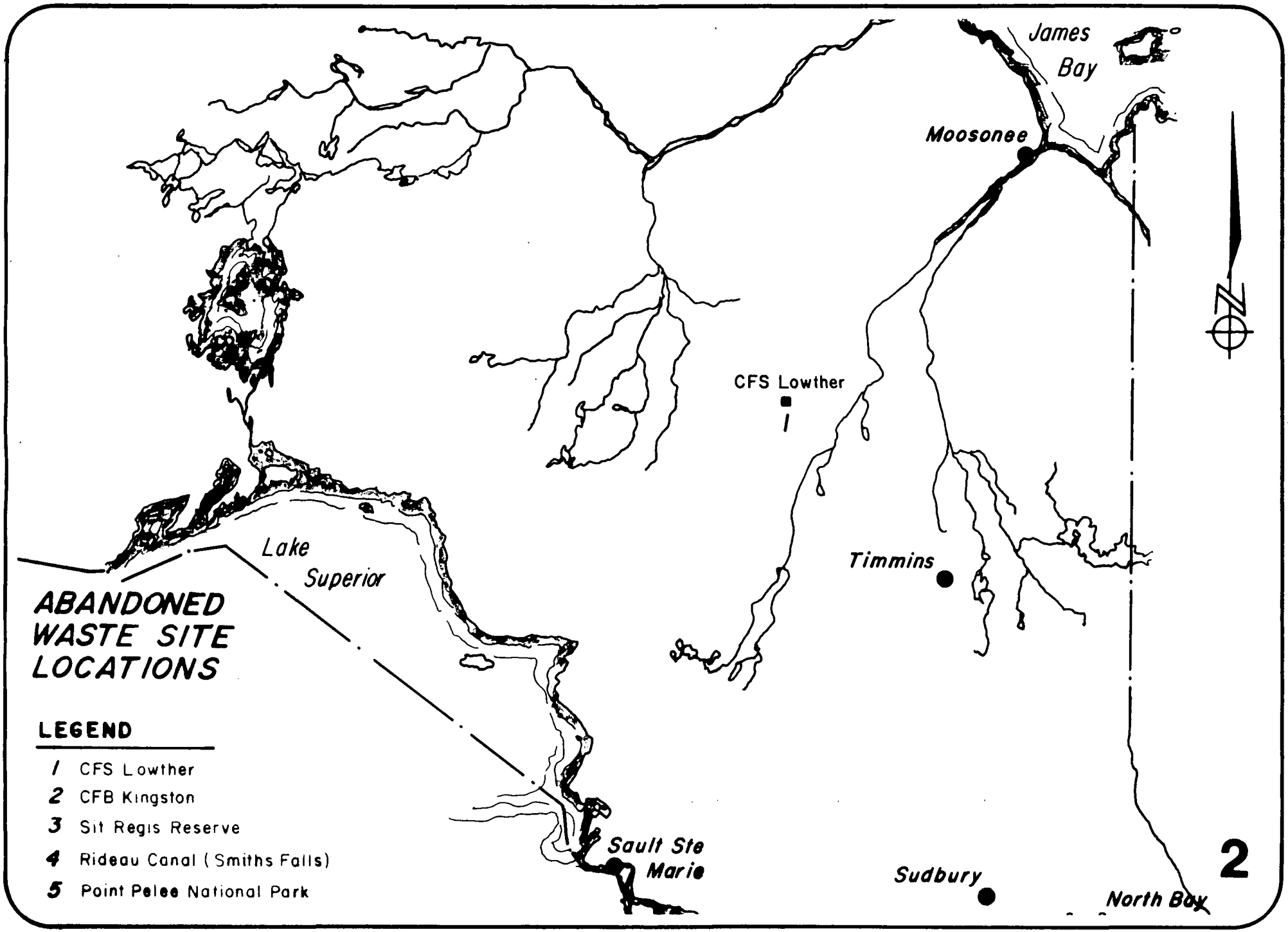
The sites are as follows:

Priority I: CFS Lowther, D-75
CFB Kingston, D-81
St. Regis Reserve, I-21
Point Pelee Provincial Park, P-105

Priority II: Rideau Canal (Smiths Falls), P-103

The location of these sites are shown on Figures 1 and 2 (overleaf).


Sault Ste Marie
Sudbury
North Bay
Georgian Bay
Lake Huron
Ottawa
Cornwall
3
Smiths Falls
4
Kingston
2
Toronto
Lake Ontario
Hamilton
London
Windsor
5
Point Pelee
Lake Erie
N
ABANDONED WASTE SITE LOCATIONS
LEGEND
1 CFS Lowther
2 CFB Kingston
3 Sit Regis Reserve
4 Rideau Canal (Smiths Falls)
5 Point Pelee National Park
1


James Bay
Moosonee
CFS Lowther
Timmins
Lake Superior
Sault Ste Marie
Sudbury
North Bay
ABANDONED WASTE SITE LOCATIONS
LEGEND
1 CFS Lowther
2 CFB Kingston
3 Sit Regis Reserve
4 Rideau Canal (Smiths Falls)
5 Point Pelee National Park
2

2.0 STUDY OBJECTIVES AND TERMS OF REFERENCE

The primary objective of this study was to assess the abandoned disposal sites for hazards which could be detrimental to public health and safety safety or the environment. The intent of the Phase II program was to determine the direction of further studies should they be needed.

The following is a brief summary of the terms of reference for the Phase II study:

- confirm the general stratigraphy and hydrogeology of the site,
- determine the waste types and quantities disposed of at each site,
- inspect the site and immediate surroundings (500 m) for environmental problems associated with the site,
- develop and carry out a field program for the sampling and testing of water resources, soils and wastes and for methane gas testing to indicate the nature of any contamination,
- estimate the potential quantities of leachate and gas likely to be produced and the probable direction of the contaminant plume (if any),
- identify the actual extent of identified or potential hazards, recommend sites which require further investigation and give direction to the Phase III studies.

3.0 METHODOLOGY

The tasks outlined below are the general tasks common to all sites. The site-specific study programs are detailed in the dossier for each site.

3.1 Background Preparation

Prior to the field investigations some preparatory work was required to maximize the effectiveness of the field programs. This included a review of the following data:

- the Phase I report, priority ranking sheets, site inspection sheets and maps,
- available geologic, soils, topographic and watershed mapping for each of the five areas,
- aerial photography including 1978 (1:10,000) photos and historical photographs for CFB Kingston and the Rideau Canal sites. Historical photographs for the remaining sites were not available from the Ontario Archives,
- water well records on file for the area,
- any available information on the types and quantities of wastes obtained from people involved in the disposal operations or those familiar with the documented disposal practices.

Once the above information was reviewed, site-specific field programs were developed. These programs were discussed with Environment Canada prior to the onset of the field work. A field inspection report form was developed at this time to provide a summary for each site. These summaries are included in each dossier.

3.2 Field Studies

Site Reconnaissance - Each site was inspected to verify and supplement the compiled data from Phase I and to examine the field conditions. The occurrence of leachate seepage, ground settlement, erosion, and proximity to buildings and private wells were noted. An inspection of vegetation stress was not possible due to snow cover.

Test Drilling and Observation Well Installation - Test drilling was completed at each site to determine subsurface geology. At least four observation wells were installed at each site to facilitate groundwater sampling, hydraulic conductivity tests, and determine groundwater flow paths. Details of the drilling procedures and well installations are provided below for each site:

CFS Lowther

Test drilling was completed using a CME 750 track mount drill rig with 8 inch hollow stem augers. Testholes were augered to refusal with the exception of one borehole which was terminated in overburden at 6.1 m. Since auger refusal occurred consistantly at between 2 to 4 m at all but one of the testholes, bedrock contact was assumed. There was no indication of boulders in the overburden that would cause auger refusal.

Observation wells are constructed of 40 mm diameter ABS plastic casing. The screens are slotted ABS and wrapped with nylon filter cloth. The borehole annulus above the screen is sealed with bentonite.

Adequate definition of the landfill limits eliminated the need to confirm this with test pits. Further, it was not considered necessary to probe the waste with pits for the objectives of this study.

CFB Kingston

Test drilling was completed using a track mount drill rig 20 cm (diam.). Hollow stem augers were used to drill through the overburden. The bedrock was cored using a DX diamond bit. The Base water supply was used for coring.

Observation wells are constructed of 50 mm diameter PVC plastic casing in the overburden. The corehole is uncased below the bedrock contact. The borehole annulus above the bedrock is sealed with bentonite.

Test pits were not considered at this site due to the potential hazard of the waste.

St. Regis, Cornwall

A track mount drill rig with 20 cm (diam.) hollow stem augers was used to drill the overburden testholes. Bedrock was not encountered.

Observation wells were screened in the till beneath the site. Wells are constructed of 40 mm diameter PVC plastic casing. The screens are slotted 40 mm PVC. The borehole annulus above the screen is sealed with peltonite.

Adequate definition of the site boundaries from field observation and air photos eliminated the need to confirm this with test pits. It was not considered necessary to probe the waste with pits for the purpose of this study.

Rideau Canal, Smiths Falls

Test drilling and observation well construction was conducted with a track-mounted drill rig using hollow-stem augers. All testholes were advanced through the waste material to refusal. Bedrock contact was assumed since bedrock outcrops in the area at similar elevations.

The observation wells were screened in the waste material. Steel protection covers with hinged and lockable caps were provided for each well, since they are accessible to the public. The wells are cased with 40 mm PVC plastic pipe. The screens are slotted PVC plastic.

The site is well defined by the canal, river, pond and railway tracks; eliminating the need for test pits.

Point Pelee

Test drilling in the overburden was carried out using a Boa drill rig and 20 cm (diam.) hollow-stem augers. Bedrock was not encounterd.

Observation wells were installed about 3 m below the water table. PVC plastic casing (40 mm diam.) was used to construct the wells. Well screens are slotted PVC pipe. The annulus above the screen is sealed with peltonite.

Test pits were not installed at this site because of time constraints.

Well Elevations - Elevations (relative to a local or geodetic datum) were established for all wells. The details of the local and geodetic datums are provided under the site-specific details for each site.

Soil Sampling - Soil samples were collected by split-spoon sampling inside the hollow augers during the drilling. Soil samples were not obtained at the Smiths Falls site since all drilling was confined to the waste. Samples from CFB Kingston were returned to that site due to safety precautions after visual identification was completed. Representative samples from the three remaining sites were analyzed for grain-size distribution and organic content.

Gas Probe Installation - Permanent gas probes were installed in selected boreholes above the saturated zone. The probes were constructed of 13 mm diameter CPVC or PVC pipe with a slotted screen intake.

Observation Well Development - Any "foreign" water introduced to an observation well by the use of drilling water or seepage from water at the surface, was removed by hand-bailing prior to sampling.

Water Levels - Water levels were monitored in all wells prior to groundwater sampling.

Hydraulic Conductivity Tests - Bail-down tests were conducted on selected wells at each site. The results are presented in the site dossier.

Groundwater Sampling - Groundwater from all wells at each site was analyzed in the field or laboratory for conductivity, a key leachate indicator. One background and at least two downgradient observation wells were sampled for other leachate indicators. Samples were analyzed for pH, major ion distribution, TOC and COD at a private laboratory. Although field pH readings are considered more accurate than those conducted later in a laboratory, all pH readings were done in a laboratory due to time constraints. This does not affect the measurement of relative differences in pH which may reflect a leachate impact.

- An ionic balance was calculated using the major cations and anions analyzed (calcium, magnesium, sodium, potassium, sulphate, chloride and bicarbonate). In some cases the percentage differences between the concentrations of anions and cations are high. This suggests the presence of other ions that were not analyzed.

- Care was taken during the sampling procedure to prevent cross-contamination of wells. The samplers were either rinsed with distilled water between wells or individual samplers were used for each well.

Field Interviews - During the field programs, the site owners were questioned regarding their knowledge of the disposal site. In several cases, useful background information was obtained.

4.0 CFS LOWTHER: SITE NO. D-75

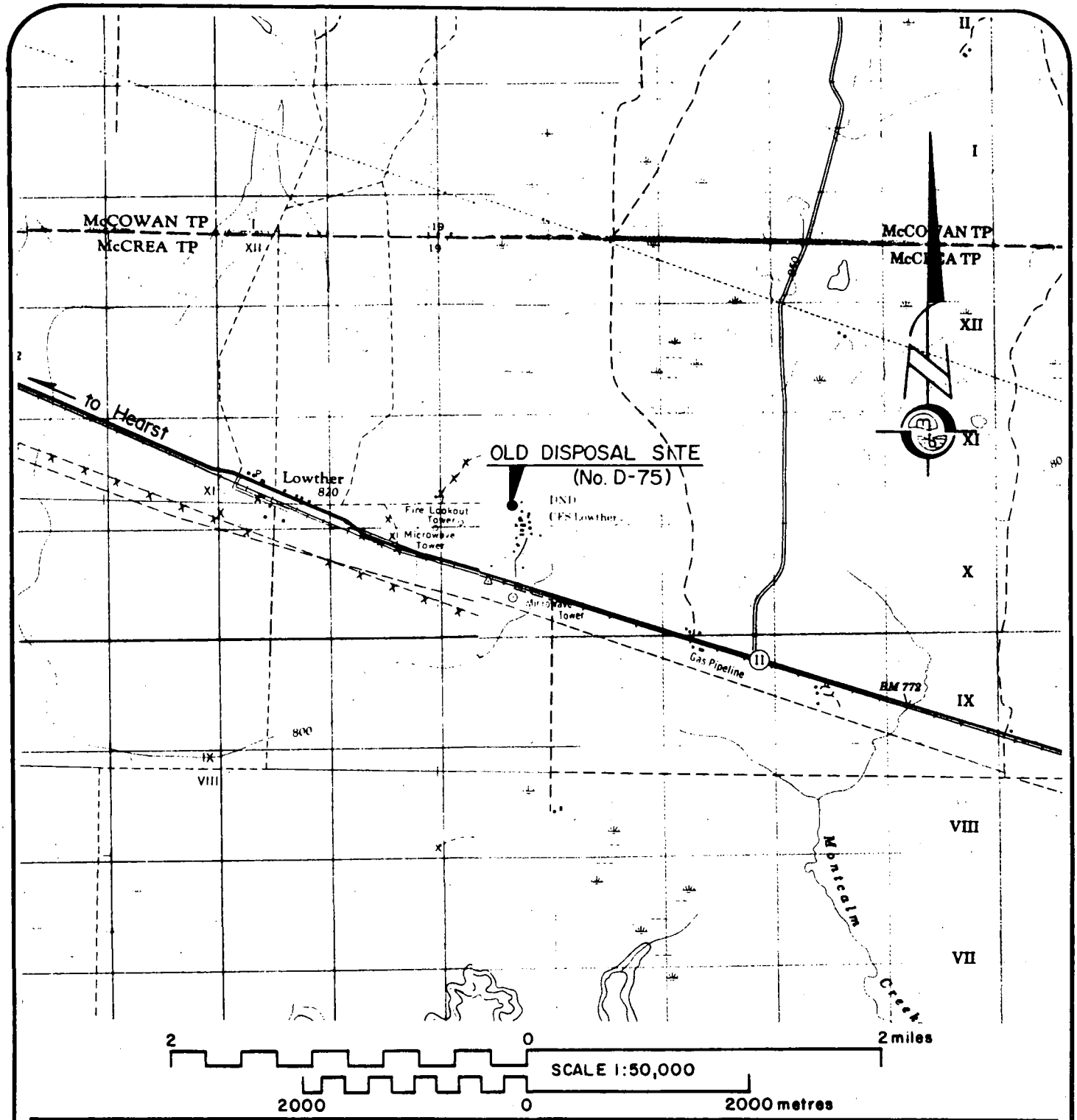
4.1 Introduction

The CFS Lowther old disposal site is located on a Department of National Defence (DND) Station near Lowther in McCrea Township, District of Cochrane. CFS Lowther is about 50 km east of Hearst, Ontario on Highway #11. The regional location is shown on Figure A-1 on the following page.

The site was operated by the U.S. Air Force in 1963 to dispose of equipment when they vacated the site. The DND used the site for building rubble and fill. We understand that some PCB contaminated oils have been stored on the disposal site from time-to-time. The site was used until 1973.

The site is about 4000 m^2 in size and is situated at the northwest corner of the CFS Lowther building development. The location of the site in relation to the Station buildings is shown on Figure A-2. The site was originally a vacant wooded area. It appears that some excavation took place below ground level to dispose of large items (i.e., school bus). A wooded area abuts the site to the north and west.

Access to the site is from Highway #11 through the CFS Lowther property. It is not visible to public view; however, the site is accessible to Station personnel.



ENVIRONMENT CANADA
Abandoned Waste Disposal Sites
Phase II
SITE: CFS LOWTHER

TOPOGRAPHIC LOCATION

MORRISON BEATTY LIMITED

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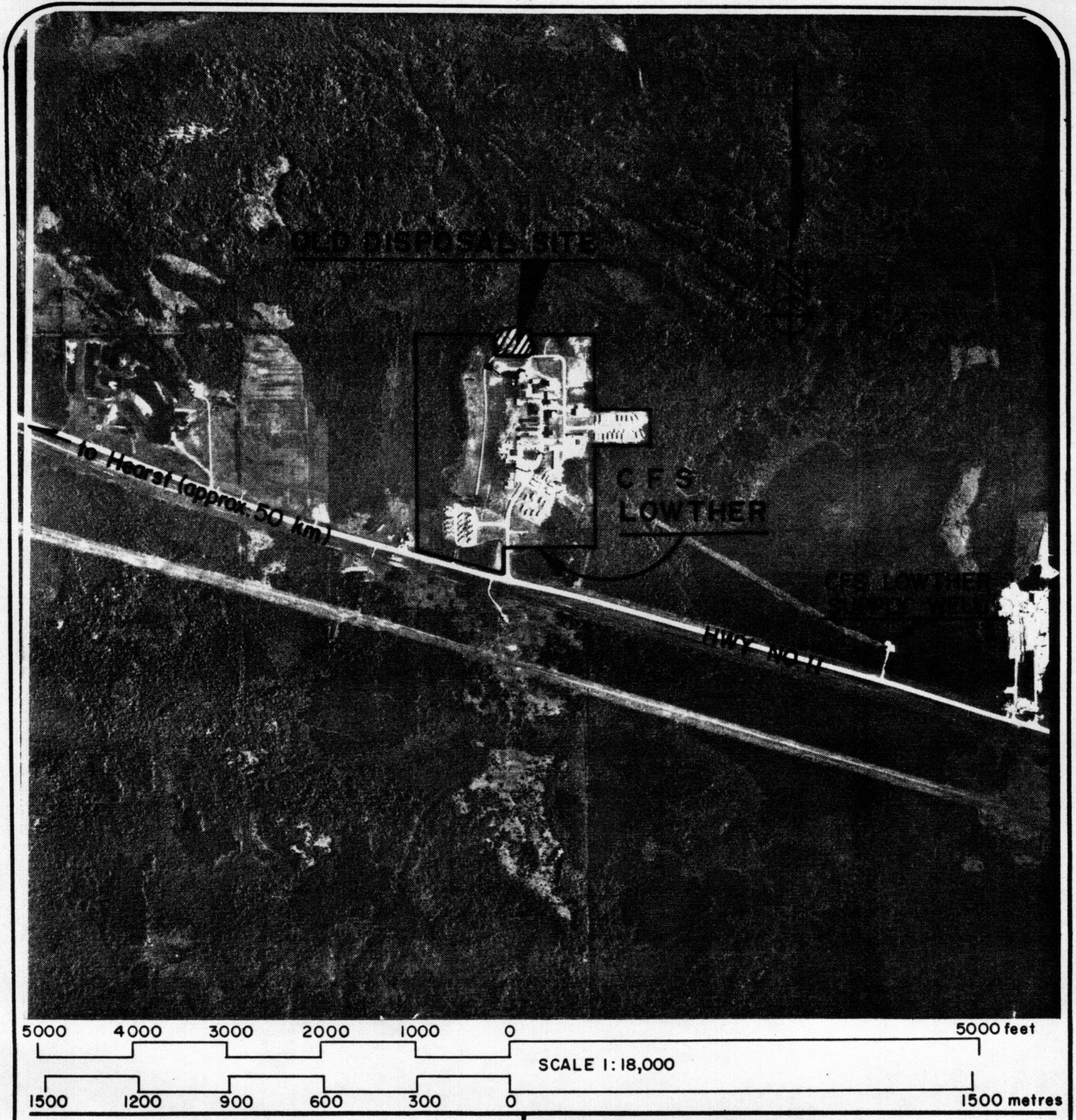
MAR. 1984

A1



ENVIRONMENT CANADA
Abandoned Waste Disposal Sites
Phase II

SITE: CFS LOWTHER

AIR PHOTO LOCATION

MAR. 1984

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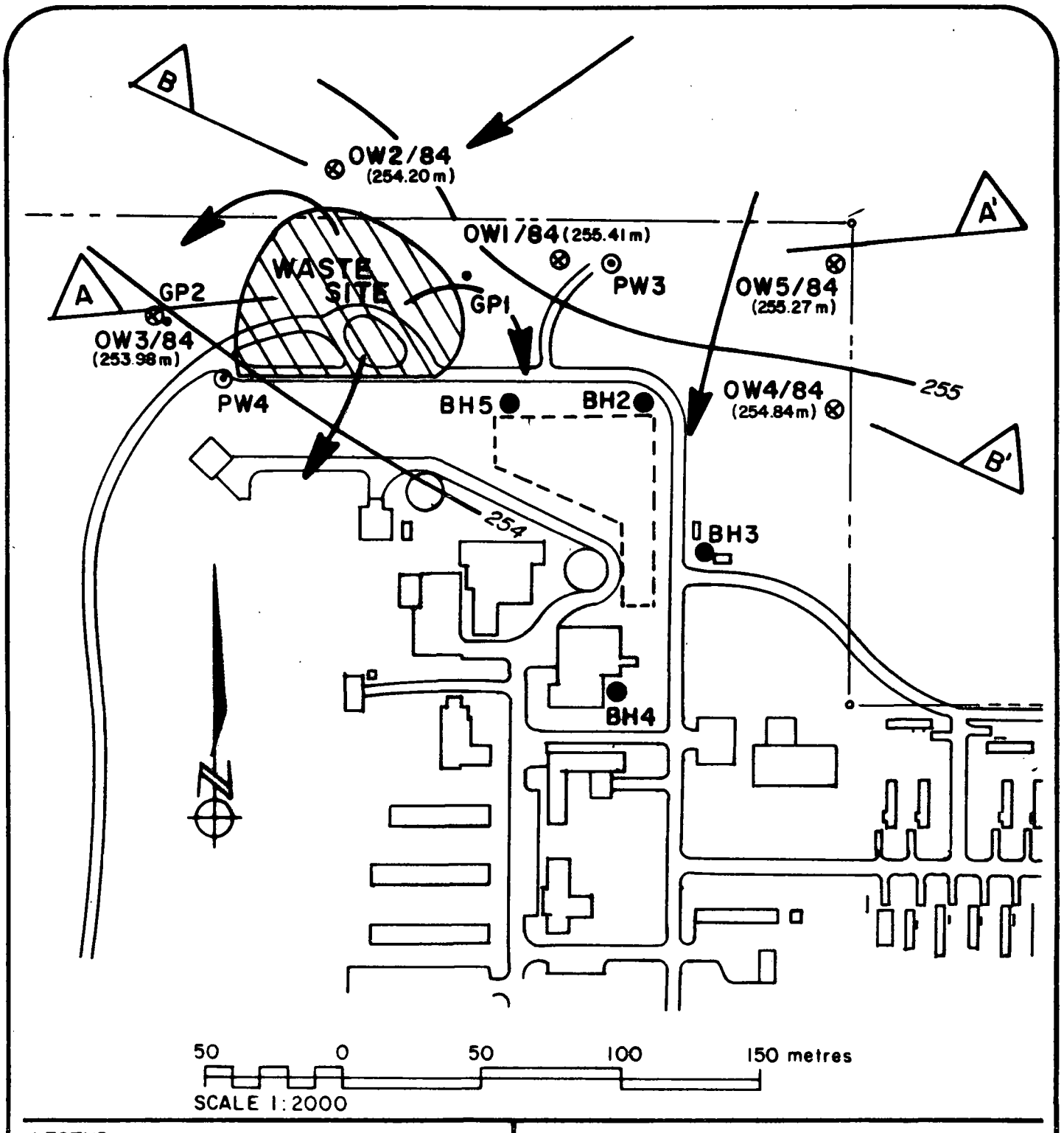
PROCTOR & REDFERN LIMITED

A2

4.2 Site-Specific Studies

The general field study methods carried out for this site are outlined in Section 3.0. The specific field program for CFS Lowther involved the following:

- A site reconnaissance was carried out to identify drainage patterns, landfill details, etc.
- Discussions were held with Station personnel to obtain details on site history, Station water supply and monitoring programs.
- Test drilling was carried out to confirm overburden stratigraphy, obtain soil samples and confirm depth to bedrock.
- Five permanent observation wells and two permanent gas probes were installed. Four of these wells are located downgradient of the site and the fifth serves as a background well upgradient of the site.
- Observation well and gas probe construction details are included in Section 1 of the Appendix. The monitors' locations are shown on Figure A-3, overleaf.
- Permeability tests were conducted on OW 1 and OW 4-84.
- Well elevations were referenced to a local bench mark.
- Water levels were monitored in all wells including PW 3, which is the Station's supplementary well. Water levels are included in Table A-1 (Section 2 of the Appendix).
- All wells were field tested for conductivity. Samples from OW 1, OW 2, OW 3 and OW 5-84 were tested in a private laboratory for pH, alkalinity, COD, TOC and major ions. OW 1 and OW 3-84 samples were also analyzed for PCB's. The chemical analyses are included in Table A-2 (Section 2 of the Appendix).
- Discussions were held with MOE personnel to determine if any monitoring programs were previously carried out at this site
- Borehole logs from a soils study conducted for CFS Lowther were used to further interpret the local geology. These boreholes are located on Figure A-3, overleaf. The logs show clayey, silty overburden and bedrock assumed at 1.68 m to 4.11 m. No water levels were obtained for this study and the boreholes were not cased.



LEGEND

- Base Water Supply Well
- Observation Well (overburden)
- Borehole (uncased)
- Gas Probe
- (253.98m) Groundwater Elevation (metres local datum)
- Groundwater Contour
- Direction of Groundwater Flow

ENVIRONMENT CANADA
Abandoned Waste Disposal Sites
Phase II
SITE: CFS LOWTHER

SITE PLAN

MORRISON BEATTY LIMITED
PROCTOR & REDFERN LIMITED

MAR. 1984

A3

4.3 Study Results

4.3.1 Hydrogeologic Setting

i) Geology

Test drilling at the site confirmed a silty clay till overburden over bedrock. Test drilling confirmed depth to bedrock at the toe of the landfill ranged from 2 m to over 6.1 m. Cross-sections Figures A-4 and A-5 show the stratigraphy. Till composition details are listed in the borehole log sheets (Section 1 of the Appendix). It contains 30-40% clay, 30-40% silt, and about 20% sand. Grain-size distribution curves for two samples are included in Figures A-6 and A-7.

The organic analysis is listed below.

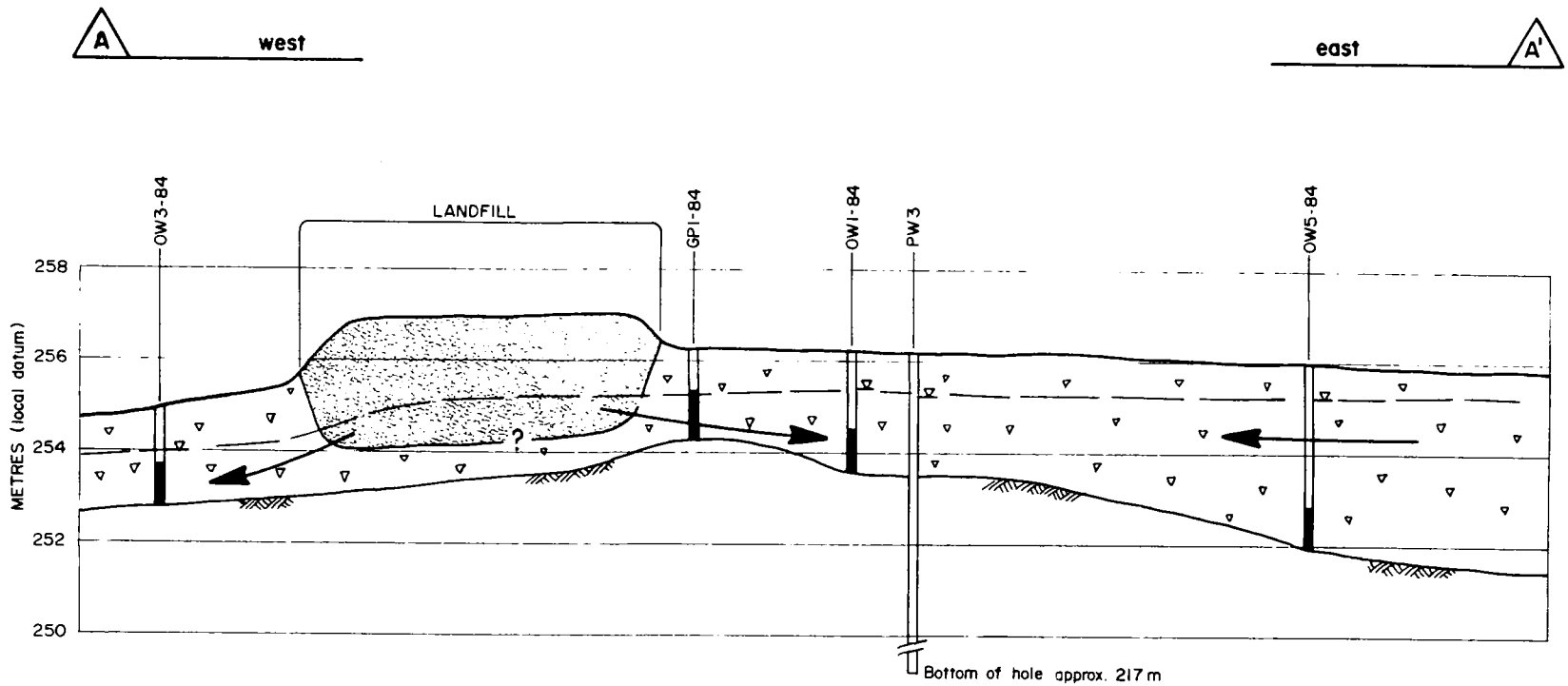
Well	Sample Depth, m	% Organics
OW 1-84	2	7.95
OW 2-84	5	0.87

Bedrock in the area is Precambrian metasedimentary rocks. The yield of some of the Station's wells indicate the bedrock contains significant fractures.

ii) Topography and Drainage

The site is situated in a relatively flat area. Maximum relief near the disposal area is 2 m. The land slopes gently to the south with some local depressions to the west and north. These depressions are low-lying and wet.

Drainage south of the site is to the southeast. North of the site, drainage is northward. Regionally, the site is within the watershed of Montcalm Creek, a tributary of Crow Creek.



LEGEND

- Static Water Level
- Water Table
- Screened Interval

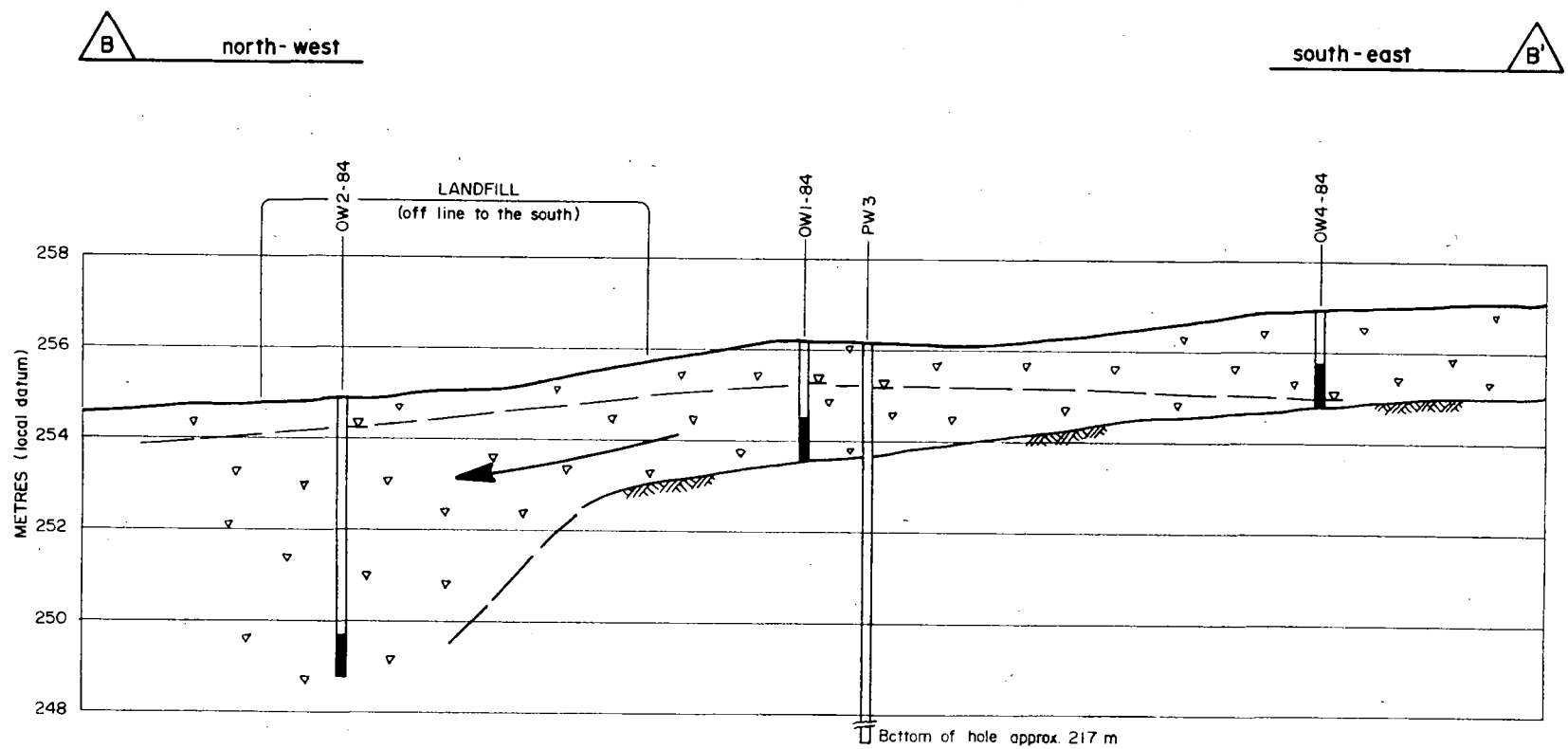
SCALE Horizontal = 1 1,000
Vertical = 1 100
Exaggeration = 10 times

Groundwater Flow Path

- Sand
- Silt
- Gravel
- Till
- Fill
- Refuse
- Limestone
- Bedrock

25 0 25 metres
HORIZONTAL SCALE

SITE: CFS LOWTHER	Cross-Section A-A' (Refer to Figure A3)	ENVIRONMENT CANADA Abandoned Waste Disposal Sites Phase II	PROJECT NO 390-841	MAR 1984
			MORRISON BEATTY LIMITED PROCTOR & REDFERN LIMITED	A4



SITE: CFS LOWTHER	Cross-Section B-B' (Refer to Figure A3)	ENVIRONMENT CANADA Abandoned Waste Disposal Sites Phase II	PROJECT NO. 390-841	MAR. 1984
			MORRISON BEATTY LIMITED PROCTOR & REDFERN LIMITED	A5

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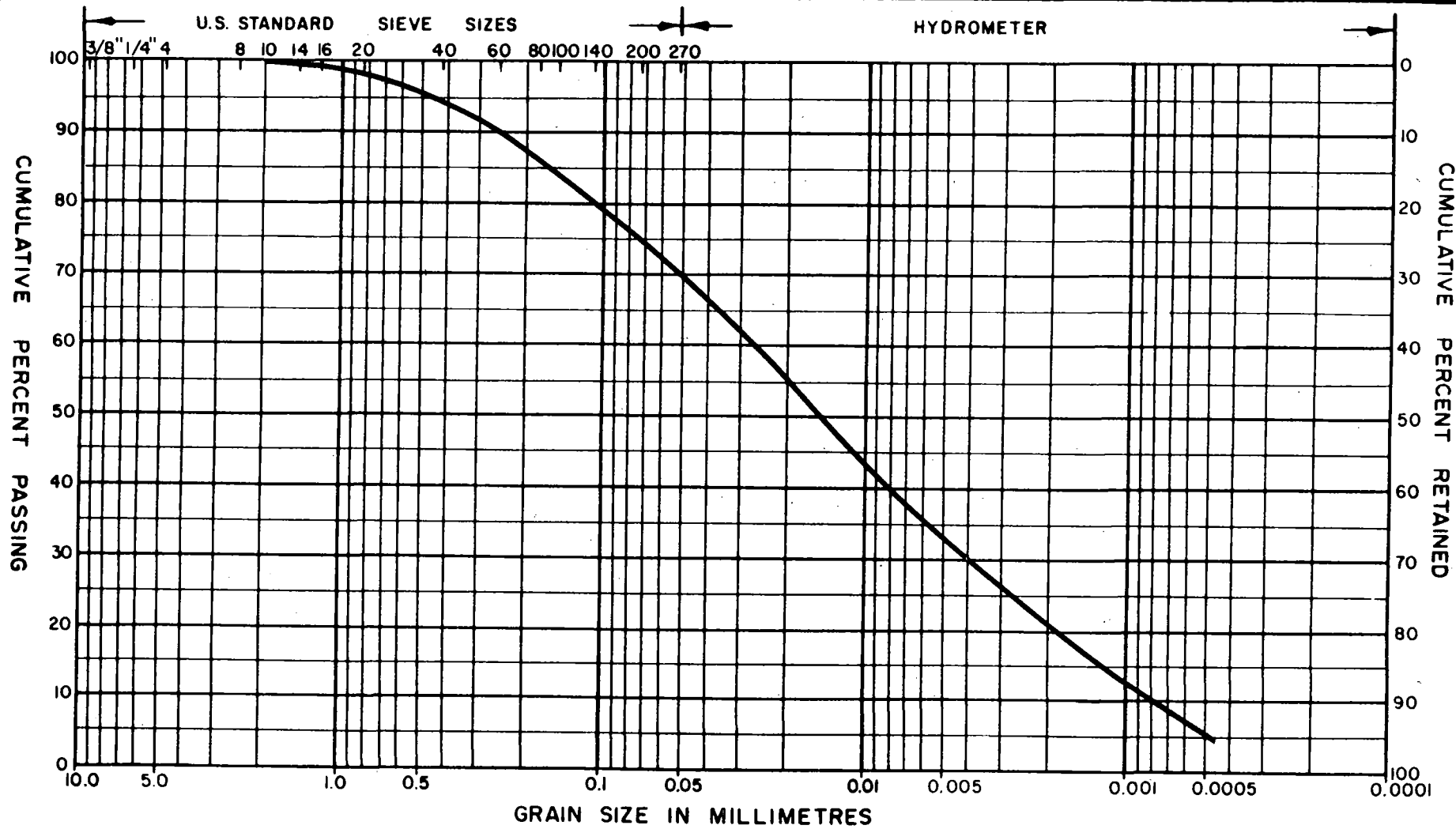
GRAIN SIZE DISTRIBUTION CURVE

ENVIRONMENT CANADA - CFS LOWTHER

OW1-84 SS1 1.5 - 2.0 m Project No. 390-841

A6



UNIFIED	GRAVEL	COARSE	MEDIUM	FINE		SILT & CLAY			
		SAND							
M.I.T.	GRAVEL	COARSE	MEDIUM	FINE		COARSE	MEDIUM	FINE	CLAY
		SAND				SILT			
U.S. BUREAU	GRAVEL	COARSE	MEDIUM	FINE	V.FINE	SILT		CLAY	
		SAND							

GS-060781

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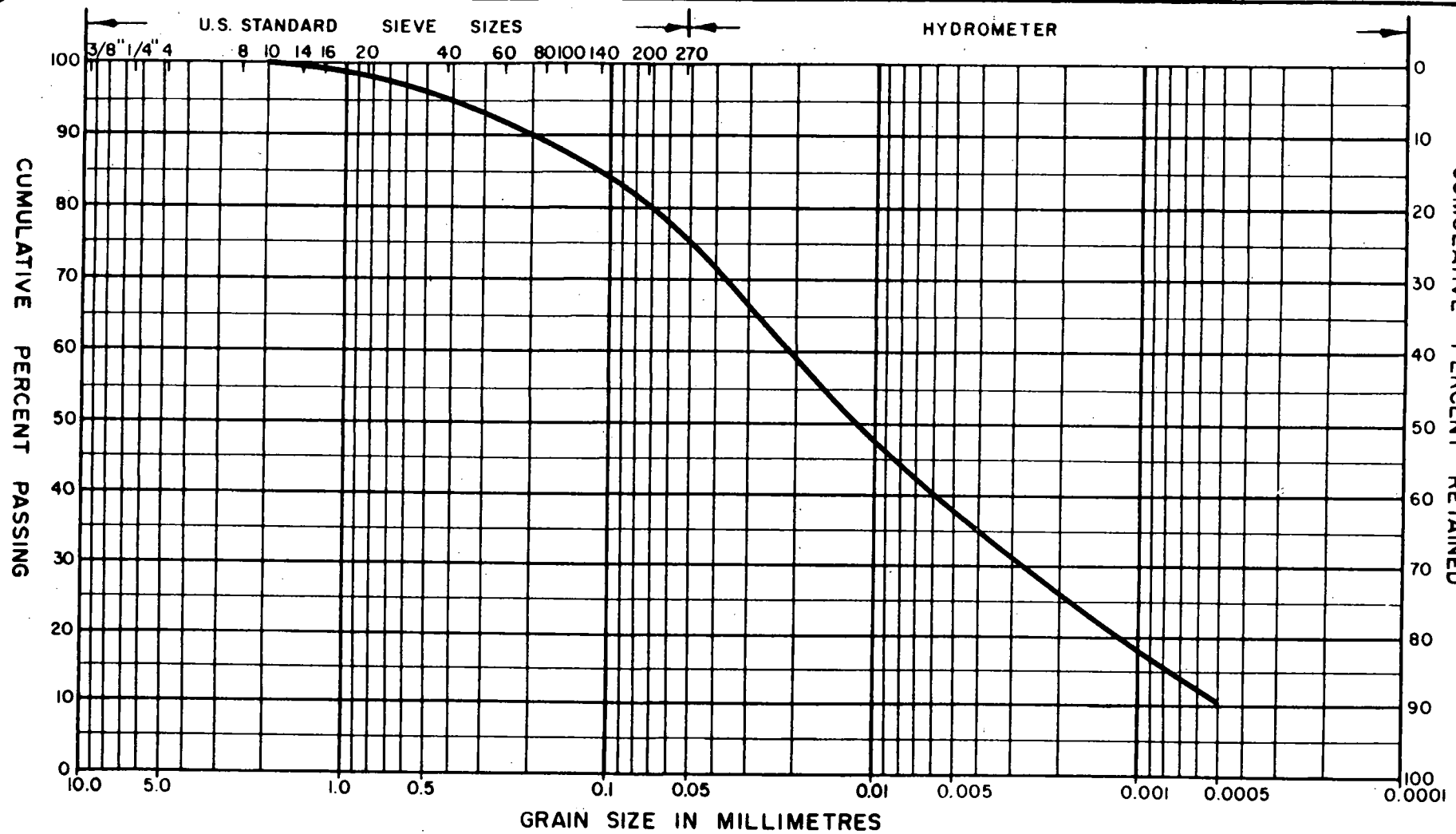
GRAIN SIZE DISTRIBUTION CURVE

ENVIRONMENT CANADA - CFS LOWTHER

A7

OW2-84 SS3 4.5 - 5.0 m Project No. 390-841



UNIFIED	GRAVEL	COARSE	MEDIUM	FINE		SILT & CLAY				
		SAND								
M.I.T.	GRAVEL	COARSE	MEDIUM	FINE		COARSE	MEDIUM	FINE	CLAY	
		SAND				SILT				
U.S. BUREAU	GRAVEL	COARSE	MEDIUM	FINE	V.FINE	SILT			CLAY	
		SAND								

iii) Groundwater

The configuration of the water table is shown on Figures A-4 and A-5. It is a subdued reflection of the surface topography. The groundwater flow paths, which are perpendicular to the water table contours, are southwestward at the landfill site.

Groundwater uses in the area are limited to the bedrock aquifer. Ontario Ministry of the Environment (MOE) water well records for the area indicate deep (45-50 m) bedrock wells predominate. Private wells in the area are usually 45-50 m deep. Supplies are reported as adequate. The closest private residence is over 500 m from the landfill, just west of the Station entrance. The well is located about 30 m northeast of the residence. MoE investigations indicate it is an old dug well. There have been no water quality complaints.

The Station obtains its water supply from a network of deep wells. There are records of nine wells on the base, installed between 1956 and 1972. The current lead well is 1500 m southeast of the landfill. It is 45.8 m deep. The driller's log shows it has a specific capacity (pumping rate divided by drawdown) of .13 L/s/m (.62 gpm/ft).

Two of the Station's supply wells (PW 3 and PW 4) are located near the landfill. PW 4 has been taken out of service due to reported water quality problems. PW 3 is connected to the distribution system and operates on demand. The well is automatically operated when the water level in the reservoir drops below a certain point. This usually only occurs during special projects using large quantities of water (eg. ice making); however, water from PW 3 then becomes mixed with water from the lead well. The drawdown cones from PW 3 and PW 4 probably extend beneath the landfill when they are in operation.

4.3.2 Water Budget

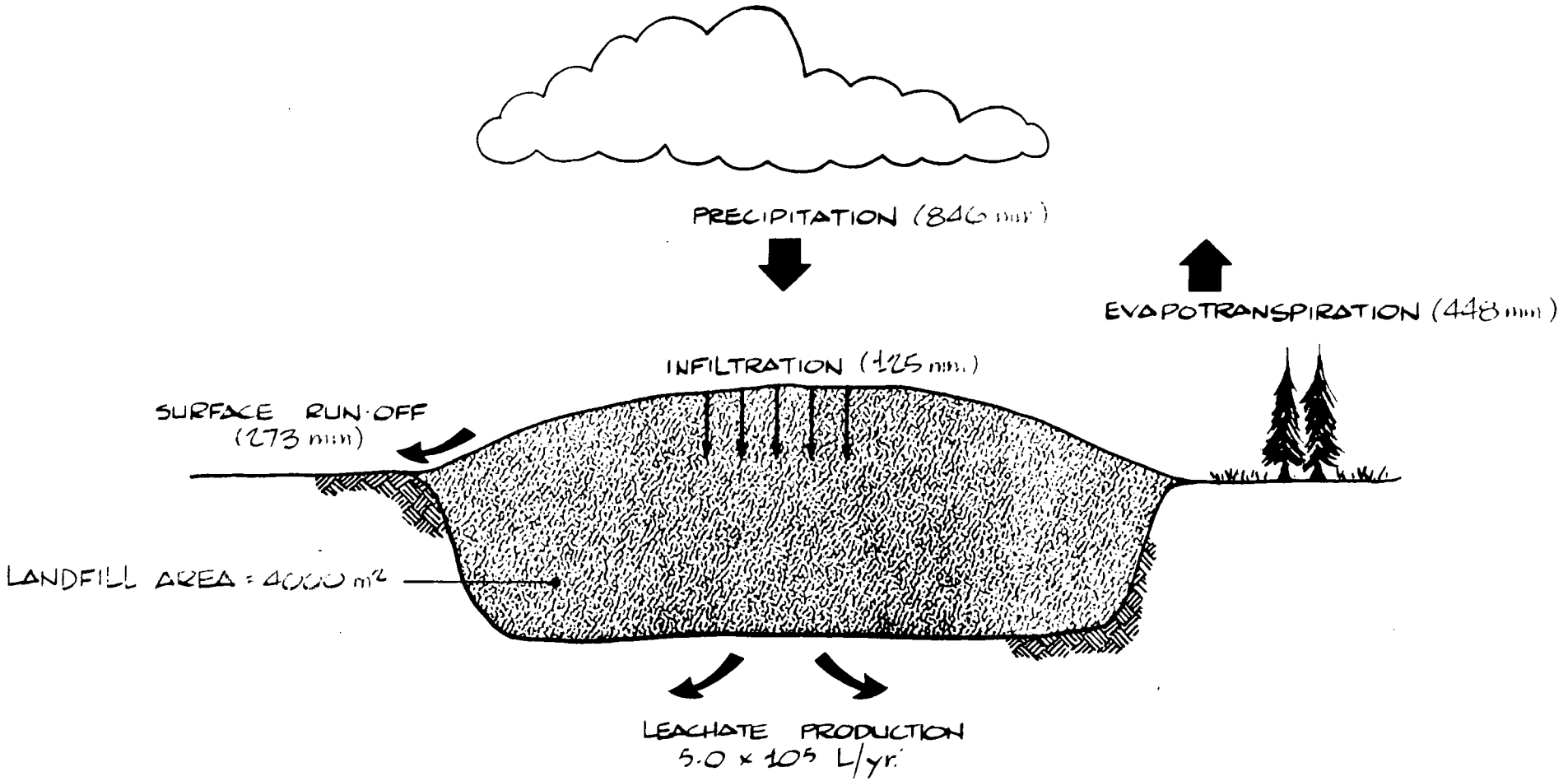
The site receives an average of 846 mm precipitation annually, based on thirty year normals (1941-1970) for the Mattice TCPL Meteorological Station (located approximately 20 km west of Lowther). In the Lake Superior Basin, evapotranspiration losses are about 53% of precipitation (The Climate of the Great Lakes Basin, 1972). This amounts to about 448 mm.

The landfill has a silty clay till cover material. An infiltration rate of 100-150 mm/a can be expected in these soils. Using an average infiltration rate of 125 mm/a, the annual loss to runoff would be 273 mm. The annual average water budget and leachate production rate for the CFS Lowther site are shown schematically on the following diagram, Figure A-8.

Leachate production at the CFS Lowther landfill will be equivalent to the infiltration rate. The landfill is about 4000 m^2 in area. Assuming an infiltration of 125 mm/a, the average annual leachate production rate would be about 5.0×10^5 L/year or 0.016 L/s.

The permeability of the till was measured as follows: 1.2×10^{-5} cm/s at OW 1-84 and 5×10^{-7} cm/s at OW 4-84. The higher value at OW 1-84 (the shallowest well) probably reflects the effect of fractures in the surficial weathered zone. The groundwater flux in the till beneath the landfill can be calculated from $Q = KiA$
where:

Q = groundwater flux
K = permeability
i = hydraulic gradient
A = cross sectional area through which flow occurs



INFILTRATION = TOTAL PRECIPITATION - EVAPOTRANSPIRATION - RUNOFF
(125 mm) (846 mm) (448 mm) (273 mm)

SITE: CFS LOWTHER	**ENVIRONMENT CANADA** Abandoned Waste Disposal Sites Phase II	PROJECT NO. 390-841	MAR. 1984
		MORRISON BEATTY LIMITED PROCTOR & REDFERN LIMITED	**A8**

Assuming K = 10^{-5} cm/s, i (slope of water table) = 0.1 and A (perimeter of landfill (assuming radial flow) times average depth of till) = 250 m^2, the flux would be .0002 L/s. This is a factor of 100 less than the predicted leachate production rate. This indicates the water table would mound in the landfill to cause seasonal toe seepage.

Determination of vertical gradients in the groundwater regime was beyond the scope of this study but may be warranted in light of the possible existence of contaminants in the Station's bedrock well. This would require the installation of nested wells.

It should be noted that a higher K in the weathered till would allow greater lateral migration via the groundwater regime. This would reduce the amount of mounding and volume of toe seepage.

4.3.3 Groundwater Quality and Leachate Impacts

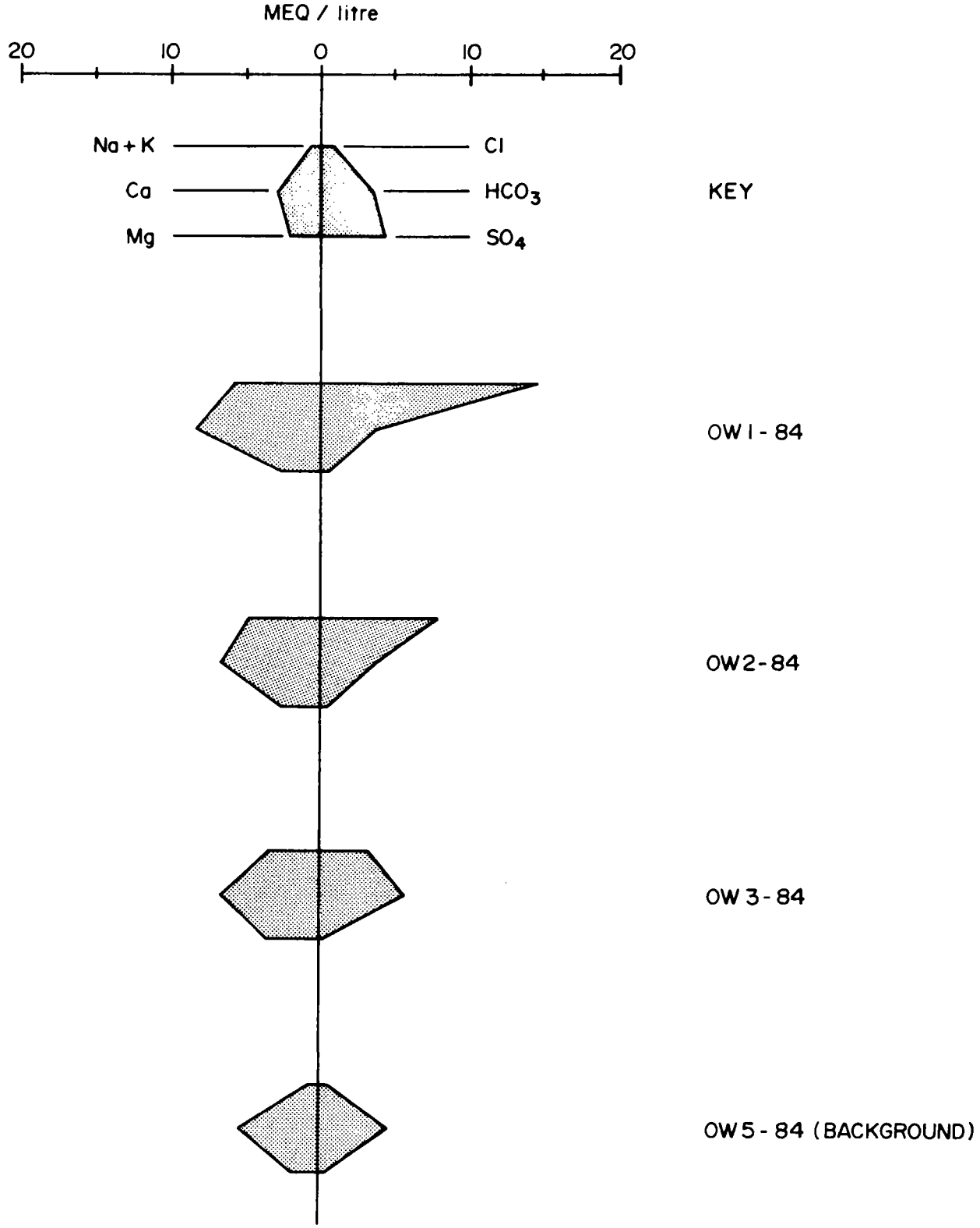
A detailed evaluation of key leachate indicators is presented in the following sections.

i) pH and Conductivity

Natural groundwater has pH in a range of 6 to 9. All observation wells at this site have pH levels in this range. Conductivity ranges from a background level of 310 umhos/cm^2 to 500 umhos/cm^2 in OW 1-84.

ii) Major Ions

The ionic balance is listed in Table A-3 in Section 2 of the Appendix. Stiff diagrams showing the major anion and cation distribution are on Figure A-9 on the following page.



Major Anion and Cation Distribution

SITE: CFS LOWTHER | **A9**

The stiff diagrams show a distinct change in ion distribution between the background well (OW 5-84) and the other wells. Wells OW 1, OW 2 and OW 3-84 all show evidence of a leachate impact. It appears that the leachate mixing zone radiates out from the landfill in all directions.

The chloride ion is relatively mobile in groundwater and is a good indicator of leachate migration. Chloride concentrations in OW 1-84 are about 100 times background levels. It is over twice the recommended Ontario drinking water criteria of 250 mg/L. The chloride level in OW 2-84 is also above the recommended criteria (50 times background). In OW 3-84, chloride is 20 times background.

Sodium and potassium are also elevated in OW 1, OW 2 and OW 3-84. Concentrations of calcium, magnesium and sulphate are only slightly elevated (less than twice background).

iii) Organics

COD is the measure of oxygen required to oxidize organic and inorganic compounds. The background well, OW 5-84, had a COD concentration of 19 mg/L. The COD mixing zone extends to OW 1 and OW 2-84, which show concentrations about twice background levels. OW 3-84 was not impacted by COD.

TOC (total organic carbon) is one of the best measures of the organic content of leachate from landfills. TOC is less than 10 mg/L in all wells. The TOC mixing zone appears to be confined close to the landfill.

iv) PCB's

Two analyses for PCB's were also completed. OW 1-84, closest to the landfill, contained 0.03 ug/L PCB's and OW 3-84 contained 0.20 ug/L. It appears that there is some PCB contamination from past disposal practices; however, these concentrations are below the MoE recommended maximum of 3 ug/L in drinking water.

v) Summary of Leachate Characteristics and Impacts

Maximum leachate strengths were not determined at this site; however, the general leachate mixing zone extends 35 to 50 m south from the landfill. It appears that the water table has mounded within the landfill based on the observed radial migration of the leachate constituents.

PCB's were detected in the two wells sampled for this parameter. The levels are below the recommended limit for drinking water.

Although no analyses are available for supply well PW 4, the contamination in this well may be caused by the landfill. Further monitoring is being undertaken.

We understand that the MoE has arranged with CFS Lowther to sample and analyze water from PW 3 which is still in use as a supplementary well. CFS Lowther personnel sampled the well, but the analyses are not yet available. According to the MOE in Kapaskasing, this is the first time the well has been sampled. PW 3 is located upgradient of the landfill; however, when pumping takes place, it is expected that the drawdown cone will extend beneath the site. This would draw leachate towards the well. This could lead to contamination of this water source as well, if leachate constituents have not already reached it.

4.3.4 Methane Impacts

Permanent gas probes were installed in two locations (see Figure A-3) for future methane monitoring. Readings were taken but no methane gas was detected; however, soil conditions should be allowed to stabilize around the probes prior to taking readings.

Methane production can be expected in the landfill, but it should not migrate far from the site through the till overburden. Building should be restricted from the landfill site and immediately adjacent to it to prevent future methane hazards.

4.3.5 Potential Hydrogeologic Impacts

There is a distinct possibility that leachate constituents from the landfill site could enter the water supply for the Station when the supplementary well (PW 3) is used. One production well (PW 4) has already been put out of service due to a contamination problem. Although the reason for abandonment is not certain, leachate from the landfill is the likely cause.

Leachate constituents have migrated over 35 m from the landfill. The overburden is less than one metre thick in some places around the landfill. There is a potential for leachate to enter the bedrock aquifer since adequate protection may not be provided by the overburden.

Methane production should not be a problem at this site as long as building development does not encroach closer to the site.

4.4 Future Land Use Plans

The CFS Lowther disposal site is presently vacant. Dicussions with the Department of National Defence (DND) revealed that there is no present intended use for the site. The site is expected to remain as vacant open space.

4.5 Conclusions

Leachate has migrated away from the site in the till and has probably entered the bedrock aquifer. The water analyses indicate a decay in leachate strength is occurring.

The permeability of the till is low. Under this condition the water table is expected to be mounded in the disposal site. This is further indicated by the presence of leachate in wells around the site perimeter.

The drawdown cones from the two production wells (PW 3 and PW 4) probably extend beneath the landfill during pumping. This could induce leachate contaminants to the wells. PW 4 has already been abandoned because of apparent contamination problems.

Methane generated at this site will not pose a problem providing building is restricted on the landfill and a 50 m buffer zone around it.

4.6 Recommendations

The following recommendations are based on the Phase II field program:

1. Production well PW 3 should be taken out of operation until its water quality is evaluated.

2. A monitoring program should be developed which would include:

   - resampling the observation wells, PW 3, PW 4 and nearby private wells

   - confirm and monitor leachate seepage

3. If contaminants are identified in the bedrock aquifer at PW 3 and PW 4, the following should be carried out:

   - installation of nested observation wells to establish vertical gradients and confirm the downward and lateral extent of leachate migration

   - installation of observation wells in the landfill to define the water table mound and establish leachate quality at the source

4. A site closure plan should be developed for this site. It should address the need for additional cover, contouring to promote runoff, vegetation and long-term maintenance.

APPENDIX

CFS LOWTHER : SITE NO. D-75

SECTION 1 : OBSERVATION WELL LOGS

SECTION 2 : TABLES

SECTION 3 : SITE SUMMARY REPORT

SECTION 1 : OBSERVATION WELL LOGS

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OW1/84

CLIENT ENVIRONMENT CANADA FILE NO. 390-841

PROJECT ENVIRONMENTAL IMPACT LOCATION C.F.S. LOWTHER

GEOLOGIST/ENGINEER T.H. DATE COMPLETED JAN. 23/84

DESCRIPTION	DEPTH metres	DEPTH feet	SAMPLE no.	SAMPLE type	SAMPLE "N"	WELL DETAIL	REMARKS BLOWS PER FOOT 10 20 30 40 50 60 70 80 90
TOPSOIL, silty black						A	
TILL, sandy silty clay with stones, wet, compact	1					C	
		5				F	
	2					E	
Refusal @8.5'	3	10					
	4						
		15					
	5						
	6	20					
	7						
		25					
	8						
	9	30					

GS- GRAB SAMPLE SS- SPLIT SPOON ST- SHELBY TUBE "N" BLOWS PER FOOT WATER LEVEL ▽

WL-040281

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GP1/84

CLIENT ENVIRONMENT CANADA FILE NO. 390-841

PROJECT ENVIRONMENTAL IMPACT LOCATION C.F.S. LOWTHER

GEOLOGIST/ENGINEER T.H. DATE COMPLETED JAN.23/84

DESCRIPTION	DEPTH metres	DEPTH feet	SAMPLE no.	SAMPLE type	SAMPLE "N"	WELL DETAIL	REMARKS BLOWS PER FOOT 10 20 30 40 50 60 70 80 90
TOPSOIL, silty black						A	
TILL, sandy silty clay, brown, weathered, wet	1	5				B D E	
	2						
Refusal @ 6.5'	3	10					
	4						
		15					
	5						
	6	20					
	7						
		25					
	8						
	9	30					

GS- GRAB SAMPLE SS - SPLIT SPOON ST - SHELBY TUBE "N" BLOWS PER FOOT WATER LEVEL ▽

WL-04080-1A

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OW2/84

CLIENT ENVIRONMENT CANADA FILE NO. 390-841

PROJECT ENVIRONMENTAL IMPACT LOCATION C.F.S. LOWTHER

GEOLOGIST/ENGINEER T.H. DATE COMPLETED JAN 23/84

DESCRIPTION	DEPTH metres	DEPTH feet	SAMPLE no.	SAMPLE type	SAMPLE "N"	WELL DETAIL	REMARKS BLOWS PER FOOT 10 20 30 40 50 60 70 80 90
TOPSOIL, silty clay black							
TILL, silty clay with stones, brown, moist compact	1	5				A	
	2					C	
Grey 9'	3	10					
	4						
TILL, clay with some subangular stones, saturated	5	15				E	
as above	6	20				F	
E.O.H. 20'	7						
	8	25					
	9	30					

GS- GRAB SAMPLE SS- SPLIT SPOON ST- SHELBY TUBE "N" BLOWS PER FOOT WATER LEVEL ▽

WL-040281

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OW3/84
GP2/84

CLIENT ENVIRONMENT CANADA FILE NO. 390-841

PROJECT ENVIRONMENTAL IMPACT LOCATION C.F.S. LOWTHER

GEOLOGIST/ENGINEER T.H. DATE COMPLETED JAN. 23/84

DESCRIPTION	DEPTH metres	DEPTH feet	SAMPLE no.	SAMPLE type	SAMPLE "N"	WELL DETAIL	REMARKS BLOWS PER FOOT
TOPSOIL, black silty							
TOPSOIL, black silty						A	
TILL, clayey silt to silty clay, fractured, some mottling, moist, compact	1					B	
		5				C	
	2					D	
						E	
Refusal @7'	3	10					
	4						
		15					
	5						
	6	20					
	7						
		25					
	8						
	9	30					

10 20 30 40 50 60 70 80 90

GS- GRAB SAMPLE SS - SPLIT SPOON ST - SHELBY TUBE "N" BLOWS PER FOOT WATER LEVEL ▽

WL-040281

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OW4/84

CLIENT ENVIRONMENT CANADA FILE NO. 390-841

PROJECT ENVIRONMENTAL IMPACT LOCATION C.F.S. LOWTHER

GEOLOGIST/ENGINEER T.H. DATE COMPLETED JAN.23/84

DESCRIPTION	DEPTH metres	DEPTH feet	SAMPLE no.	SAMPLE type	SAMPLE "N"	WELL DETAIL	REMARKS BLOWS PER FOOT 10 20 30 40 50 60 70 80 90
TOPSOIL silty						A	
TILL clay silt-silty clay with stones, moist campact	1					C	
		5				D	
	2					E	
Refusal @ 7'	3	10					
	4						
		15					
	5						
	6	20					
	7						
		25					
	8						
	9	30					

GS - GRAB SAMPLE SS - SPLIT SPOON ST - SHELBY TUBE "N" BLOWS PER FOOT WATER LEVEL ▽

WL-040281

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OW5/84

CLIENT ENVIRONMENT CANADA FILE NO. 390-841
PROJECT ENVIRONMENTAL IMPACT LOCATION C.F.S. LOWTHER
GEOLOGIST/ENGINEER T.H. DATE COMPLETED JAN.23/84

DESCRIPTION	DEPTH metres	DEPTH feet	SAMPLE no.	SAMPLE type	SAMPLE "N"	WELL DETAIL	REMARKS BLOWS PER FOOT 10 20 30 40 50 60 70 80 90
TOPSOIL, black silty clay						A	
TILL, silty clay wet with stones	1					C	
		5					
Grey 10'	2					D	
	3	10				E	
	4						
Refusal @ 13.25'		15					
	5						
	6	20					
	7						
		25					
	8						
	9	30					

GS- GRAB SAMPLE SS - SPLIT SPOON ST - SHELBY TUBE "N" BLOWS PER FOOT WATER LEVEL ▽

WL-040881

LEGEND

Well Detail Remarks

A NATIVE BACKFILL

B 13mm dia. PVC

C 38mm dia. A.B.S.

D SAND

E SLOTTED AREA WITH NYLON FILTER CLOTH

F PEA GRAVEL

G

H

I

J

K

L

Stratigraphy

- TOPSOIL
- PEAT OR MUCK
- CLAY
- TILL
- SILT
- LIMESTONE
- SAND
- DOLOSTONE
- GRAVEL
- SHALE
- COBBLES, BOULDERS
- BEDROCK
- FILL
- REFUSE

SECTION 2 : TABLES

Table A1 - Water Levels
Table A2 - Chemical Water Analysis
Table A3 - Ionic Balance

PROJECT ENVIRONMENT CANADA **TABLE** A - 1 **SHEET** Site No. D-75, Lowther CFS

OBSERVATION WELL	WELL DETAILS						GROUNDWATER ELEVATIONS (metres A.S.L. /local datum)						
	Nest No.	Ø cm	Type	ELEVATIONS									
				Ground	Top of pipe	Top of screen	Jan 28, 1984						
OW 1		4	ABS	256.17	257.21		255.41						
OW 2		4	ABS	254.83	256.46		254.20						
OW 3		4	ABS	254.96	255.85		253.98						
OW 4		4	ABS	256.91	257.45		254.84						
OW 5		4	ABS	255.95	257.31		255.27						
PW 3*				256.15			255.06						
PW 4*				-									

Piezometer **Standpipe**

* CFS Lowther water wells

TABLE A - 2
CHEMICAL WATER ANALYSIS

Client: Environment Canada
Project Description: Waste Disposal Sites: Lowther
Project No.: 390-841

Date Sampled: January 28, 1984
Date Analyzed: February 28, 1984
Analyzed by: Technical Services Laboratory

Parameter	OW 1-84	OW 2-84	OW 3-84	OW 4-84	OW 5-84		
pH	7.3	7.7	7.4	N.S	7.6		
*Conductivity (umhos/cm^2)	500	410	440	325	310		
Alkalinity	275	295	435	N.S	335		
COD	39	42	28	N.S	19		
TOC	4.0	12.5	9.0	N.S	8.5		
PCB's (ug/L)	.03	N.S	.20	N.S	N.S		

Concentrations in mg/ℓ excepted as noted * FIELD MEASUREMENT N.S - no sample

WT - 070979

TABLE A - 2
CHEMICAL WATER ANALYSIS

Client: Environment Canada
Project Description: Waste Disposal Sites: Lowther
Project No.: 390-841

Date Sampled: January 28, 1984
Date Analyzed: February 28, 1984
Analyzed by: Technical Services Laboratory

Parameter	OW 1-84	OW 2-84	OW 3-84	OW 4-84	OW 5-84		
Major Ions							
Cations							
Calcium	163	129	133	N.S	113		
Potassium	6	11	14	N.S	2.2		
Magnesium	30	26	41	N.S	24		
Sodium	133	102	67	N.S	8.1		
Anions							
Chloride	526	284	112	N.S	5.5		
Sulphate	15	17	12	N.S	9.5		
Bicarbonate	226	242	357	N.S	275		

Concentrations in mg/ℓ excepted as noted

N.S - no sample

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IONIC BALANCE

A-3

Area of Survey Site No. D-75, CFS LOWTHER **Sample :** Groundwater **Date** January 28, 1984

CATIONS

ANIONS

Ion	Ca			Mg			Na			K			Na+K	Total	Alkalinity			SO_4			Cl			Total	Diff.
Conversion Factor	ppm x .0499			ppm x .0822			ppm x .0435			ppm x .0256				Cations	HCO_3 ppm x .0164 CO_3 ppm x .0333			ppm x .0208			ppm x .0282			Anions	%
Well No.	ppm	epm	%	ppm	epm	%	ppm	epm	%	ppm	epm	%		epm	ppm	epm	%	ppm	epm	%	ppm	epm	%	epm	
OW 1-84	163	8.13		30	2.47		133	5.79		6	0.15		5.94	16.54	275	3.71		15	0.31		526	14.83		18.85	12%
OW 2-84	129	6.44		26	2.13		102	4.44		11	0.28		4.72	13.29	295	3.97		17	0.35		284	8.01		12.33	7%
OW 3-84	133	6.64		41	3.37		67	2.91		14	0.36		3.27	13.28	435	5.85		12	0.25		112	3.16		9.26	30%
OW 5-84	113	5.64		24	1.97		8.1	0.35		2.2	.056		0.91	8.02	335	4.51		9.5	0.20		5.5	0.16		4.87	39%

SECTION 3 : SITE SUMMARY REPORT

SITE REPORT SUMMARY

BACKGROUND:

1. General

Site Name: CFS Lowther

Site Area: 4000 m^2

Site Owner: Dep't of National Defence

Date of Operation: 1963 to 1973

Site Location: 356300 5491300

Name of Operator: U.S.A.F. and DND

2. Land Uses

Original - wooded

Present - vacant

Future Potential Land Use - none identified

3. Present Development

On-Site - none

Abutting (distance) - CFS Lowther army buildings including a small building for the pumping well.

FIELD INVESTIGATION RESULTS:

1. Type of Investigation Performed - site reconnaissance, test drilling, split-spoon sampling, observation well and gas probe installation, water level monitoring, permeability tests and groundwater sampling.

2. Site Chacteristics

Site Access - from Hwy #11, through the controlled entrance of CFS Lowther

Site Visibility - the site is not visable to the public

Site Security - controlled by CFS Lowther; however, the site is not fenced and is accessible to any base personnel

Vegetation on Site - sparse weeds

3. Waste Disposal Practices

Quantity of Refuse - approx. 12000 m^3

Thickness of Waste - 3 to 4 metres

Type of Waste (confirmation) - commercial and domestic; rubble, automobile parts, kitchen wastes etc. from U.S.A.F; some possible PCB contaminated oil (temporary storage on site)

Cover Material and Thickness - silty clay to clayey silt (0.5 to 1.0 m thick)

4. Hydrogeologic Setting

Overburden type and thickness - silty clay till; depth ranges from 2 m to about 6.5 m

Bedrock type - PreCambrian migmatites, conglomerate, sandstone, mudstone, marble, chert, and iron formation

Local topography - gently sloping to the south, local depressions to the west and north

Drainage Patterns (regional and local)
- some wetlands in depressions
- drainage south of site is to the south-east; north of site, drainage is to the north

Surface water bodies - none with 2 km

Depth to Water Table - ranges from .5 m to 2.0 m in observation wells

Direction of Groundwater Flow - southwest

5. Identified Impacts

Leachate characteristics - the actual leachate was not analyzed, however, observation wells at the toe have elevated concentrations of chloride, sodium, potassium, COD and PCB's

Evidence of Leachate seepage - none

Evidence of leachate migration and attenuation - leachate has migrated up to OW 1 and OW 2 (10-35 m), most parameters have been attenuated by OW 3 (30 m) although methane may migrate short distances in the winter months under frozen conditions

Evidence of gas generation and migration - none

Vegetation stress - none noted (snow covered during field visit)

Settlement and erosion - not a problem at this site

Other potential sources of contamination - none noted

POTENTIAL IMPACTS:

1. Leachate

Water Supplies within 500 m - two wells are located within 50 m of the landfill; one is used as an emergency supply, the other (within 10 m) is not in use (contaminated)

Potential human hazard - there is a significant potential for leachate constituents to reach the supplementary well (PW 3) when it is in use

Potential environmental hazard - negligible

2. Methane

Nearby buildings - closest occupied building is located 65 m to the south

Potential human hazard - may be some methane migration in winter months, however methane production should be fairly low at this site because of limited organic material in the waste

Potential environmental hazard - negligible

5.0 CFB KINGSTON: SITE NO. D-81

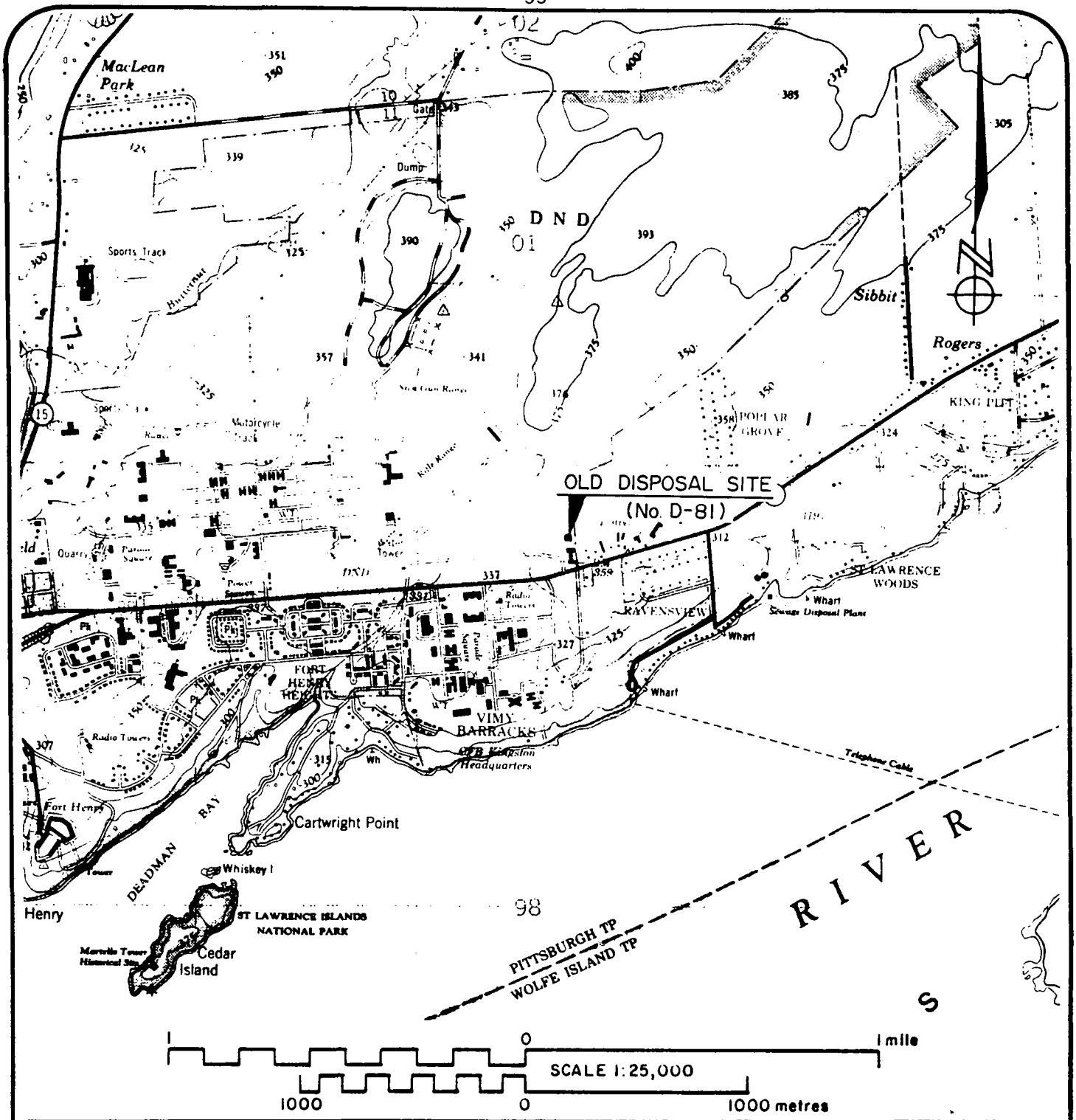
5.1 Introduction

The CFB Kingston disposal site is located on the Department of National Defence's (DND) CFB Kingston base. The Base is on the eastern boundary of the City of Kingston. The disposal site is adjacent the eastern property boundary. The regional location of the site is shown on Figure B-1 on the following page.

The site was operated by DND's Defence Research Laboratories from 1951 to 1964. The laboratory was in an abandoned building known as Building H55. This building is located about 60 m southwest of the disposal site. According to DND's Research, wastes from biological warfare research was disposed of at the site. The term "war-fare" may be a misnomer since it was used to describe all training, research and development even if it was defencive in nature. The normal procedure was to autoclave the wastes in high pressure steam and burn them leaving small amounts of inorganic ash. No documentation is available on the quantity or types of bacterial wastes disposed of in this manner.

The Defence Research Laboratory was also involved in research involving low-level radioactive tracers to monitor animal physiology. These tests are well documented. The radioactive tracers were C^{14} and Cr^{51} which are beta-emitters. The remains of small laboratory test animals were placed in plastic bags inside metal cans and disposed of in a small trench.

From 1964 to 1975, the Royal Military College (affiliated with DND) used the site for disposal. Laboratory reagents are reported to have been disposed of here; however, there are no records of the materials placed in the site.



ENVIRONMENT CANADA
Abandoned Waste Disposal Sites
Phase II

SITE: CFB KINGSTON

TOPOGRAPHIC LOCATION

MORRISON BEATTY LIMITED

PROCTOR & REDFERN LIMITED

MAR. 1984

B1

The Defence Research Laboratory wastes were placed in a trench near the east property line. The area surrounding the trench is densely wooded and has been fenced. "No Digging" warning signs have been placed around the site. A lawn and parking area surround the fenced area to the south and west; private property abuts it to the east and woods abut it to the north.

Site access is through the CFS Kingston controlled access gate. The fenced area and warning signs are visible from Highway #2 which is located about 200 m to the south. The site location can be seen on Figure B-2, overleaf.

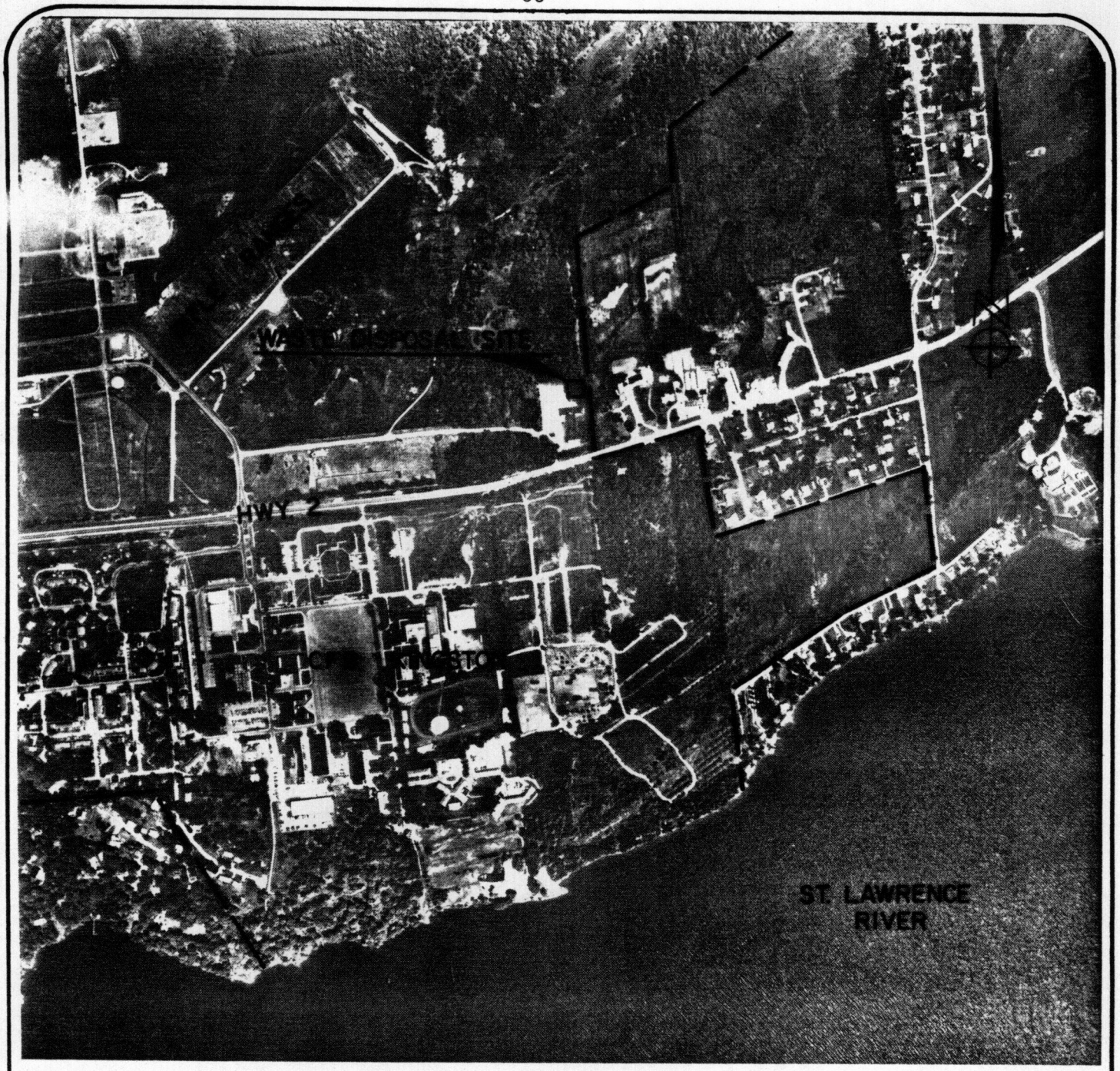
5.2 Site-Specific Studies

The general study methods carried out for this site are outlined in Section 3.0. Some aspects of the field program were treated differently from the other sites studied because of the hazardous nature of wastes reported to be buried at this site. The specific program for CFB Kingston involved the following:

- A detailed investigation of reported wastes disposed of at the site was conducted including discussions with DND Research personnel.

- A meeting and site reconnaissance were held with Environmental Protection Service (EPS), Department of National Defence and the Ontario Ministry of the Environment personnel to discuss safety equipment and procedures for the field studies.

- Due to the unknown character of the waste, special precautions were taken to protect field staff. Protective clothing and respirators were worn by all field personnel including drillers and technologists. Only those involved in the safety program were allowed on the drilling site. Special decontamination and cleanup procedures were used. Radioactivity dosimeters were also worn since some radioactive wastes were reported to have been disposed of in the site. No measurable readings were recorded.



1/2 0 1/2 mile

SCALE 1:10,000

500 0 500 metres

ENVIRONMENT CANADA
Abandoned Waste Disposal Sites
Phase II

SITE: CFB KINGSTON

AIR PHOTO LOCATION

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MAR. 1984

B2

- Field studies included overburden augering, bedrock drilling and observation well installation. The wells are located in a grid surrounding the fenced area; however, no wells were placed within the fenced area.

- Observation well construction details are included in Section 1 of the Appendix. The well locations are shown on the following site plan, Figure B-3.

- Water levels were monitored in all observation wells. Groundwater elevations are included in Table B-1 (Section 2 of the Appendix). The well elevations were referenced to local datum. The bench mark is a metal pipe fitting located near the door at the northwest corner of Building #55.

- A permeability test was conducted on OW 2-84.

- All wells were sampled and samples were submitted to a private laboratory for analyses of pH, conductivity, COD, TOC, major ions and total organic halides (TOX). The results of these analyses are included in Table B-2 (Section 2 of the Appendix).

- Observation wells were sampled with individual samplers to avoid cross-contamination.

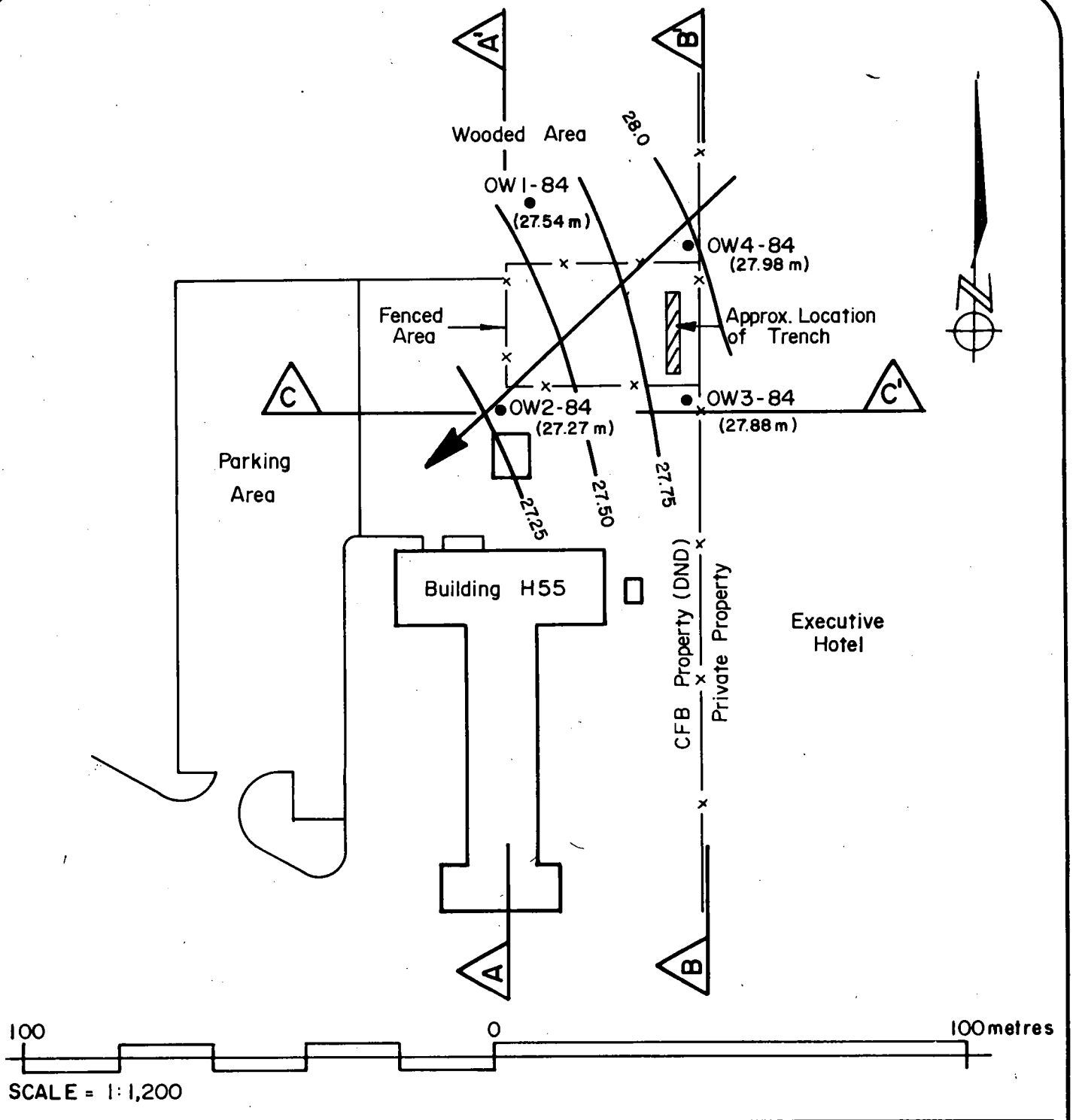
- In keeping with the safety procedures, the soil samples and the bedrock core were not removed from the site. Detailed inspections of the soil and bedrock core were made in the field. The samples were then returned to the disposal site.

5.3 Study Results

5.3.1 Hydrogeologic Setting

i) Geology

The site is situated in the physiographic region known as the Napanee Plain. It is a flat to undulating plain of limestone. Test drilling at the site confirmed a silty clay overburden which appears to be lacustrine in origin. It ranges in thickness from 0.82 m to 2.65 m.



LEGEND

- Observation Well
- Disposal Area
- Groundwater Contours (metres)
- (27.98 m) Water Table Elevation (local datum)
- Groundwater Flow Direction

ENVIRONMENT CANADA
Abandoned Waste Disposal Sites
Phase II
SITE: CFB KINGSTON

SITE PLAN

MAR. 1984

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B3

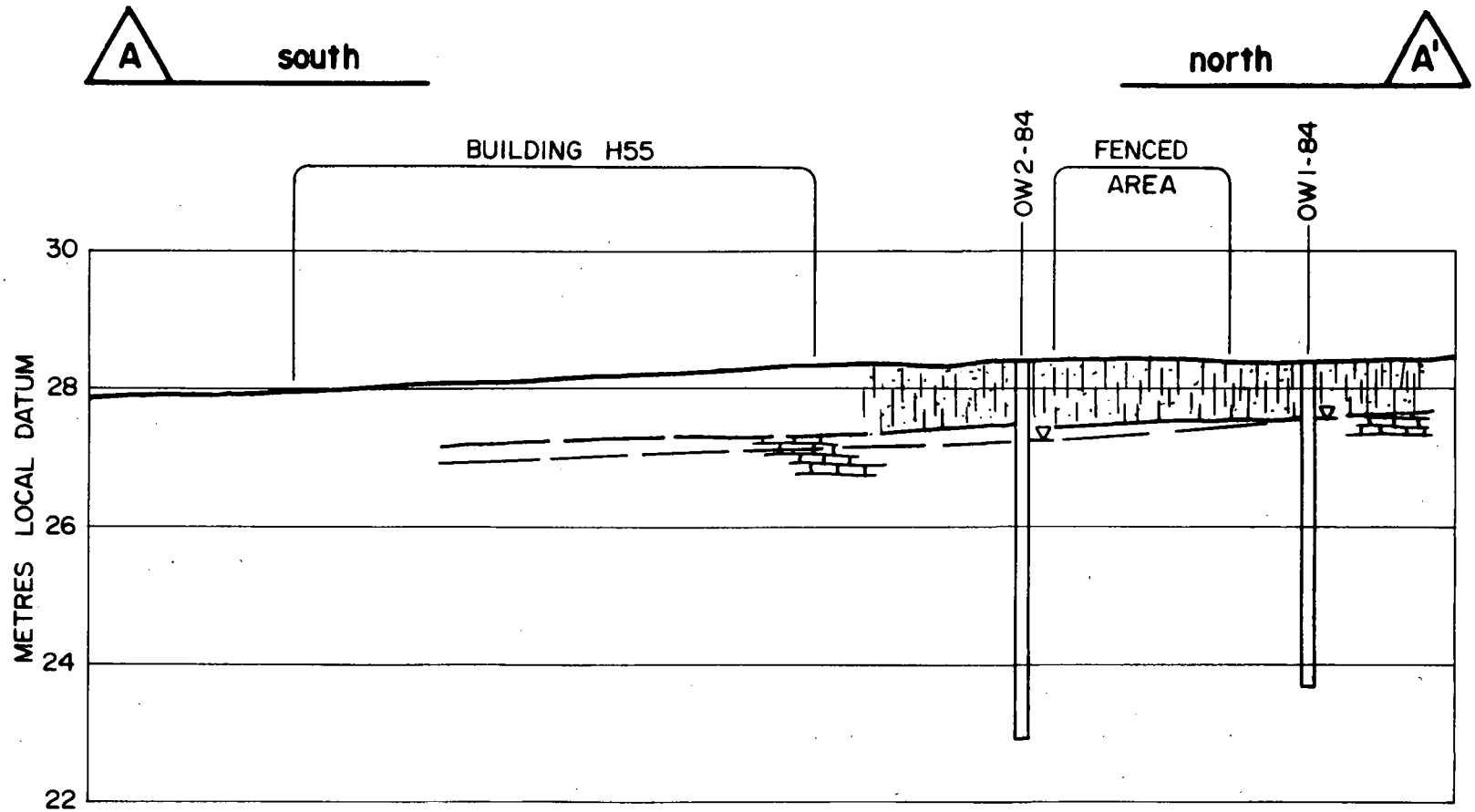
The underlying bedrock is limestone of the Trenton and Black River Groups. A bedrock core was retained and inspected at the site. It was logged as light grey to blue-grey, fine-grained limestone with shale partings. Some calcite crystals and iron staining were noted in the fractures.

Specific details of the overburden and limestone bedrock are listed in the borehole logs (Section 1 of the Appendix). The general stratigraphy is shown on the cross-sections in Figure B-4, B-5 and B-6 (following pages).

ii) Topography and Drainage

The area is relatively flat with a gentle slope to the northeast and a slight rise in elevation towards Highway #2. South of Highway #2, the surface slopes steeply southeast to the St. Lawrence River. There is more than a 30 m drop in elevation from the site to the river.

Waste and cover material in the disposal trench has settled leaving a slight depression in the surface; therefore, surface drainage will not occur away from the disposal trench. Drainage from the area around the trench is directed northeastward or to a small localized depression immediately south of the fenced area. Eventually, all drainage travels southeast to the St. Lawrence River.



LEGEND

Static Water Level
Water Table
Screened Interval

SCALE Horizontal = 1:1,000
Vertical = 1:100
Exaggeration = 10 times

Sand
Silt
Gravel
Till

Fill
Refuse
Limestone
Bedrock

25 0 25 metres
HORIZONTAL SCALE

CROSS-SECTION A-A'

(Refer to Figure B3)

ENVIRONMENT CANADA
Abandoned Waste Disposal Sites
Phase II
SITE: CFB KINGSTON

PROJECT NO. 390-841

MAR. 1984

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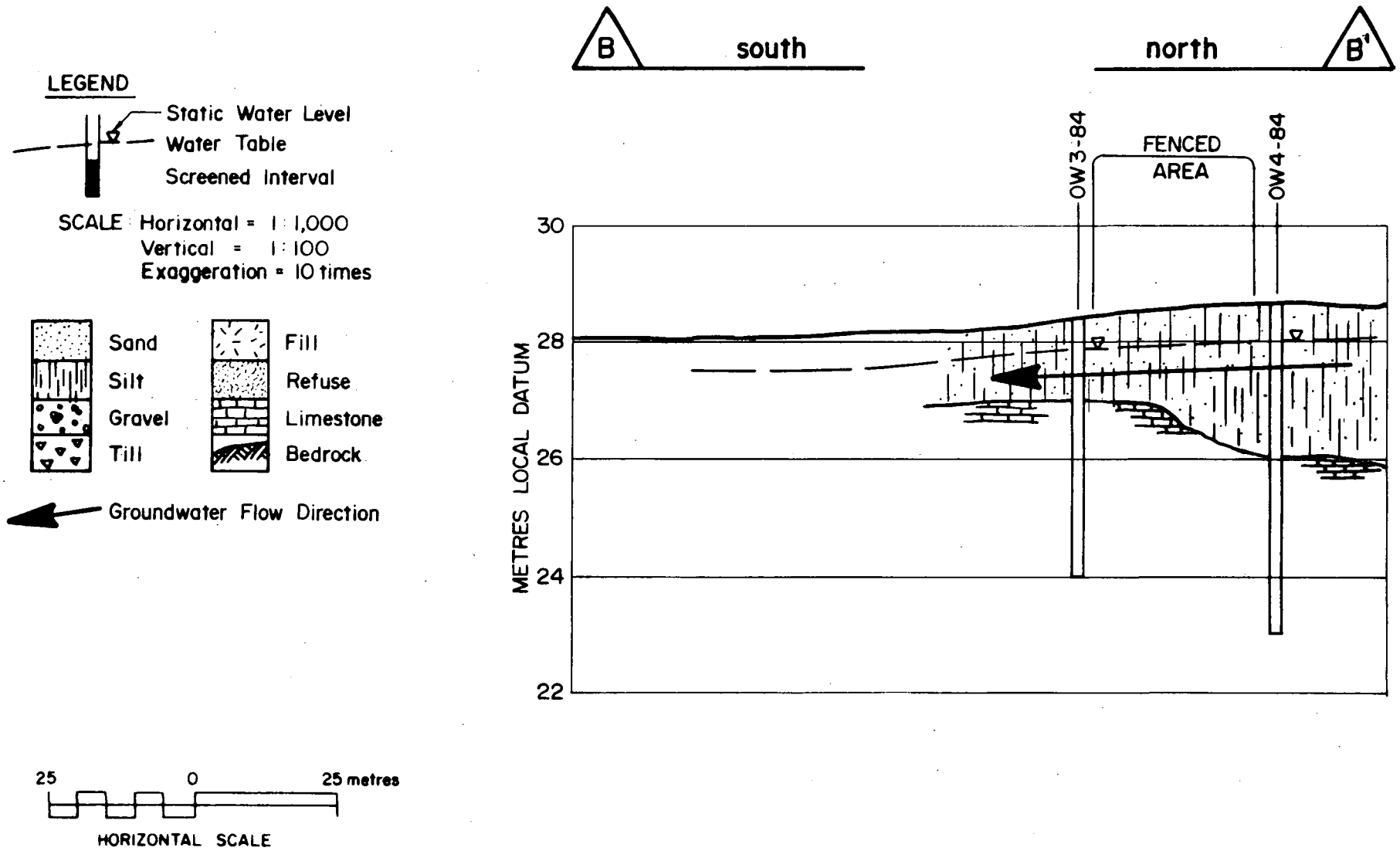
B4



CROSS-SECTION B-B'

(Refer to Figure B3)

ENVIRONMENT CANADA
Abandoned Waste Disposal Sites
Phase II
SITE: CFB KINGSTON

PROJECT NO. 390-841

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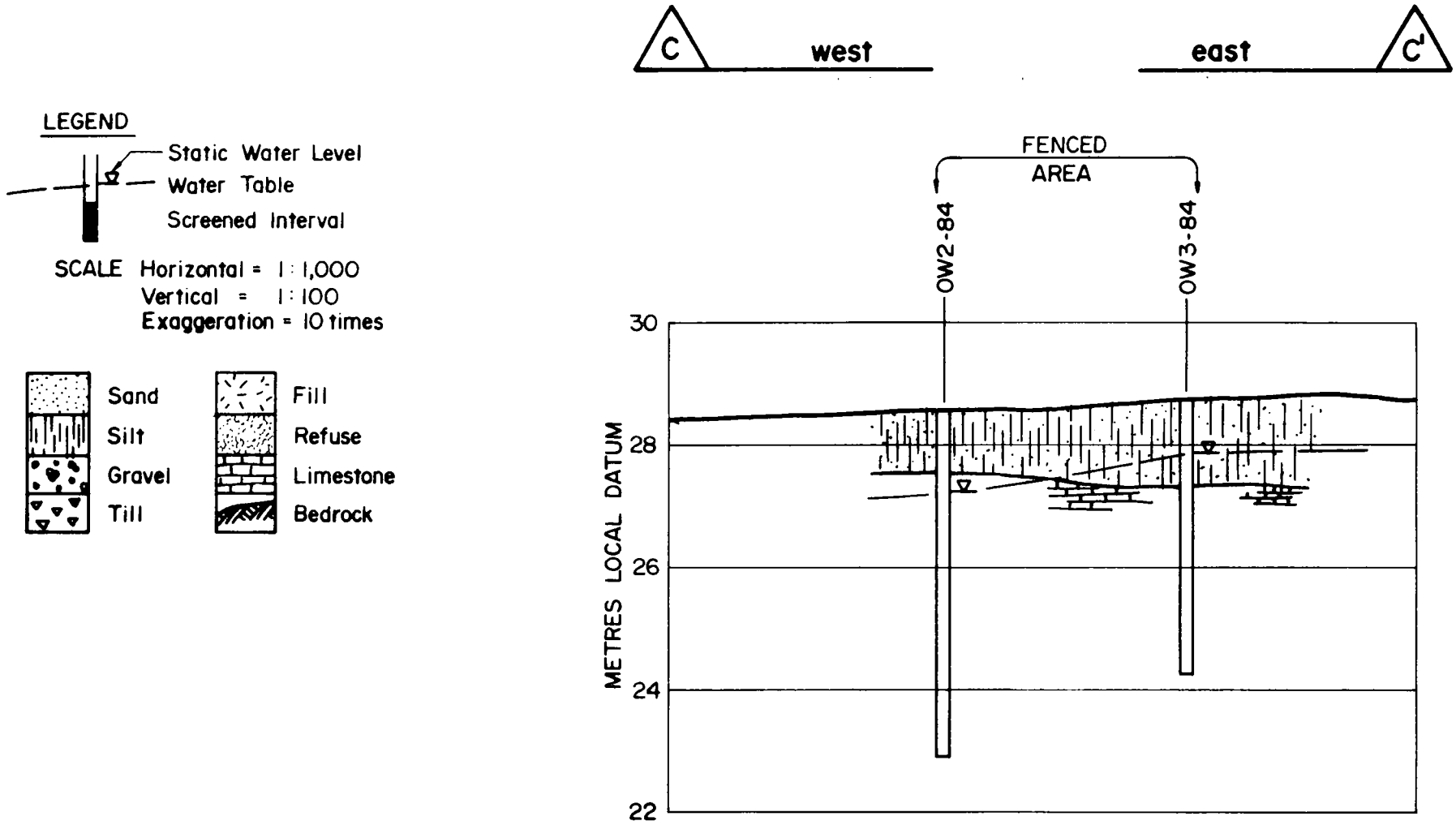
B5



CROSS-SECTION C-C'

(Refer to Figure B3)

ENVIRONMENT CANADA
Abandoned Waste Disposal Sites
Phase II
SITE: CFB KINGSTON

PROJECT NO 390-841

MAR. 1984

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B6

iii) Groundwater

The configuration of the water table in the vicinity of the observation wells is shown on Figure B-3. The direction of groundwater flow appears to be towards the southwest. Regional groundwater flow is expected to be towards the southeast. Local variations in flow pattern are likely due to the bedrock topography and fracture system.

Groundwater uses in the area are limited to the bedrock aquifer. Municipal water is available to CFB Kingston, subdivisions to the southeast (Ravenview) and properties east on Highway #2; however, a number of the hotels, businesses and residences on Highway #2 are still using private wells. These include MOE No. 635 (Petro Can station), No. 2634 (R. Isabell), No. 2635 (W. Knorr), No. 2636 (Leduc Bros.), No. 2641 (G. Lucas) and the C. MacCallum residence (no MOE record). The hotel property adjacent the site (The Executive Hotel) is served by municipal water.

5.3.2 Water Budget

Based on thirty year normals (1941-1970), the Kingston site receives an average of 898 mm precipitation per year. The meteorological station used to obtain this data was Kingston Ontario Hydro, the closest station to the study site. In the Lake Ontario Basin about 55% of the total precipitation is lost by evapotranspiration (The Climate of the Great Lakes Basin, 1972). This amounts to 494 mm/yr.

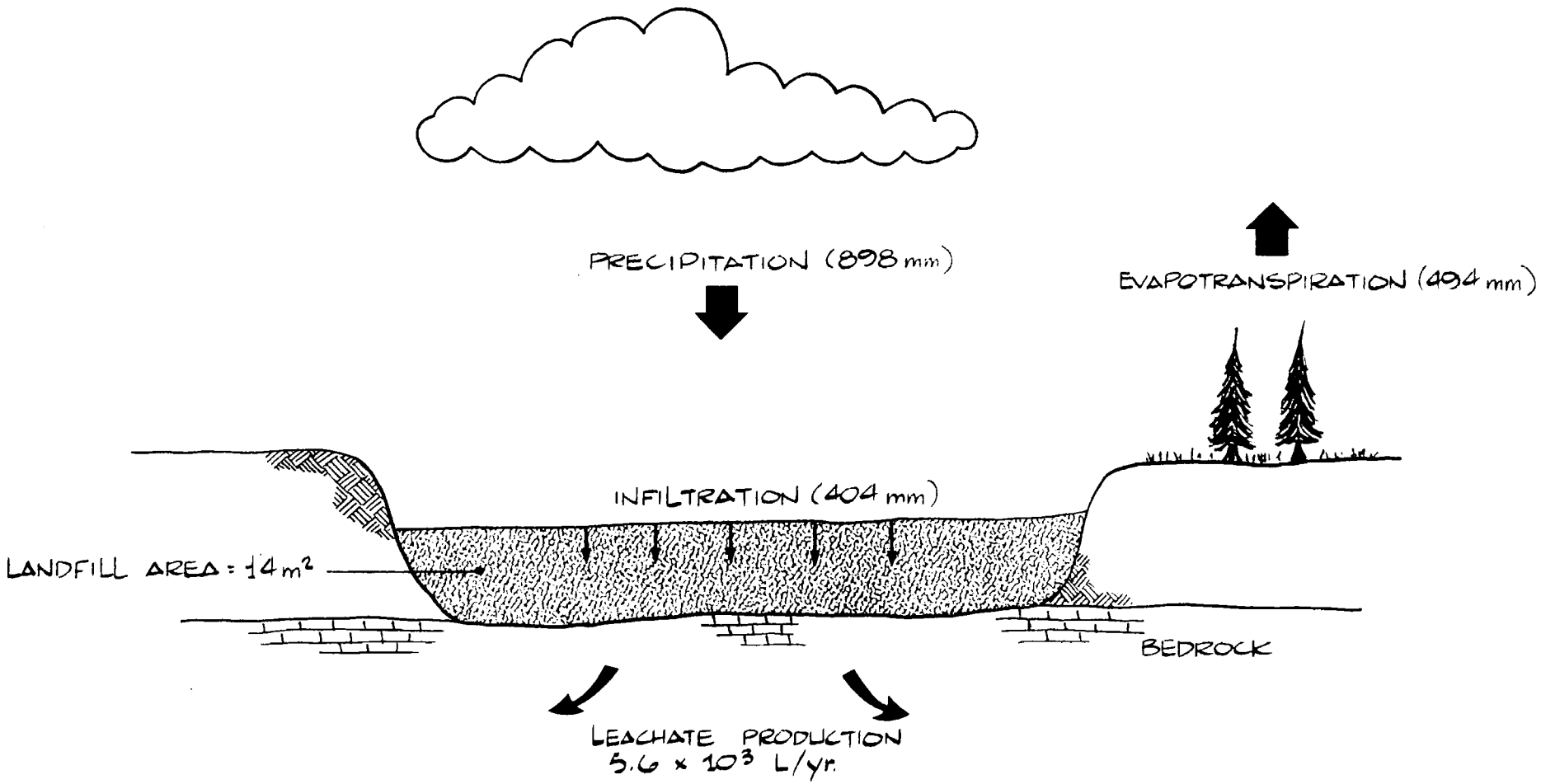
As noted previously, the disposal trench has settled over the years creating a depression. This means that all precipitation which falls on the buried waste and is not lost through evapotranspiration, will infiltrate. With no runoff, infiltration of about 404 mm/yr can be expected. The annual average water budgets and leachate production rate for the disposal site are shown schematically on the following diagram, Figure B-7.

If organic wastes in this disposal site are still undergoing decomposition, or if inorganic wastes are still present, leachate will be produced. The rate of production will be equivalent to the infiltration rate and the groundwater flux through the trench, if any. The disposal site is about 14 m^2 in area. Using the infiltration average of 404 mm/yr, a leachate production rate of 5.6×10^3 L/yr or .0002 L/s can be expected. This is a very small quantity. If the water table rises above the trench bottom, it is estimated that a similar quantity could be produced.

The groundwater flux in the bedrock beneath the site can be determined from Q = KiA where:

Q = groundwater flux
K = permeability
i = hydraulic gradient
A = cross sectional area through which flow occurs

Field bailing tests indicate a K in the order of 10^{-2}. With a K = 10^{-2} cm/s, i (slope of water table) = .01 and A (width of the landfill times average depth of saturated zone) = 23 m^2, the flux would be 2.3 L/s. This means the groundwater flux is so much greater than the leachate production rate, it would be highly unlikely to have a measurable impact on the bedrock aquifer.



INFILTRATION = TOTAL PRECIPITATION - EVAPOTRANSPIRATION - RUNOFF
(404 mm) (898 mm) (494 mm) (0 mm)

SITE: **CFB KINGSTON**	**ENVIRONMENT CANADA** Abandoned Waste Disposal Sites Phase II	PROJECT NO. 390-841	MAR. 1984
		MORRISON BEATTY LIMITED **PROCTOR & REDFERN LIMITED**	**B7**

5.3.3 Groundwater Quality and Leachate Impacts

Although the quantity of leachate produced at this site will be quite small, the hazard potential is high due to the nature of the wastes which may have been disposed of in the trench. In order to identify the impacts of leachate from this site, the four observation wells were sampled on February 4, 1984. The results are listed in Table B-2 in Section 2 of the Appendix. OW 1-84 and OW 4-84 should be indicative of background quality since they are located upgradient of the site.

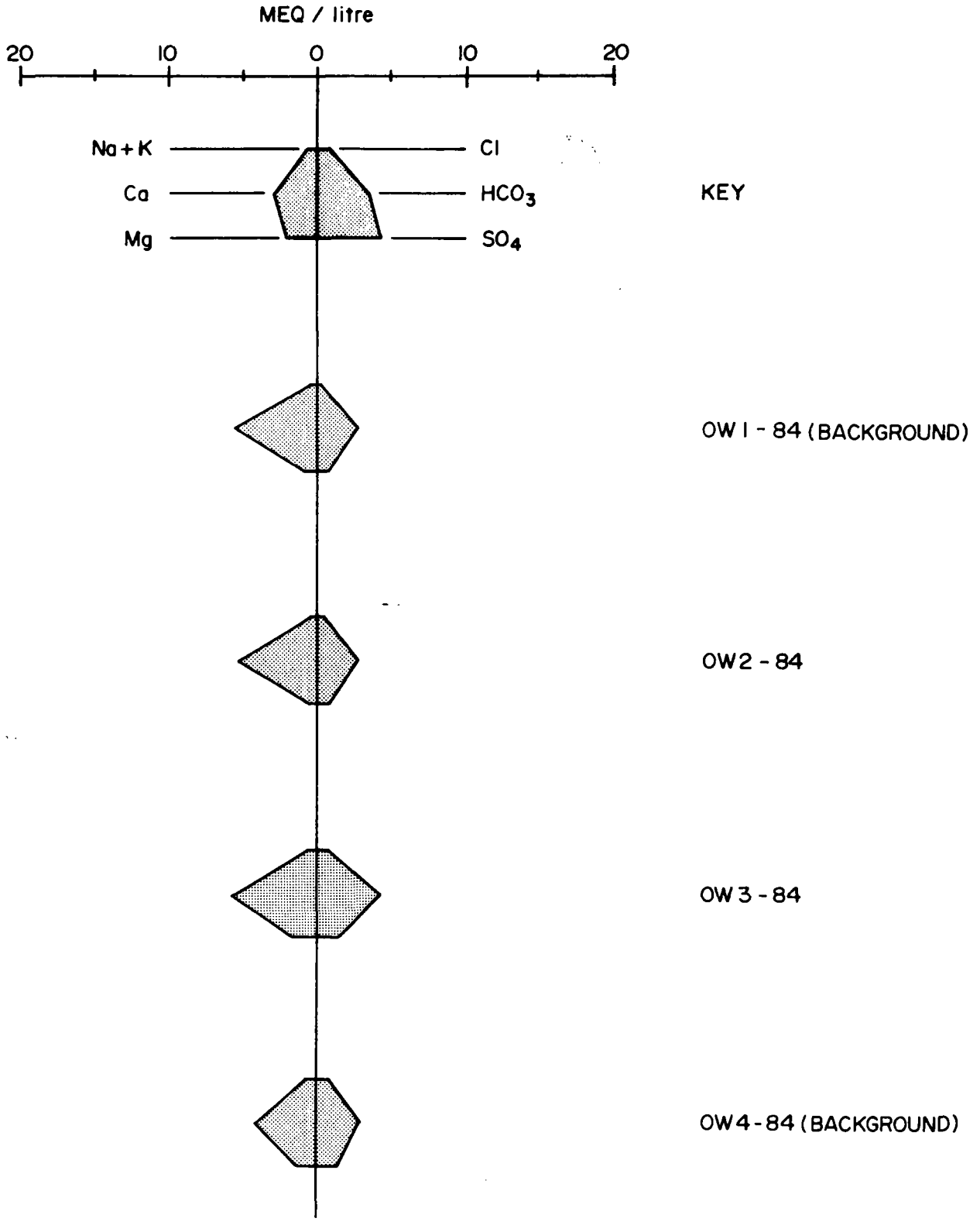
i) pH and Conductivity

Natural levels of pH in limestone bedrock range from 6.5 to 8.5. Although pH at OW 2 and OW 3-84 is slightly below the background level, all wells are within the expected range of fluctuation.

Conductivity ranges from a background level of 379 umhos/cm^2 to 470 umhos/cm^2 in OW 3-84. The slight elevation in this downgradient well is within the expected fluctuation range but may also reflect a minor leachate impact.

ii) Major Ions

The ionic balance is listed Table B-3 in Section 2 of the Appendix. Stiff diagrams showing the major anion and cation distribution are on Figure B-8 on the following page.



Major Anion and Cation Distribution

SITE: CFB KINGSTON **B8**

The stiff diagrams show very little change in ion distribution between background (OW 4-84) and the downgradient wells (OW 2 and OW 3-84). There are small increases in chloride, potassium, magnesium and sodium. The increases above background are listed below:

Ion	Well No.	Increase above Background
chloride	OW 2	2 times
	OW 3	6 times
potassium	OW 3	3 times
magnesium	OW 3	3-4 times
sodium	OW 2	2 times
	OW 3	4 times

Although chloride is slightly elevated, the levels are well below Ontario's recommended criteria of 250 mg/L. Similarly, none of the other parameters pose a health hazard.

iii) Organics

TOC and COD were analyzed for in each well. All wells had background levels of both parameters. TOC exceeds the MoE criteria for drinking water of 5 mg/L in the background well. It is at or below the criteria in the three downgradient wells.

iv) Total Organic Halides (TOX)

All four wells were sampled and analyzed for TOX. TOX is a relatively new lab test which is intended to give an indication of organic contamination. It has seldom been used before and therefore little background data is available on the significance of the results.

The TOX analysis shows 10's of ug/L in the three wells nearest the disposal site, but over 1000 ug/L in the background well, OW 1-84. The data suggests there is an unknown contaminant source upgradient (i.e., northeast) of OW 1-84. A more complete analysis of all the wells is required to identify the specific organic halides that are present.

v) Summary of Leachate Characteristics and Impacts

The chemical analyses did not show any evidence of significant impacts. Some parameters appear to be slightly elevated downgradient of the disposal trench, but the levels are within the normal range of fluctuation in groundwater flow systems. An anomalous high TOX in the background well is not believed to be due to the disposal site.

The data suggests that if leachate is still being generated at the site, it is confined to a small mixing zone within the site enclosure. The groundwater flow paths (to the southwest) will confine any leachate that is produced to the DND property. There is no threat to private water supplies that may exist in the area.

5.3.4 Methane Impacts

Gas probes were not installed at this site. Insignificant methane gas would be produced by the type and quantity of waste disposed of at this site. The small amount which would be produced by the decomposition of organic matter (laboratory animals) would not migrate more than a few metres from the disposal trench. The site is densely vegetated and no vegetation stress is apparent.

5.3.5 Potential Hydrogeologic Impacts

Potential hydrogeologic impacts from this site are not expected to be significant. The reasons for this are:

i) no measureable impact on the groundwater regime,

ii) small potential leachate generation rate (less than 0.0005 L/s),

iii) large dilution available from groundwater in the bedrock aquifer.

Further chemical analyses, particularly for organic halides, is required to identify possible sources of contamination in the vicinity of the site.

5.4 Future Land Use Plans

The DND have plans to renovate Building H55 (former laboratory building) into the CFB Kingston administrative offices. The fenced area, including the burial trench are located where they have planned to construct a paved parking area. The timing of these projects is not certain.

The area to the north will probably remain wooded for some time. The adjacent property is expected to remain in use as a motel and private residence.

5.5 Conclusions

Based on our findings, there is no apparent threat to the off-site environment (surface water and groundwater resources) or to public health and safety. This is due to the absence of identified impacts on the groundwater and the security of the site.

The hydrogeologic setting is such that off-site impacts are unlikely. The groundwater flux in the bedrock aquifer beneath the site is so much greater than the potential leachate production, that a groundwater impact could not likely be measured. An anomalous high reading of total organic halides (TOX) was obtained from a well located upgradient of the site (OW 1-84); however the reason for this is not apparent.

The characteristics and quantity of wastes originally disposed of at this site is uncertain.

5.6 Recommendations

The following recommendations are based on the Phase II field program:

1. Studies should be conducted to further identify the type and the extent of the wastes and their impacts.

2. No uses should be made of the enclosed area until the wastes are shown to be safe or are removed.

APPENDIX

CFB KINGSTON : SITE NO. D-81

SECTION 1 : OBSERVATION WELL LOGS

SECTION 2 : TABLES

SECTION 3 : SITE SUMMARY REPORT

SECTION 1 : OBSERVATION WELL LOGS

morrison beatty limited
consulting engineers and hydrogeologists
4500 dixie road, 12a, mississauga, ontario (416) 624 - 9306

OW1/84

CLIENT ENVIRONMENT CANADA FILE NO. 390-841

PROJECT ENVIRONMENTAL IMPACT LOCATION CFB KINGSTON

GEOLOGIST/ENGINEER JWW DATE COMPLETED FEBRUARY 3,1984

DESCRIPTION	DEPTH metres	DEPTH feet	SAMPLE no.	SAMPLE type	SAMPLE "N"	WELL DETAIL	REMARKS BLOWS PER FOOT 10 20 30 40 50 60 70 80 90
						A, B	
SILT: sandy, lacustrine						C, D	
LIMESTONE: light grey, fine grained, argillaceous	1	5				E, B	
	2						
LIMESTONE: as above with increased shale partings, fracture, staining	3	10				F	
LIMESTONE: light grey, argillaceous, shale partings -fractured	4	15					
	5						
E.O.H. 4.75 metres	6	20					
	7						
	8	25					
	9	30					

GS- GRAB SAMPLE SS - SPLIT SPOON ST - SHELBY TUBE "N" BLOWS PER FOOT WATER LEVEL ▽

WL-040281

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consulting engineers and hydrogeologists
4900 dixie road, ltd., mississauga, ontario (416) 624 - 9300

OW2/84

CLIENT ENVIRONMENT CANADA FILE NO. 390-841

PROJECT ENVIRONMENTAL IMPACT LOCATION CFB KINGSTON

GEOLOGIST/ENGINEER JWW DATE COMPLETED FEBRUARY 3,1984

DESCRIPTION	DEPTH metres	DEPTH feet	SAMPLE no.	SAMPLE type	SAMPLE "N"	WELL DETAIL	REMARKS BLOWS PER FOOT 10 20 30 40 50 60 70 80 90
						A, B	
SILT: sandy, lacustrine						C	
	1					D	
LIMESTONE: light grey, argillaceous, shale partings, fractures and staining		5				E, B	
	2						
LIMESTONE: dense, grey to blue grey, argillaceous, fine-grained, calcite crystals, fractures, shale partings	3	10					
	4					F	
LIMESTONE: as above with thin dark shale partings		15					
	5						
E.O.H. 5.54 metres	6	20					
	7						
		25					
	8						
	9	30					

GS - GRAB SAMPLE SS - SPLIT SPOON ST - SHELBY TUBE "N" BLOWS PER FOOT WATER LEVEL ▽

WL-840381

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OW3/84

CLIENT ENVIRONMENT CANADA FILE NO. 390-841

PROJECT ENVIRONMENTAL IMPACT LOCATION CFB KINGSTON

GEOLOGIST/ENGINEER JWW DATE COMPLETED FEBRUARY 3,1984

DESCRIPTION	DEPTH metres	DEPTH feet	SAMPLE no.	SAMPLE type	SAMPLE "N"	WELL DETAIL	REMARKS BLOWS PER FOOT
						A, B	10 20 30 40 50 60 70 80 90
SILT: sandy, lacustrine	1	5				C, D	
LIMESTONE: argillaceous, grey, fractures, no staining until 2.3 metres	2					E, B	
	3	10				F	
LIMESTONE: as above, shale partings and fractures -dense 3.3 to 4.4 m	4						
		15					
E.O.H. 4.42 metres	5						
	6	20					
	7						
		25					
	8						
	9	30					

GS - GRAB SAMPLE SS - SPLIT SPOON ST - SHELBY TUBE "N" BLOWS PER FOOT WATER LEVEL ▽

WL-040881

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consulting engineers and hydrogeologists
4900 dixie road, 120, mississauga, ontario (416) 624 – 9300

OW4/84

CLIENT ENVIRONMENT CANADA FILE NO. 390-841
PROJECT ENVIRONMENTAL IMPACT LOCATION CFB KINGSTON
GEOLOGIST/ENGINEER JWW DATE COMPLETED FEBRUARY 3,1984

DESCRIPTION	DEPTH metres	DEPTH feet	SAMPLE no.	SAMPLE type	SAMPLE "N"	WELL DETAIL	REMARKS BLOWS PER FOOT 10 20 30 40 50 60 70 80 90
						A, B	
SILT: sandy, lacustrine	1	5				C	
	2						
LIMESTONE: dense, grey with thin shale partings, fractures with Fe staining	3	10				D, E, B	
	4						
LIMESTONE: as above, with dark shale partings occasional calcite crystals	5	15				F	
E.O.H. 5.7 metres	6	20					
	7						
	8	25					
	9	30					

GS- GRAB SAMPLE SS - SPLIT SPOON ST - SHELBY TUBE "N" BLOWS PER FOOT WATER LEVEL ▽

WL-040281

LEGEND

Well Detail Remarks

A PVC CAP

B 50 mm DIA. PIPE

C BACKFILL

D BENTONITE SEAL

E PVC COUPLING(pipe extends approx. 20 cm into uncased hole)

F UNCASED HOLE

G

H

I

J

K

L

Stratigraphy

- TOPSOIL
- PEAT OR MUCK
- CLAY
- TILL
- SILT
- LIMESTONE
- SAND
- DOLOSTONE
- GRAVEL
- SHALE
- COBBLES, BOULDERS
- BEDROCK
- FILL
- REFUSE

SECTION 2 : TABLES

Table B1 - Water Levels

Table B2 - Chemical Water Analysis

Table B3 - Ionic Balance

PT-080383

PROJECT ENVIRONMENT CANADA **TABLE** B - 1 **SHEET** Site No. D-81, CFB Kingston

OBSERVATION WELL	WELL DETAILS						GROUNDWATER ELEVATIONS (metres A.S.L./local datum)						
	Nest No.	ø cm	Type	ELEVATIONS			Feb 4, 1984						
				Ground	Top of pipe	Top of screen							
OW 1		5	PVC	28.37	28.58		27.54						
OW 2		5	PVC	28.43	29.23		27.27						
OW 3		5	PVC	28.33	29.53		27.88						
OW 4		5	PVC	28.66	29.80		27.98						

Piezometer Standpipe

WT - 070879

TABLE
CHEMICAL WATER ANALYSIS

Client	Environment Canada	Date Sampled	February 4, 1984
Project Description	Waste Disposal Sites: Kingston	Date Analyzed	February 28, 1984
Project No.	390-841	Analyzed by	Technical Services Laboratory

Parameter							
pH	7.1	6.9	6.9	7.2			
Conductivity (umhos/cm^2)	379	390	470	403			
Alkalinity	205	203	315	195			
COD	18	20	23	15			
TOC	12.0	4.0	5.0	3.0			
Total Organic Halides (ug/L)	1190	16	55	26			

Concentrations in mg/ℓ excepted as noted

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TABLE B - 2
CHEMICAL WATER ANALYSIS

Client: Environment Canada
Project Description: Waste Disposal Sites: Kingston
Project No.: 390-841

Date Sampled: February 4, 1984
Date Analyzed: February 28, 1984
Analyzed by: Technical Services Laboratory

Parameter	OW 1-84	OW 2-84	OW 3-84	OW 4-84			
Major Ions							
Cations							
Calcium	115	103	117	86			
Potassium	1.1	1.0	3.5	4.8			
Magnesium	6.1	9.8	23	13			
Sodium	2.9	6.8	13	15			
Anions							
Chloride	4.1	12	26	25			
Sulphate	40	36	61	72			
Bicarbonate	168	167	258	160			

Concentrations in mg/ℓ excepted as noted

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IONIC BALANCE

B-3

Area of Survey Site No. D-81, CFB KINGSTON **Sample :** Groundwater **Date** February 4, 1984

	CATIONS													ANIONS								
Ion	Ca			Mg			Na			K			Na+K	Total	Alkalinity			SO_4			Cl			Total	Diff.
Conversion Factor	ppm x .0499			ppm x .0822			ppm x .0435			ppm x .0256				Cations	HCO_3 ppm x .0164 CO_3 ppm x .0333			ppm x .0208			ppm x .0282			Anions	%
Well No.	ppm	epm	%	ppm	epm	%	ppm	epm	%	ppm	epm	%	epm	epm	ppm	epm	%	ppm	epm	%	ppm	epm	%	epm	
OW 1-84	115	5.74		6.1	0.50		2.9	0.13		1.1	.028		0.16	6.40	205	2.76		40	0.83		4.1	0.12		3.71	40%
OW 2-84	103	5.14		9.8	0.81		6.8	0.30		1.0	.026		0.33	6.28	203	2.74		36	0.75		12	0.34		3.83	39%
OW 3-84	117	5.84		23	1.89		13	0.57		3.5	.090		0.66	8.39	315	4.23		61	1.27		26	0.73		6.23	26%
OW 4-84	86	4.29		13	1.07		15	0.65		4.8	.123		0.77	6.13	195	2.62		72	1.50		25	0.71		4.83	21%

CA-190882

SECTION 3 : SITE SUMMARY REPORT

SITE REPORT SUMMARY

BACKGROUND:

1. General

Site Name: CFB Kingston

Site Area: $14m^2$

Site Owner: Dept't of National Defence

Date of Operation: 1951 to 1975

Site Location: Kingston

Name of Operator: Defence Research Laboratories
Royal Military College

2. Land Uses

Original - wooded

Present - wooded

Future Potential Land Use - Parking lot (on site)
- Administrative Building (adjacent)

3. Present Development

On-Site - none

Abutting (distance) - abandoned laboratory (H55) on CFB Kingston property to south
- motel and private property to east

FIELD INVESTIGATION RESULTS:

1. Type of Investigation Performed - site reconnaissance, overburden and bedrock test drilling, observation well installation, permeability test, water level groundwater sampling and radiation scan

2. Site Chacteristics

Site Access - through CFB Kingston controlled entrance

Site Visibility - the actual disposal area is not visable to the public; however, the fenced area and warning signs around the site can be seen from Hwy #2

Site Security - access must first be obtained through CFB Kingston (Department of National Defence)
- the site is also fenced with "No Digging" signs posted

Vegetation on Site - disposal site has grass and weed cover and is surrounded by mature trees

3. Waste Disposal Practices

Quantity of Refuse - a maximum volume of 28 m^3, however this does not account for any cover material

Thickness of Waste - 2.0 m (this includes cover material)

Type of Waste (confirmation) - biological warfare wastes which were autoclaved prior to disposal; laboratory animals used in radioactive tracer tests (C^{14} and cr^{51}); unknown wastes from the Royal Military College lab

Cover Material and Thickness - unknown depth, however, local soils of silt and clay were probably used

4. Hydrogeologic Setting

Overburden type and thickness - lacustrine silt and clay ranging in depth from 0.82 to 2.65 m

Bedrock type - limestone, Trenton and Black River Groups

Local topography - site is flat with gentle slope to the northeast
- south of Hyw #2, the surface slopes steeply to the St. Lawrence River

Drainage Patterns (regional and local) - regional drainage is to the northeast
- local drainage is to the southeast

Surface water bodies - located within 700 m of the St. Lawrence River

Depth to Water Table - ranges in observation wells from .45 m to 1.16 m below surface

Direction of Groundwater Flow - southwest

5. Identified Impacts

Leachate characteristics - very low production rate

Evidence of Leachate seepage - none

Evidence of leachate migration and attenuation - none, anomolous high level of TOX was measured in OW 1-84 (background well)

Evidence of gas generation and migration - none

Vegetation stress - none

Settlement and erosion - about .5 m of settlement has occurred in the trench

Other potential sources of contamination - none

POTENTIAL IMPACTS:

1. Leachate

Water Supplies within 500 m - several hotels and residences obtain water from private wells within 500 m to the southeast

Potential human hazard - the nature of the suspected wastes created a high human hazard potential for this site. No leachate impact was measured; however further monitoring for a complete chemical and bacteriological analysis is recommended.

Potential environmental hazard - none

2. Methane

Nearby buildings - closed laboratory within 50 m, hotel within 50-60 m

Potential human hazard - none due to very small quantifies of wastes which would produce methane

Potential environmental hazard - none

6.0 ST. REGIS RESERVE: SITE NO. I-21

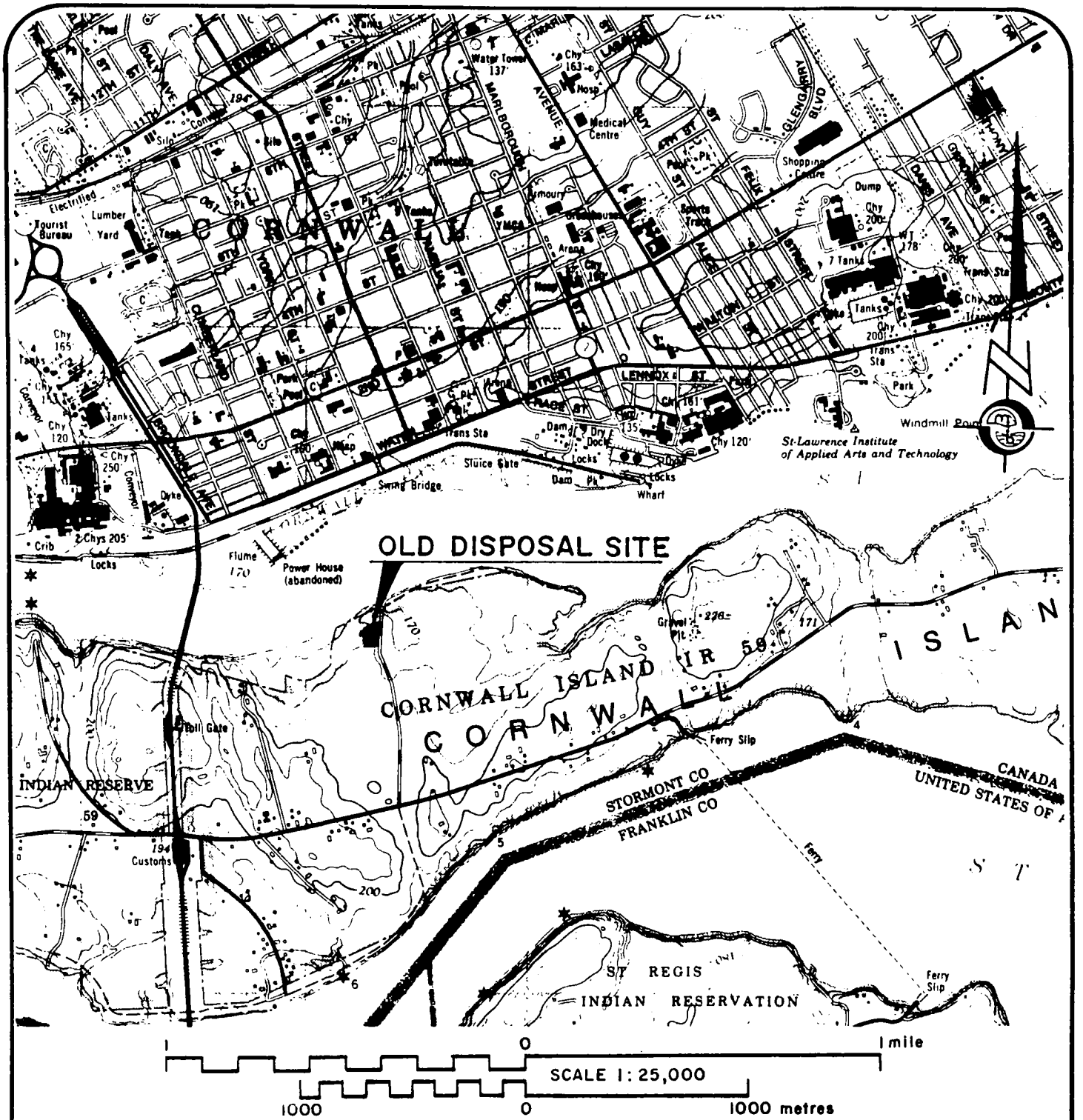
6.1 Introduction

The St. Regis site is located on the St. Regis Indian Reserve on Cornwall Island. It is approximately 8000 m^2 in area and is situated on the north shore of the island. Cornwall Island is located in the St. Lawrence River south of the City of Cornwall. The location of the site in a regional context is shown on Figure C-1 on the following page.

Access to the site is controlled by the Indian Band Council. The site is reached from the first north-south road east of the Seaway International Causeway. It is visible from a public park on the City of Cornwall shoreline and from the Seaway Bridge.

Disposal of domestic waste took place between the 1920's and 1979 by the residents of the island. Some unauthorized dumping still takes place. The operation consisted of the disposal of wastes in trenches. We understand that some burning also took place. The disposal site is outlined on the following air photo, Figure C-2.

Excavation materials were placed in the vicinity of the site during construction of the Seaway International Bridge in the late 1950's. The St. Lawrence Seaway Authority has provided preliminary information on the disposal of shoreline and river bottom materials on Cornwall Island. This data shows that the study area did receive some spoil.



ENVIRONMENT CANADA
Abandoned Waste Disposal Sites
Phase II

SITE: ST. REGIS

TOPOGRAPHIC LOCATION

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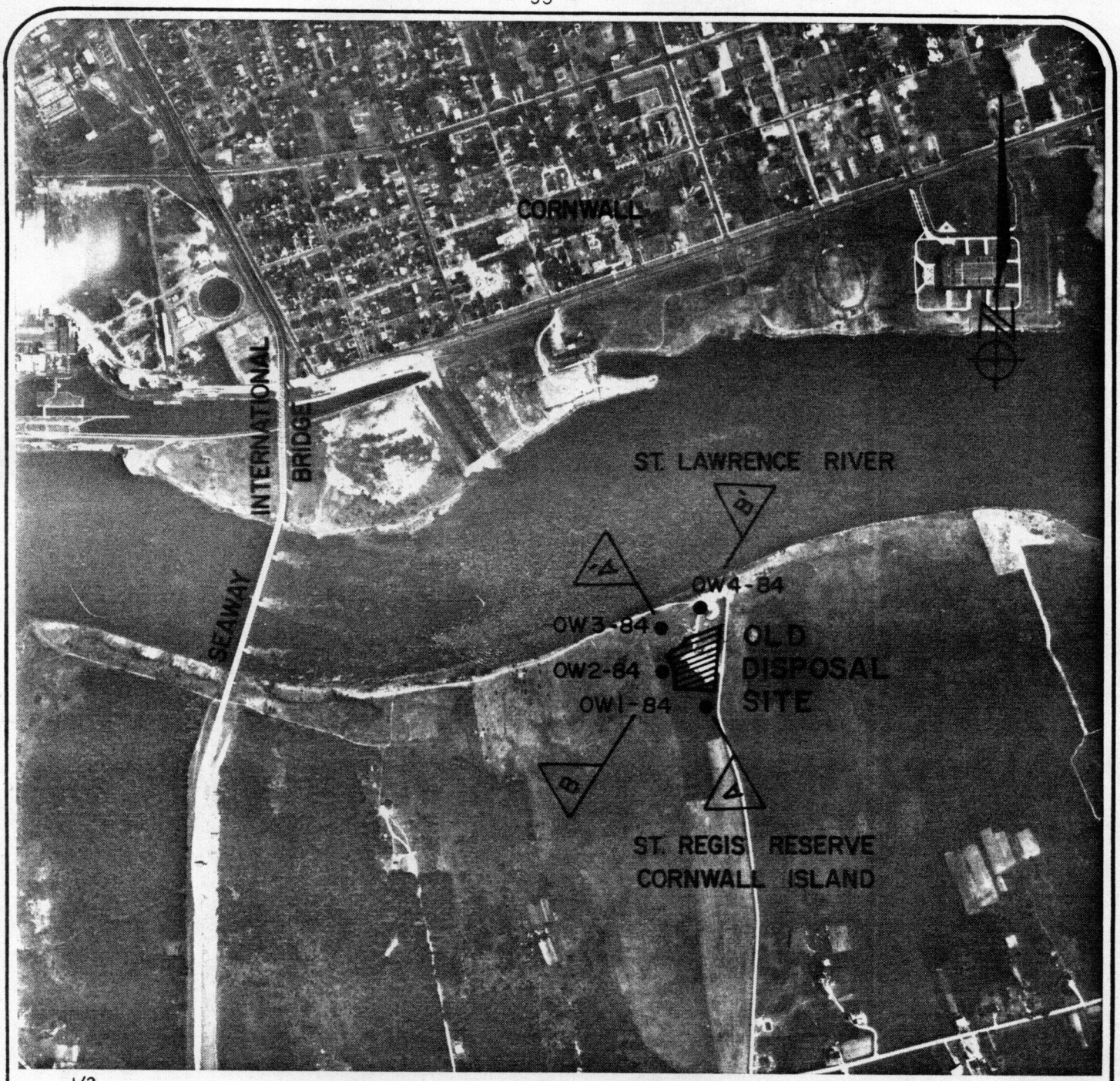
C1



ENVIRONMENT CANADA
Abandoned Waste Disposal Sites
Phase II

SITE: ST. REGIS

AIR PHOTO LOCATION

MORRISON BEATTY LIMITED
PROCTOR & REDFERN LIMITED

MAR. 1984

C2

6.2 Site-Specific Studies

The general field study methodology is outlined in Section 3.0. The field program at the St. Regis site consisted of the following:

- A site reconnaissance of the site and surrounding area was carried out with a representative from the Indian Band Council.

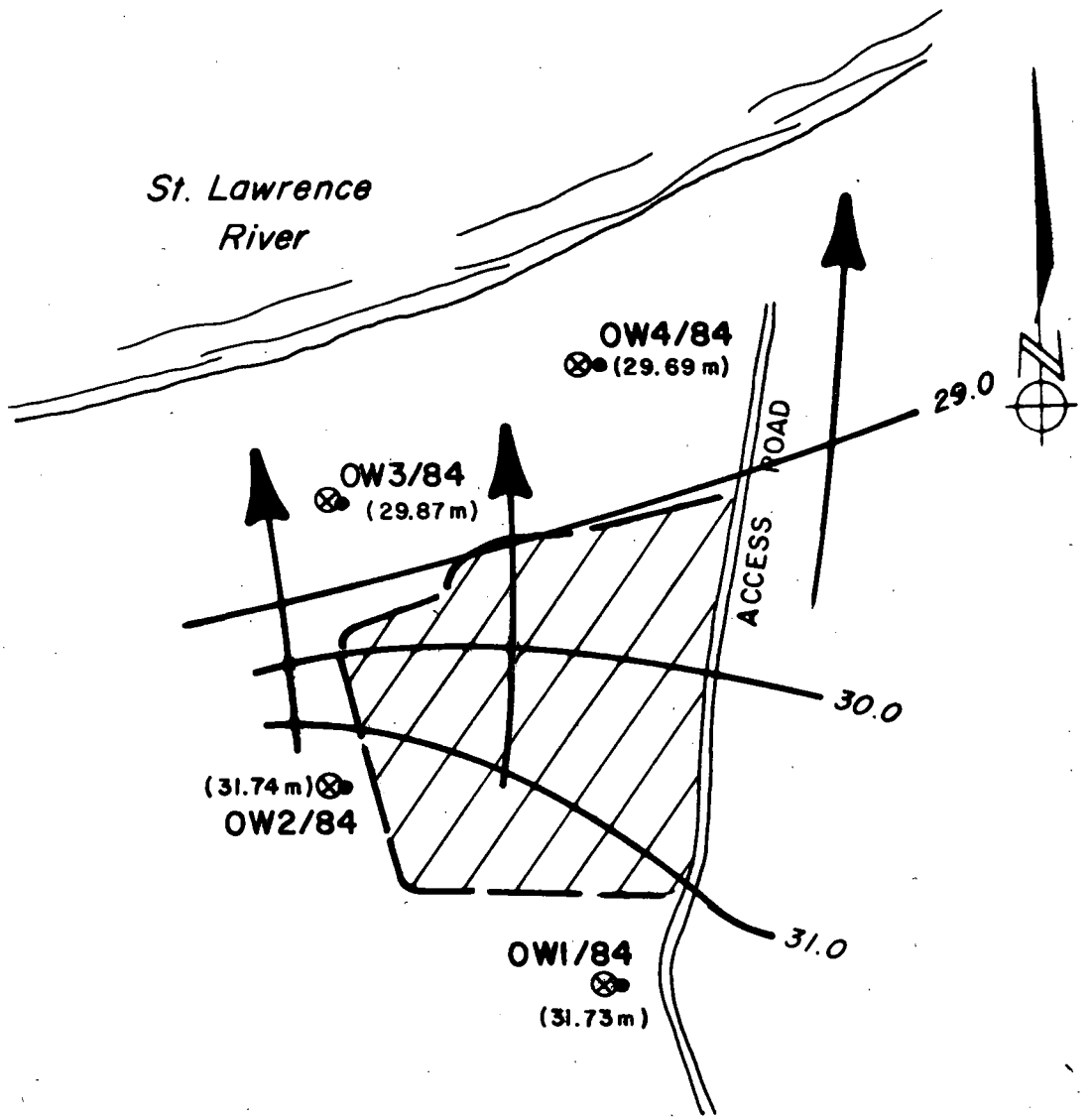
- Field studies included test drilling; split-spoon sampling at all boreholes and grain-size distribution analyses. Organic content and moisture content analyses were conducted on representative samples.

- Four permanent observation wells and four permanent gas probes were installed around the perimeter of the site to identify off-site impacts. Construction details are included on the observation well logs found in Section 1 of the Appendix. The locations of the wells and gas probes are shown on Figure C-3.

- Groundwater elevations were established in all wells and related to a local datum. The local datum is located on the top of a Bell Canada box aqt the north end of the N-S access road. The Bell box is located on the east side of the access road. Groundwater levels are included in Table C-1, Section 2 of the Appendix.

- A permeability test (bail-down) was conducted on one well to give an indication of permeability.

- Water samples were collected from all observation wells and analyzed for conductivity and pH in a private laboratory. Three samples (OW 1, OW 3 and OW 4-84) were analyzed for alkalinity, COD, TOC, major ions and mercury. An extra sample from each well was collected and delivered to the Environmental Protection Service for PCB analyses. Although all PCB results were less than detection levels, the data is included in Table C-2, Section 2 of the Appendix.



SCALE = 1:2,000

LEGEND

- Observation Well
- Gas Probe
- (25.93 m) Groundwater Elevation (local datum)
- Groundwater Contour
- Direction of Groundwater Flow
- Disposal Area

ENVIRONMENT CANADA
Abandoned Waste Disposal Sites
Phase II
SITE : ST. REGIS

SITE PLAN

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C3

6.3 Study Results

6.3.1 Hydrogeologic Setting

i) Geology

The Cornwall area, including Cornwall Island, is within a till plain known as the Glengarry Till Plain. Geologic mapping for the area indicates this part of the plain is undrumlinized.

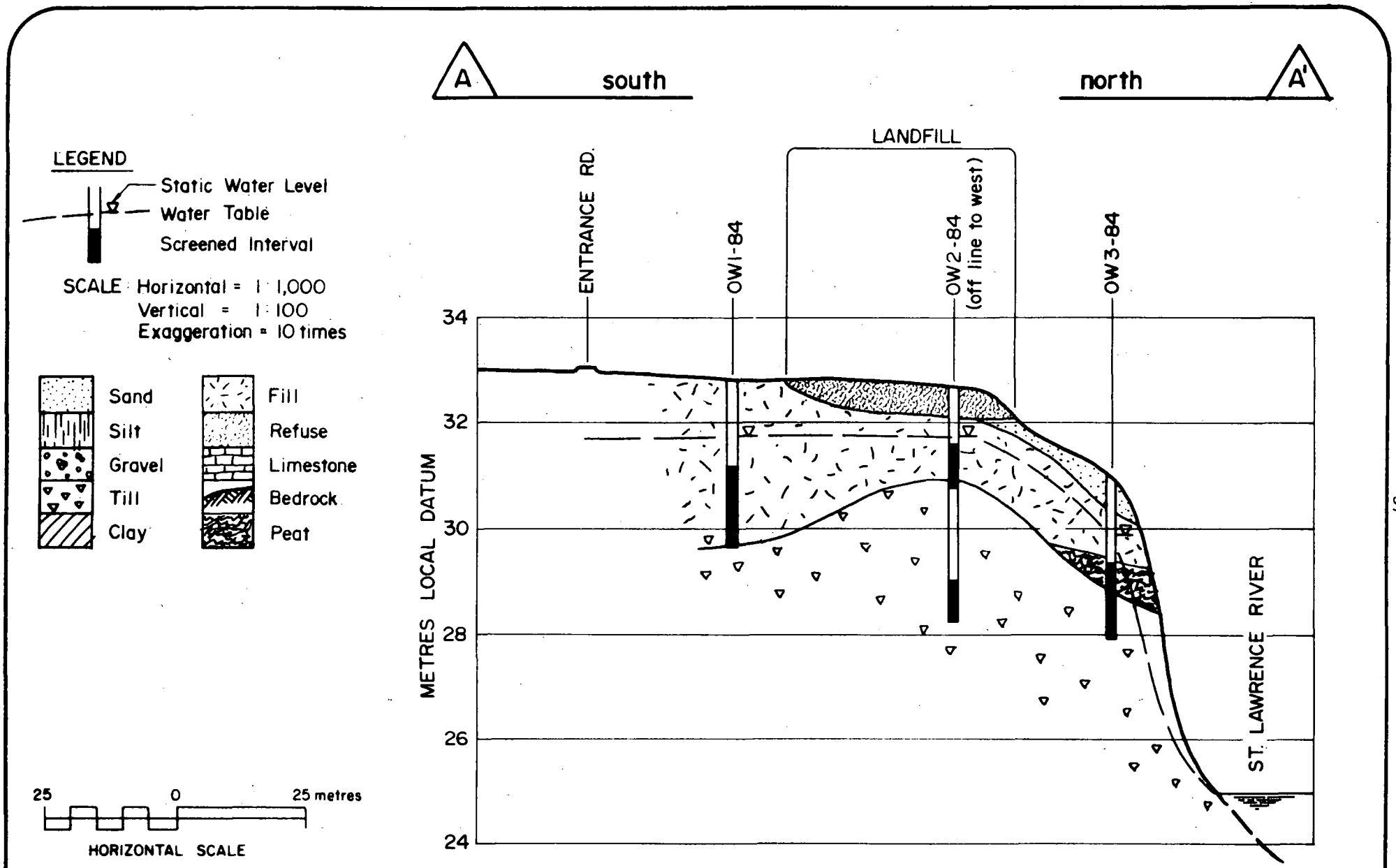
The test drilling at the site shows the till is overlain by up to two metres of silty sand. Occasional black sediments were found in the top material. We suspect the surface sediments are the dredgings from the St. Lawrence River. The deepest borehole is 4.5 m. The till extends to the bottom. The general stratigraphy at the site is shown on the cross-sections in Figures C-4 and C-5, on the following pages.

The grain-size distribution curves for a silty sand and till sample is shown in Figures C-6 and C-7. The till curve shows it contains about 15% clay, 25% silt and 60% sand and gravel sizes.

The organic analysis is listed below.

Well	Sample Depth, m	% Organics
OW 2-84	0.6	2.05
OW 3-84	3	0.80

Bedrock in the area is limestone and minor dolostone of the Trenton and Black River Groups. Geologic mapping shows the depth to bedrock is about 23 m.



CROSS-SECTION A-A'

(Refer to Figure C3)

ENVIRONMENT CANADA
Abandoned Waste Disposal Sites
Phase II
SITE: ST. REGIS

PROJECT NO. 390-841

MAR. 1984

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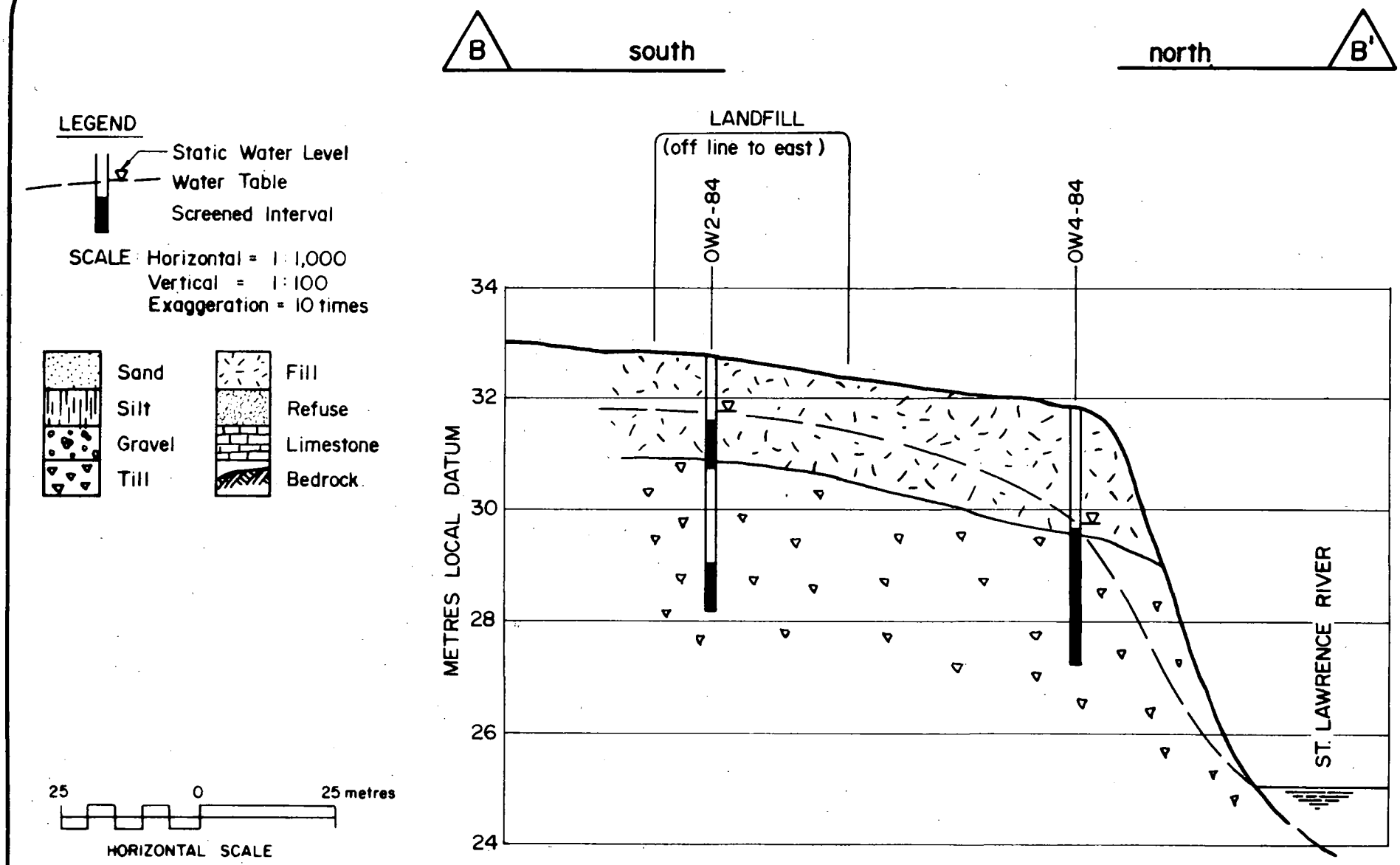

CROSS-SECTION B-B'

(Refer to Figure C3)

ENVIRONMENT CANADA
Abandoned Waste Disposal Sites
Phase II
SITE: ST. REGIS

PROJECT NO. 390-841

MAR. 1984

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C5

GS-060781

morrison beatty limited
consulting engineers and hydrogeologists
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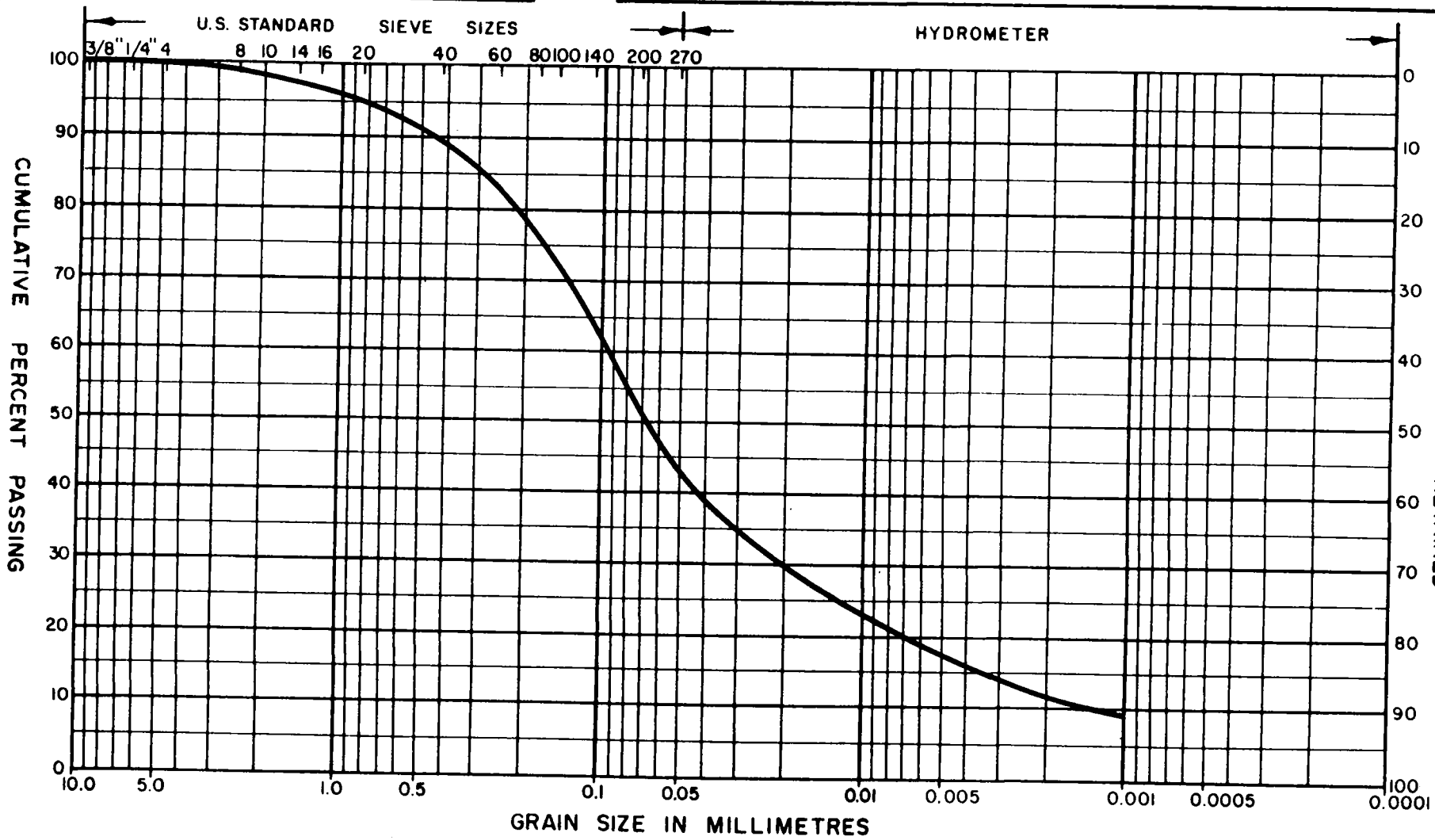
GRAIN SIZE DISTRIBUTION CURVE

ENVIRONMENT CANADA - ST. REGIS

OW2-84 1.5 m Project No. 390-841

C6



UNIFIED	GRAVEL	COARSE	MEDIUM	FINE	SILT & CLAY				
		SAND							
M.I.T.	GRAVEL	COARSE	MEDIUM	FINE	COARSE	MEDIUM	FINE	CLAY	
		SAND			SILT				
U.S. BUREAU	GRAVEL	COARSE	MEDIUM	FINE	V.FINE	SILT	CLAY		
		SAND							

GS-060781

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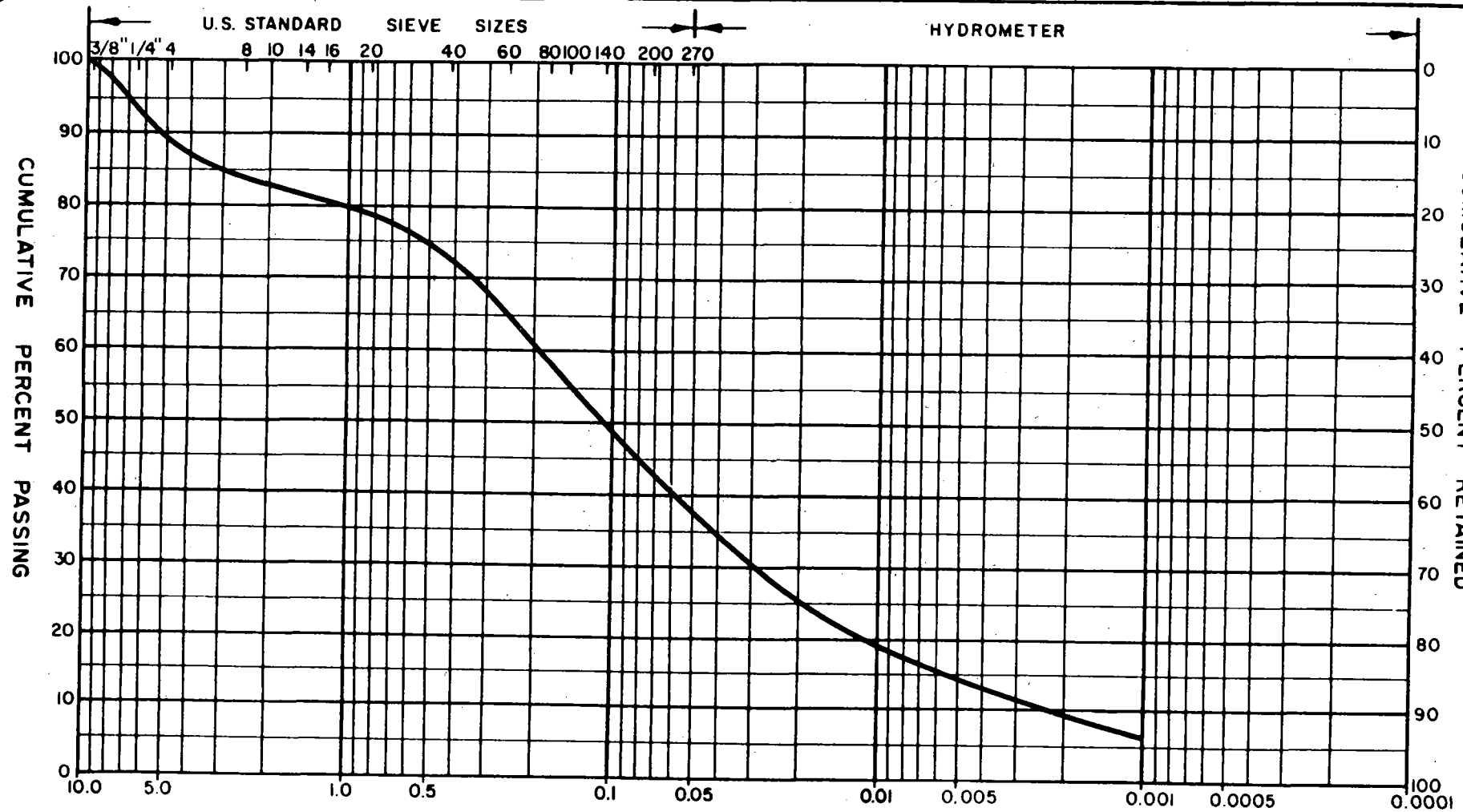
GRAIN SIZE DISTRIBUTION CURVE

ENVIRONMENT CANADA - ST. REGIS

OW3-84 3.0 m Project No. 390-841

C7



UNIFIED	GRAVEL	COARSE	MEDIUM	FINE		SILT & CLAY				
		SAND								
M.I.T.	GRAVEL	COARSE	MEDIUM	FINE		COARSE	MEDIUM	FINE	CLAY	
		SAND				SILT				
U.S. BUREAU	GRAVEL	COARSE	MEDIUM	FINE	V.FINE	SILT		CLAY		
		SAND								

ii) Topography and Drainage

The area around the old disposal site slopes gently toward the St. Lawrence River. There is a localized depression east of the site, which contains runoff. A 6-7 m high bluff occurs along the shore of the St. Lawrence River. Local drainage in the vicinity of the site is northward towards the river.

iii) Groundwater

There are two private residences located about 500 m south of the site. MoE water well records are not available for Cornwall Island; however, most wells probably tap the limestone bedrock or sand and gravel lenses located at the bedrock contact.

The water table ranges from about 1 m below surface (in OW 1, OW 2 and OW 3-84) to 2 m in OW 4-84. This indicates a steep gradient in flow toward the river as shown on Figures C-4 and C-5.

6.3.2 Water Budget

The annual precipitation in the vicinity of the site is 928 mm based on thirty year normals (1941-1970) for the Cornwall Meteorological Station. This site is within the Lake Ontario Basin and can expect 55% of the precipitation to be lost to evapotranspiration (The Climate of the Great Lakes Basin, 1972). This amounts to about 510 mm.

Based on test drilling, the site has sandy fill cover material and refuse is exposed in some places. The permeability is therefore fairly high. An average infiltration rate of about 200 mm/yr can be expected. This means that about 218 mm is lost annually in surface runoff. The following diagram (Figure C-8) schematically shows the annual water budget and the leachate production rate for the disposal site.

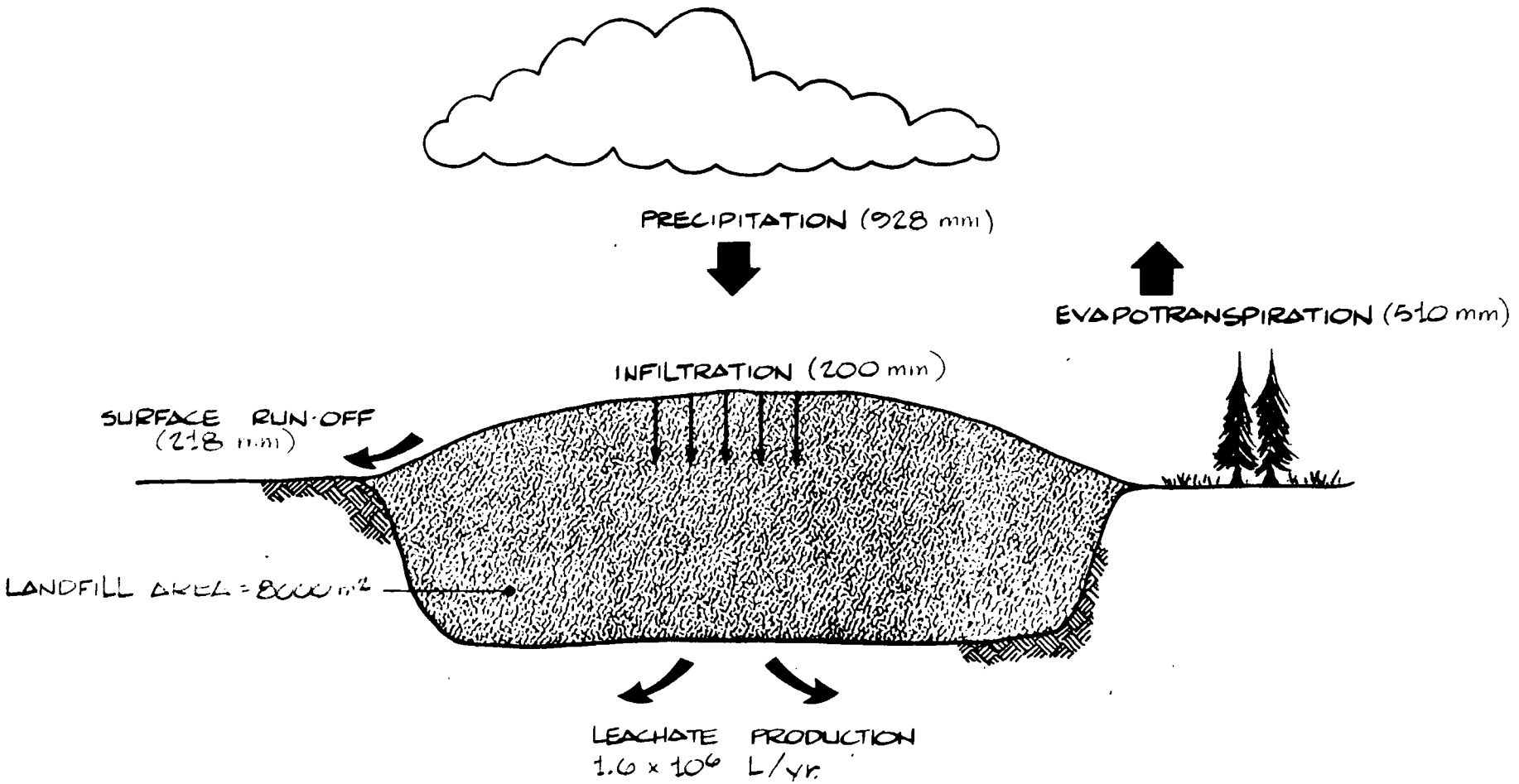
The leachate production rate can be calculated using the rate of precipitation infiltrating into the refuse (200 mm/yr) and the area of the landfill. The landfill is about 8000 m^2 in area; therefore, the average annual leachate production would be in the order of 1.6×10^6 L/yr or about 0.05 L/s.

6.3.3 Groundwater Quality and Leachate Impacts

In order to identify the impacts of leachate produced at this site, the four perimeter wells were sampled on February 8, 1984. The results are listed in Table C-2 in Section 2 of the Appendix. OW 1-84 should be indicative of background quality since it is located upgradient (south) of the site.

i) pH and Conductivity

Conductivity and pH are both within background levels at all observation wells.



INFILTRATION = TOTAL PRECIPITATION - EVAPOTRANSPIRATION - RUNOFF
(200 mm) (928 mm) (510 mm) (218 mm)

SITE: ST. REGIS	**ENVIRONMENT CANADA** Abandoned Waste Disposal Sites Phase II	PROJECT NO. 390-841	MAR. 1984
		MORRISON BEATTY LIMITED PROCTOR & REDFERN LIMITED	**C8**

ii) Major Ions

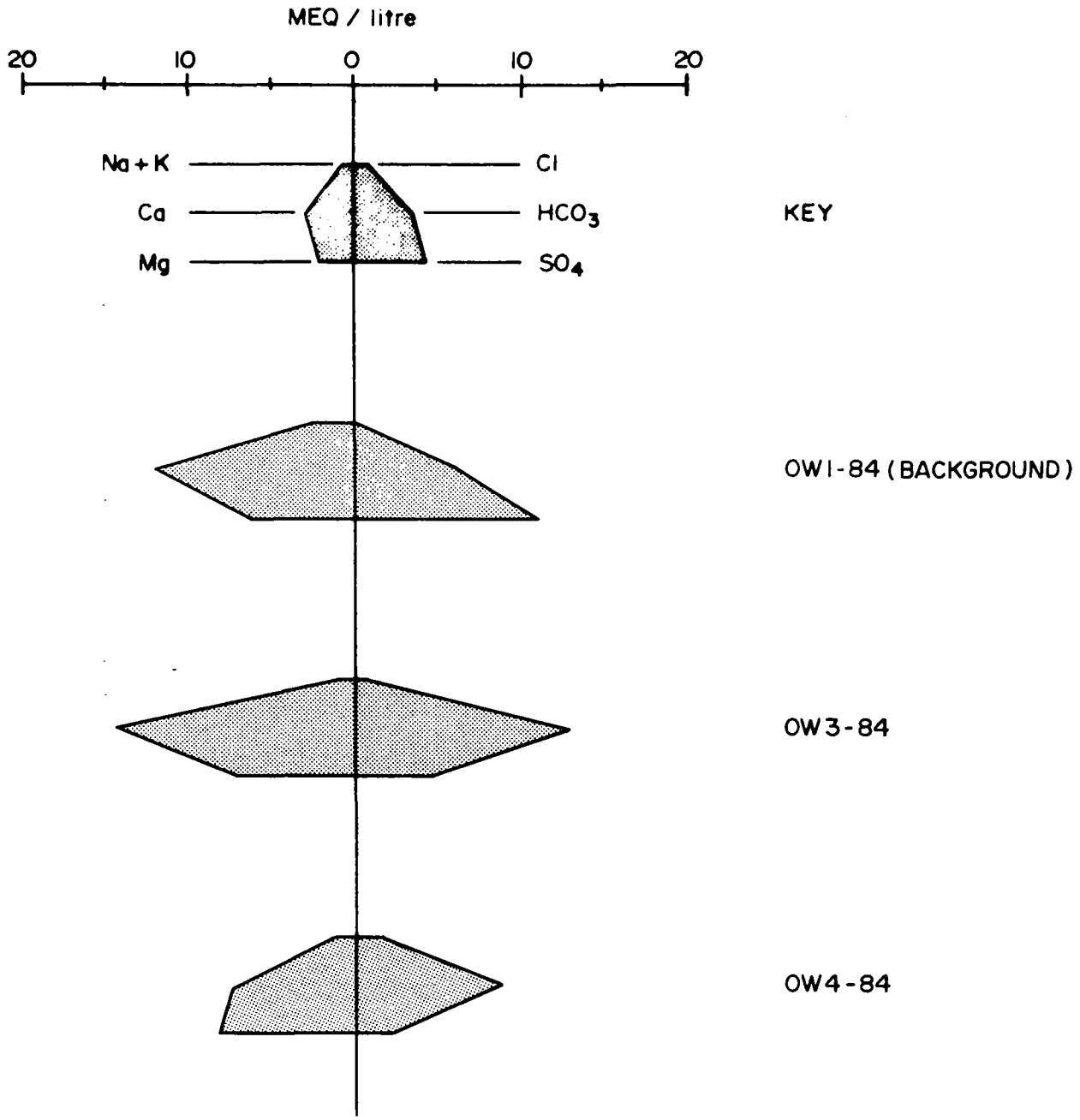
The ionic balance is listed in Table C-3 in Section 2 of the Appendix. Stiff diagrams showing major anion and cation distribution are on Figure C-9 on the following page.

The stiff diagrams give some indication that leachate is migrating from the disposal site. There are increases in chloride, bicarbonate and potassium and a very slight increase in magnesium between OW 1-84 (background levels) and OW 4-84 (directly downgradient). There is a decrease in sulphate between background and downgradient wells. This is typical of leachate impacted groundwater. Under anaerobic conditions in a landfill, sulfur and sulfate are reduced to sulfide by reducing bacteria. The following table summarizes the magnitude of impact on downgradient wells:

Ion	Well No.	Increase above Background
chloride	OW 3-84	4 times
	OW 4-84	10 times
bicarbonate	OW 3-84	2 times
	OW 4-84	4-5 times
potassium	OW 3-84	4 times
	OW 4-84	4 times
sulphate	OW 3-84	2 times (decrease)
	OW 4-84	5-6 times (decrease)

iii) Organics

The background level of COD at this site was 16 mg/L. OW 3 and OW 4-84 contain 18 and 20 mg/L, respectively, which is not a significant impact.



Major Anion and Cation Distribution

SITE: ST. REGIS

C9

TOC (total organic carbon) is one of the best indicators of the organic content from landfills. Background TOC at this site is 6.0 mg/L. The TOC in OW 3-84 and OW 4-84 is within the background range of TOC in shallow groundwater zones. TOC levels can be affected by root penetration. The MoE guideline for TOC in drinking water is 5.0 mg/L. Concentrations in all wells exceed the recommended drinking water criteria; however there are no shallow groundwater uses in this area.

iv) Mercury (Hg)

Analyses for mercury were carried out because of possible high levels in the excavation material from the St. Lawrence. The maximum acceptable concentration for mercury in drinking water is 1 ug/L. The detection limit at the IEC Beak laboratory is 0.02 ug/L. Concentrations in wells OW 1 and 3-84 were below the detection limit. The sample from OW 4-84 contained 0.06 ug/L mercury.

v) PCB's

Samples were collected for PCB analyses during the field program. The samples were analyzed at the MoE laboratories. The MoE detection limit for PCB's is 20 ppt. PCB's were not detected in any sample.

vi) Summary of Leachate Characteristics and Impacts

It appears from the water quality data that the landfill site has had a minor impact on surrounding groundwater. Leachate constituents have probably migrated to the river bluff, but are not above drinking water criteria.

The disposal site will not impact on existing domestic water supplies since wells in the area are located upgradient of the site. The concentrations of leachate constituents are too low to impact any surface springs that may be present where groundwater discharges on the bluff.

6.3.4 Methane Impacts

Permanent gas probes were installed in all four borehole locations (see Figure C-2) for future methane monitoring. Soil conditions should be allowed to stabilize around the probes prior to taking readings; therefore, no readings were taken during this study.

Methane will be produced by the decomposition of the organics in the domestic waste. There is a potential for methane migration away from the site in the permeable surface sands found at this site, especially during frozen surface conditions. Methane travel should be limited to a few 10's of metres.

6.3.5 Potential Hydrogeologic Impacts

The St. Regis landfill is too small and too remote from groundwater resources to cause a significant impact. For protection against future leachate and gas impacts, building should be restricted on the disposal site and a 50 m buffer zone around it.

An impact on surface water could occur during high rainfall events with drainage across exposed wastes; however surface water impacts are generally insignificant at covered sites. Drainage from the site would not be expected to impact the St. Lawrence River.

6.4 Future Land Use Plans

Discussions with the Department of Indian Affairs and the St. Regis Band Council revealed that there are no present plans for the site. The adjacent lands are expected to remain in use for agriculture. Future use depends upon the results of this study and any future Phase III studies.

6.5 Conclusions

The St. Regis landfill does not pose a threat to public health and safety or the environment. It has had only a minor impact on surrounding groundwater. Domestic water wells in the area are located upgradient of the site and therefore will not be impacted by the disposal site. Groundwater flow is to the St. Lawrence River; however, leachate quality is too dilute to have any significant impact.

Methane generated at this site will not pose a problem, providing building is restricted to the landfill and a 100 m buffer zone around it.

6.6 Recommendations

The following recommendations are based on the Phase II field program:

1. A site closure should be developed for this site. It should address the need for additional cover, contouring to promote good drainage, vegetation and long-term maintenance.

2. The extent of seaway excavation material should be identified in order to determine the magnitude of the identified impact and possible restrictions on development.

APPENDIX

ST. REGIS RESERVE : SITE NO. I-21

SECTION 1 : OBSERVATION WELL LOGS

SECTION 2 : TABLES

SECTION 3 : SITE SUMMARY REPORT

SECTION 1 : OBSERVATION WELL LOGS

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consulting engineers and hydrogeologists
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OW1/84
GP1/84

CLIENT ENVIRONMENT CANADA FILE NO. 390-841

PROJECT ENVIRONMENTAL IMPACT LOCATION ST. REGIS

GEOLOGIST/ENGINEER T.H. DATE COMPLETED FEBRUARY 1,1984

DESCRIPTION	DEPTH metres	DEPTH feet	SAMPLE no.	SAMPLE type	SAMPLE "N"	WELL DETAIL	REMARKS BLOWS PER FOOT 10 20 30 40 50 60 70 80 90
SAND: yellow-brown, med. grained, some silt and clay, wet, probably fill	1		1	SS		A, B, C, D	
SILT: black with organics, probably fill		5	2	SS		F, B	
SAND: light-brown, med. grained, some pebbles, some silt seams, probably fill	2, 3	10	3	SS		E, F	
E.O.H. 3.1 metres			4	SS		G	
	4	15					
	5						
	6	20					
	7						
		25					
	8						
	9	30					

GS - GRAB SAMPLE SS - SPLIT SPOON ST - SHELBY TUBE "N" BLOWS PER FOOT WATER LEVEL ▽

WL-040281

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OW2/84
GP2/84

CLIENT ENVIRONMENT CANADA FILE NO. 390-841

PROJECT ENVIRONMENTAL IMPACT LOCATION ST. REGIS

GEOLOGIST/ENGINEER T.H. DATE COMPLETED FEBRUARY 1,1984

DESCRIPTION	DEPTH metres	DEPTH feet	SAMPLE no.	SAMPLE type	SAMPLE "N"	WELL DETAIL	REMARKS BLOWS PER FOOT
						D, A	10 20 30 40 50 60 70 80 90
SILT: black with fine sand, some clay						F, B	
SAND: yellow-brown, medium grained, some iron stains	1		1	SS		C	
		5	2	SS		E	
TILL: brown, fine sand with silt, some angular pebbles, odd boulder, dry	2		3	SS		G	
	3	10	4	SS		F	
-grey, dense, some cobbles, saturated	4					E	
		15	5	SS		G	
E.O.H. 4.53 metres	5						
	6	20					
	7						
		25					
	8						
	9						
		30					

GS- GRAB SAMPLE SS - SPLIT SPOON ST - SHELBY TUBE "N" BLOWS PER FOOT WATER LEVEL ▽

WL-040281

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OW3/84
GP3/84

CLIENT ENVIRONMENT CANADA FILE NO. 390-841

PROJECT ENVIRONMENTAL IMPACT LOCATION ST. REGIS

GEOLOGIST/ENGINEER T.H. DATE COMPLETED FEBRUARY 1,1984

DESCRIPTION	DEPTH metres	DEPTH feet	SAMPLE no.	SAMPLE type	SAMPLE "N"	WELL DETAIL	REMARKS BLOWS PER FOOT
FILL: very dense, silt fine sand with gravel (possible abandoned road base)	1	5				A, D, B, C, F, E	
FILL: grey, very fine sand, silty, saturated	2						
ORGANIC: black with fine sand							
TILL: grey to brown	3	10				G	
E.O.H. 3.1 metres	4						
		15					
	5						
	6	20					
	7						
		25					
	8						
	9						
		30					

10 20 30 40 50 60 70 80 90

GS - GRAB SAMPLE SS - SPLIT SPOON ST - SHELBY TUBE "N" BLOWS PER FOOT WATER LEVEL ▽

WL-040881

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OW4/84
GP4/84

CLIENT ENVIRONMENT CANADA FILE NO. 390-841

PROJECT ENVIRONMENTAL IMPACT LOCATION ST. REGIS

GEOLOGIST/ENGINEER T.H. DATE COMPLETED FEBRUARY 1,1984

DESCRIPTION	DEPTH metres	DEPTH feet	SAMPLE no.	SAMPLE type	SAMPLE "N"	WELL DETAIL	REMARKS BLOWS PER FOOT
SAND & GAVEL: grey, loose fill (possible abandoned road base)			1	GS		A, D, B	
SAND: grey, fine some gravel, probably fill	1	5	2	SS	37	C	
ORGANICS: dark grey to black, some sand and silt, wood pieces	2		3	SS	15	E	
TILL: brown fine sand with silt, dense, some angular stones	3	10	4	SS	40		
	4	15	5	SS	41	F	
E.O.H. 4.5 metres	5					G	
	6	20					
	7	25					
	8						
	9	30					

GS- GRAB SAMPLE SS - SPLIT SPOON ST - SHELBY TUBE "N" BLOWS PER FOOT WATER LEVEL ▽

LEGEND

Well Detail Remarks

- **A** WELL CAP
- **B** PELTONITE SEAL
- **C** 1.5" DIA. PVC PIPE
- **D** .75" DIA. PVC PIPE
- **E** SLOTTED PORTION OF PIPE
- **F** NATIVE SOIL BACKFILL
- **G** END PLUG
- **H**
- **I**
- **J**
- **K**
- **L**

Stratigraphy

- TOPSOIL
- PEAT OR MUCK
- CLAY
- TILL
- SILT
- LIMESTONE
- SAND
- DOLOSTONE
- GRAVEL
- SHALE
- COBBLES, BOULDERS
- BEDROCK
- FILL
- REFUSE

SECTION 2 : TABLES

Table C1 - Water Level

Table C2 - Chemical Water Analysis

Table C3 - Ionic Balance

PROJECT ENVIRONMENT CANADA **TABLE** C - 1 **SHEET** Site No. I-21, St. Regis

OBSERVATION WELL	WELL DETAILS						GROUNDWATER ELEVATIONS (metres A.S.L. /local datum)						
	Nest No.	Ø cm	Type	ELEVATIONS									
				Ground	Top of pipe	Top of screen	Feb 8, 1984						
OW 1		4	PVC	32.74	33.06		31.73						
OW 2		4	PVC	32.76	33.14		31.74						
OW 3		4	PVC	30.95	31.29		29.87						
OW 4		4	PVC	31.72	31.92		29.69						

Piezometer **Standpipe**

TABLE C - 2
CHEMICAL WATER ANALYSIS

Client: Environment Canada
Project Description: Waste Disposal Sites: St. Regis
Project No.: 390-841
Date Sampled: February 8, 1984
Date Analyzed: February 29, 1984
Analyzed by: IEC Beak

Parameter	OW 1-84	OW 2-84	OW 3-84	OW 4-84			
Major Ions							
Cations							
Calcium	177	N.S	178	120			
Potassium	2.6	N.S	11.9	12.4			
Magnesium	76	N.S	88	98			
Sodium	50	N.S	16	17			
Anions							
Chloride	5.0/6.0	N.S	22	55			
Sulphate	520/530	N.S	220	88			
Bicarbonate	361	N.S	780	545/525			

Concentrations in mg/ℓ excepted as noted N.S - no sample

TABLE C - 2
CHEMICAL WATER ANALYSIS

Client: Environment Canada
Project Description: Waste Disposal Sites: St. Regis
Project No.: 390-841

Date Sampled: February 8, 1984
Date Analyzed: February 29, 1984
Analyzed by: IEC Beak

Parameter	OW 1-84	OW 2-84	OW 3-84	OW 4-84			
pH	7.8	7.5	7.7	8.0			
Conductivity (umhos/cm^2)	1430	1160	2000	1180			
Alkalinity	440	N.S	975	665/640			
COD	16	N.S	18	20			
TOC	6.0	N.S	11.0	19.0			
Mercury (Hg)	< 0.02	N.S	< 0.02	0.06			
PCB's (ppt)*	0	N.S	0	0			

Concentrations in mg/ℓ excepted as noted
N.S - no sample
* detection limit of 100 ppt

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IONIC BALANCE

C-3

Area of Survey Site No. I-21, ST. REGIS INDIAN RESERVE **Sample :** Groundwater **Date** February 8, 1984

CATIONS **ANIONS**

Ion	Ca			Mg			Na			K			Na+K	Total	Alkalinity			SO_4			Cl			Total	Diff.
Conversion Factor	ppm x .0499			ppm x .0822			ppm x .0435			ppm x .0256				Cations	HCO_3 ppm x .0164 CO_3 ppm x .0333			ppm x .0208			ppm x .0282			Anions	%
Well No.	ppm	epm	%	ppm	epm	%	ppm	epm	%	ppm	epm	%		epm	ppm	epm	%	ppm	epm	%	ppm	epm	%	epm	
OW 1-84	245	12.23		76	6.25		50	2.18		2.6	.067		2.25	20.73	440	5.91		520/530	11.0		5.0/6.0	0.17		17.08	18%
OW 3-84	290	14.47		88	7.23		16	0.70		11.9	0.30		1.0	22.70	975	13.11		220	4.56		22	0.62		18.29	19%
OW 4-84	151	7.53		98	8.06		17	0.74		12.4	0.32		1.06	16.65	665	8.95		88	1.83		55	1.55		12.33	27%

SECTION 3 : SITE SUMMARY REPORT

SITE REPORT SUMMARY

BACKGROUND:

1. General

Site Name: St. Regis Reserve

Site Area: 8000 m^2

Site Owner: Dept. of Indian Affairs

Date of Operation: 1920 to 1979

Site Location: 521320 4983700 UTM
Cornwall

Name of Operator: St. Regis Reserve

2. Land Uses

Original - vacant and agriculture

Present - vacant, agricultural and waste dumping

Future Potential Land Use -

3. Present Development

On-Site - a portion is still used as a dump site

Abutting (distance) - agricultural land

FIELD INVESTIGATION RESULTS:

1. Type of Investigation Performed - site reconnaissance, test drilling, soil sampling, observation well and gas probe installation, permeability tests, water level recording and groundwater sampling.

2. Site Chacteristics

Site Access - across Seaway International Bridge to Cornwall Island, east along main road to first road going north. Access is from this north-south road.

Site Visibility - highly visible from Seaway Bridge and a public park on the opposite side of the St. Lawrence River

Site Security - access is controlled by the Indian Band Council

Vegetation on Site - reported as being sparse with signs of stress within growing season

3. Waste Disposal Practices

Quantity of Refuse - assuming the waste is about 2-3 m thick throughout the site, there is between 16,000 and 24,000 m^3 of waste

Thickness of Waste - approximately 2-3 m thick

Type of Waste (confirmation) - domestic wastes from Reserve and seaway excavation material from the St. Lawrence River

Cover Material and Thickness - ranges from absent to 1.5 m of sand fill

4. Hydrogeologic Setting

Overburden type and thickness - overburden is a silty till to a depth of 0 to 3.4 m over bedrock. The till is covered by silt and sand up to 3.2 m in depth; total overburden thickness ranges from 3.2 to 4.5 m.

Bedrock type - limestone, dolostone and shale of the Trenton and Black River Groups

Local topography - flat to gently rolling

Drainage Patterns (regional and local) - regionally drainage is to the east (St. Lawrence)
- local drainage is north to St. Lawrence

Surface water bodies - located 75 m from the St. Lawrence River

Depth to Water Table - ranges from 1.01 to 2.03 m below ground level in observation wells

Direction of Groundwater Flow - north to northeast towards the St. Lawrence River

5. Identified Impacts

Leachate characteristics - some elevated leachate constituents in downgradient observation wells such as T.O.C., mercury, potassium and chloride. Sulphate is reduced in downgradient wells (indicative of leachate)

Evidence of Leachate seepage - none noted during our field visit (Jan-Feb, 1984)

Evidence of leachate migration and attenuation - some slight increases in leachate constituents in downgradient observation wells, very minor impact on groundwater

Evidence of gas generation and migration - vegetation stress noted in previous studies may be a sign of methane production

Vegetation stress - vegetation is sparse and appears stressed in summer season

Settlement and erosion - some wind erosion in dry season

Other potential sources of contamination - there are numerous sources of surface water contamination which would impact the St. Lawrence; studies have been carried out on the transport of fluorides in the air from factories in the area; however, there should be no other source of groundwater contamination

POTENTIAL IMPACTS:

1. Leachate

Water Supplies within 500 m - two domestic wells are located south of landfill within 500 m

Potential human hazard - groundwater flow is to the north; therefore, there should be no impact on water supplies to the south

Potential environmental hazard - leachate from the site will travel to the St. Lawrence River; the impact of this site on the quantity of flow through the St. Lawrence River will be insignificant especially in comparison to large pollution contributer along the river

2. Methane

Nearby buildings - two residences within 500 m, however, methane migration should be limited to a maximum of about 100 m

Potential human hazard - none at present unless development encroaches on the landfill

Potential environmental hazard - there may be some hazard to vegetation immediately surrounding the landfill

7.0 RIDEAU CANAL (SMITHS FALLS): SITE NO. P-103

7.1 Introduction

The Rideau Canal disposal site is situated on the eastern boundary of the Town of Smiths Falls. The location of the site within the Town is shown in Figure D-1 on the following page.

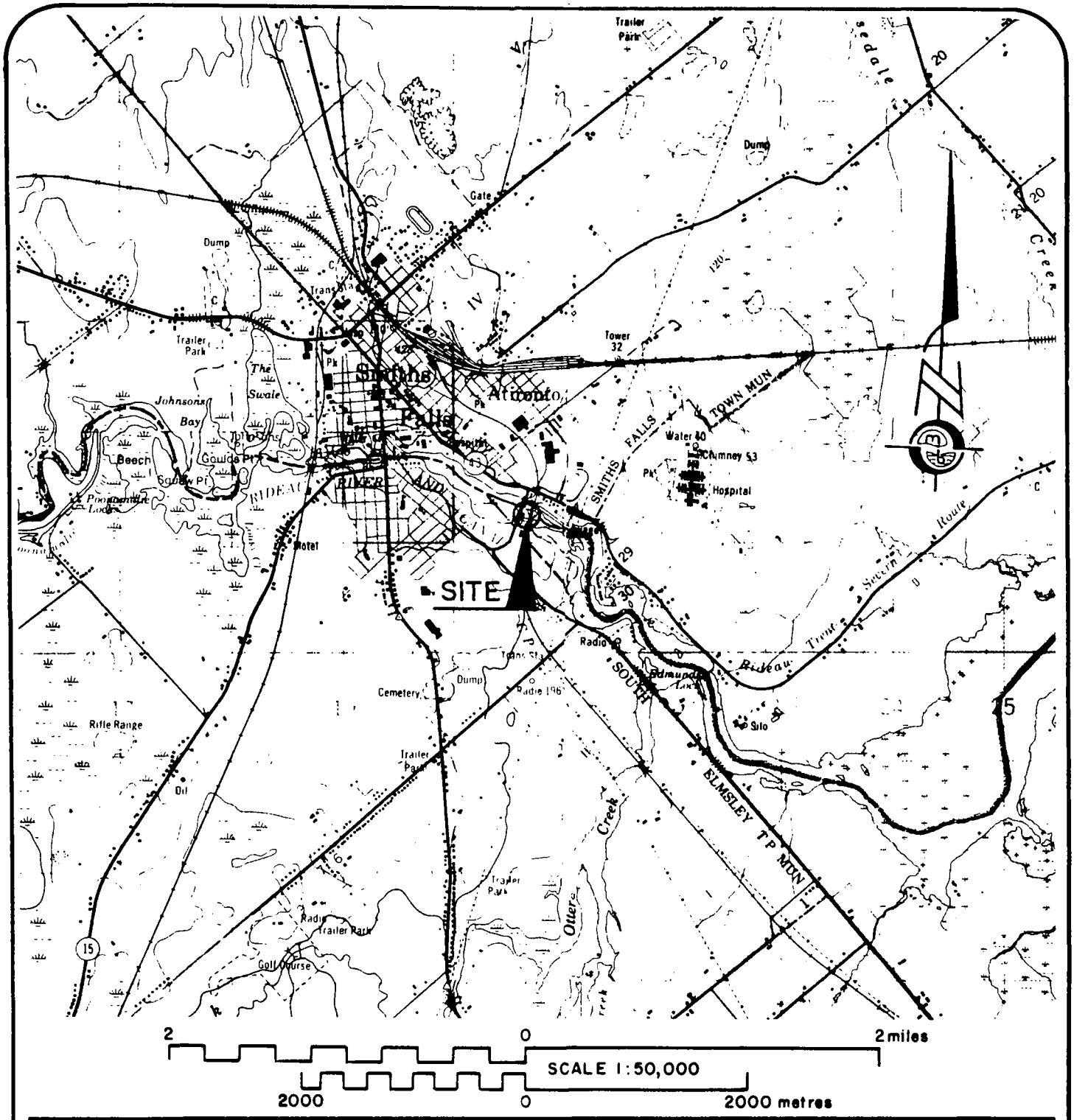
Landfilling took place on a small parcel of land (approximately 0.9 ha) situated between the Rideau Canal "Old Slys" locks to the north, the Rideau River to the south, CPR tracks to the east and Carthage Street to the west. The site was used between 1961 and 1969. Access to the site is from Carthage Street.

The site is visible from Carthage Street and the CPR tracks; however, it has been covered, landscaped and is now used as a Town park. The site and surrounding area is shown on the air photo in Figure D-2.

7.2 Site-Specific Studies

The general field study methodology is outlined in Section 3.0. The field program specific to this site is outlined below:

- Site reconnaissance determined field conditions and locations of observation wells and gas probes.
- Test drilling confirmed depth of landfill, overburden stratigraphy and depth to bedrock. All test drilling was through landfill refuse.
- Four permanent observation wells and four permanent gas probes were installed within the landfill to determine maximum leachate concentrations and the presence of methane gas. Since the site is surrounded by water with no suitable land area to place a background or downgradient observation well, all wells show on-site conditions. The monitoring locations are shown on Figure D-3.



ENVIRONMENT CANADA
Abandoned Waste Disposal Sites
Phase II
SITE: RIDEAU CANAL

TOPOGRAPHIC LOCATION

MORRISON BEATTY LIMITED

PROCTOR & REDFERN LIMITED

MAR. 1984

D1

1/2 0 1/2 mile

SCALE 1:10,000

500 0 500 metres

ENVIRONMENT CANADA
Abandoned Waste Disposal Sites
Phase II

SITE: RIDEAU CANAL

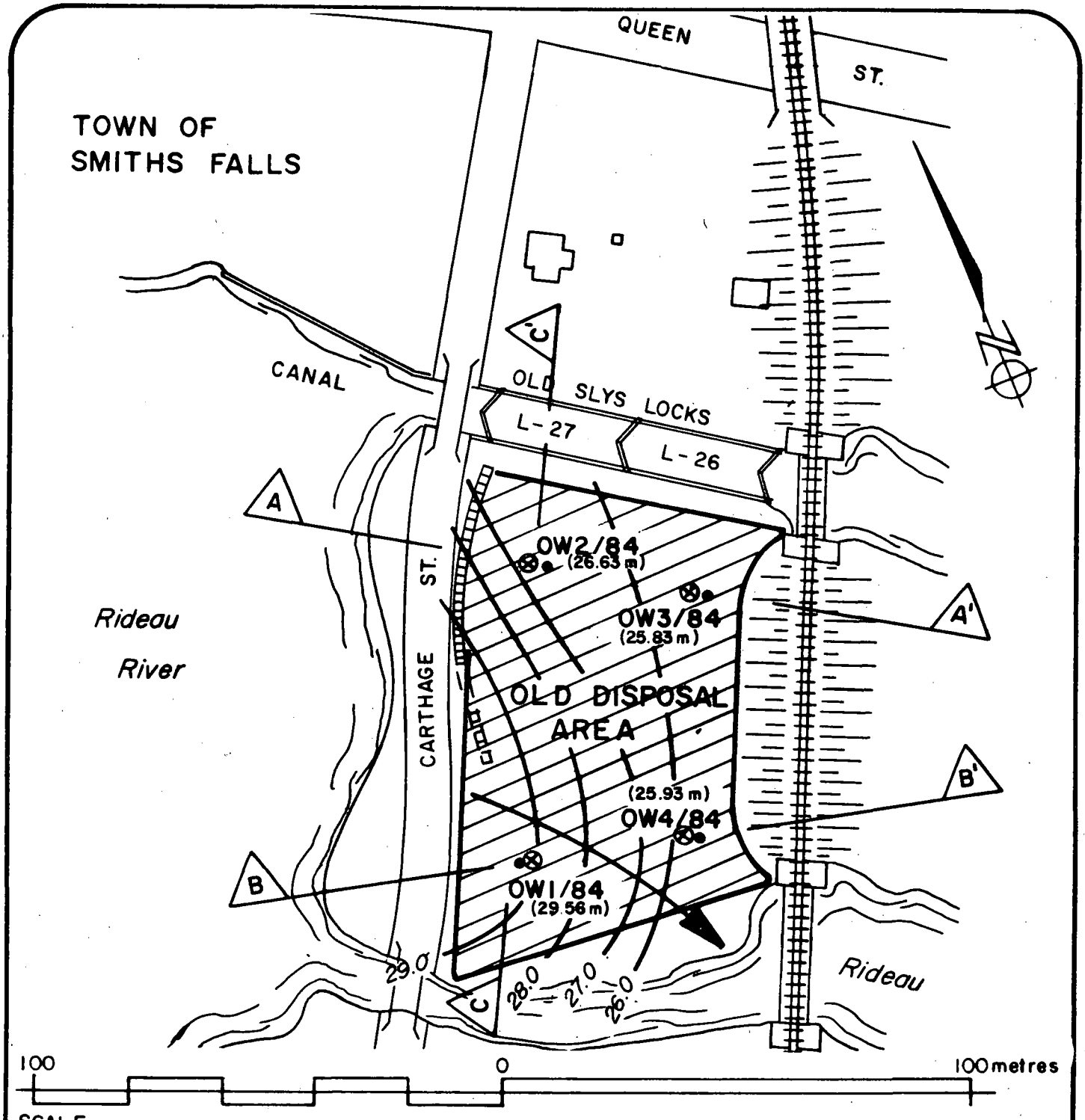
AIR PHOTO LOCATION

MORRISON BEATTY LIMITED

PROCTOR & REDFERN LIMITED

MAR. 1984

D2



LEGEND

- ⊗ Observation Well
- • Gas Probe
- (25.93 m) Groundwater Elevation (local datum)
- —— Groundwater Contour
- ◀—— Direction of Groundwater Flow

ENVIRONMENT CANADA
Abandoned Waste Disposal Sites
Phase II

SITE: RIDEAU CANAL

SITE PLAN

MORRISON BEATTY LIMITED

PROCTOR & REDFERN LIMITED

MAR. 1984

D3

- Groundwater elevations within the landfill were established for each well and referenced to a local datum located at the southeast corner of the landfill. Water levels are included in Table D-1, Section 2 of the Appendix.

- Leachate samples were collected from all observation wells and analyzed for conductivity and pH. Three samples (OW 1, OW 2 and OW 3-84) were analyzed for alkalinity, COD, TOC and major ions. An extra sample from three wells was collected and delivered to the Environmental Protection Service for PCB analyses. The results of all analyses are included in Table D-2, Section 2 of the Appendix.

- Waste characterization was completed at this site since boreholes were completed through the landfill. The description of the wastes is included on the observation well logs.

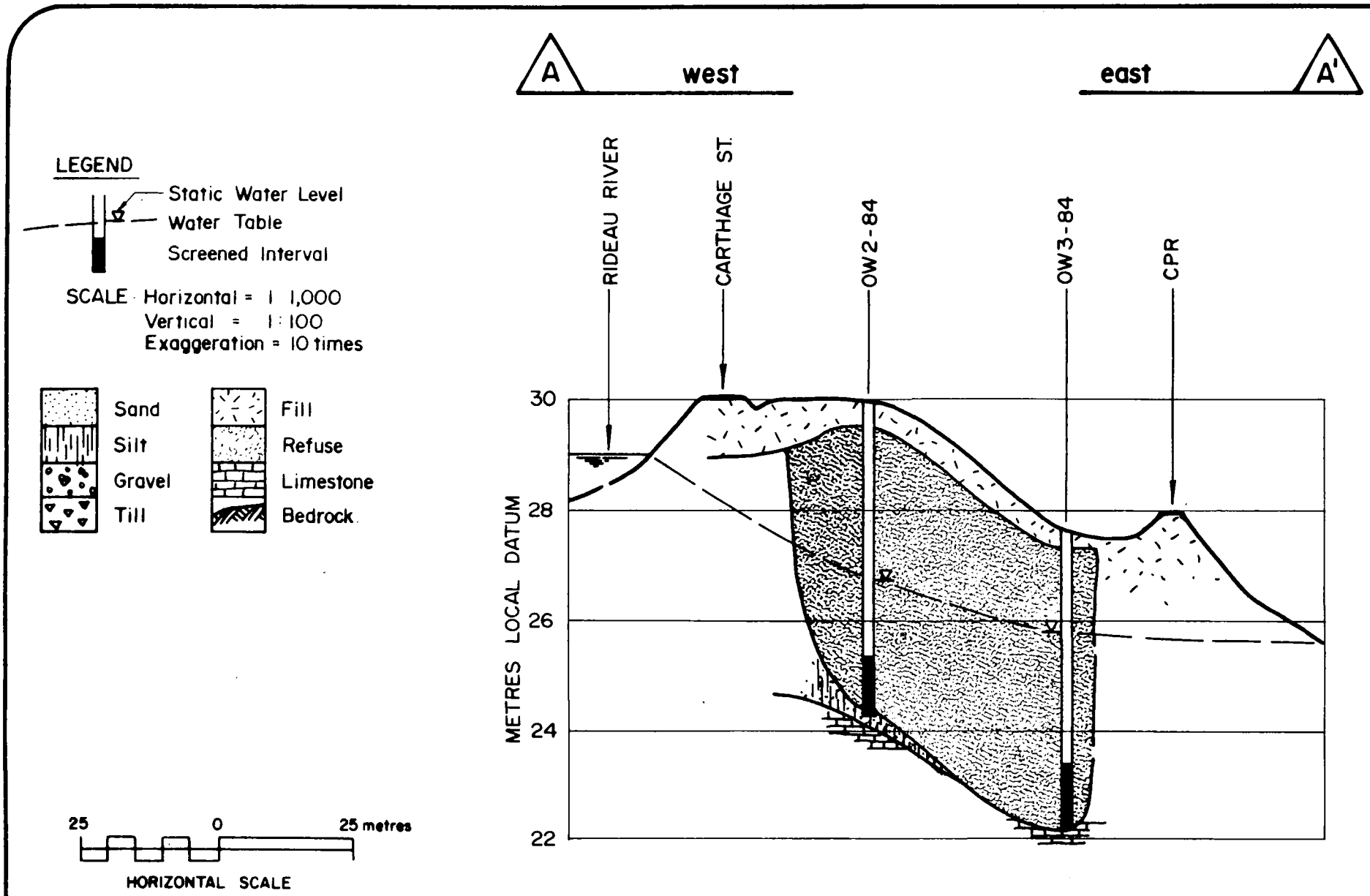
7.3 Study Results

7.3.1 Hydrogeologic Setting

i) Geology

Smiths Falls is within the physiographic region known as the Smiths Falls Limestone Plain. It is characterized by shallow soil over the limestone bedrock. Test drilling revealed a thin (less than 1 m) deposit of silt and sand beneath the landfill refuse and overlying the bedrock. This deposit is recent alluvium deposited by the Rideau River. Split-spoon samples were not taken.

Bedrock is limestone of the Beekmantown Formation. The depth to bedrock was assumed at refusal between 2.4 and 5.8 m below landfill surface. Cross-sections on the following pages show the stratigraphy of the site.



CROSS-SECTION A-A'

(Refer to Figure D3)

ENVIRONMENT CANADA
Abandoned Waste Disposal Sites
Phase II
SITE: RIDEAU CANAL

PROJECT NO. 390-841

MAR. 1984

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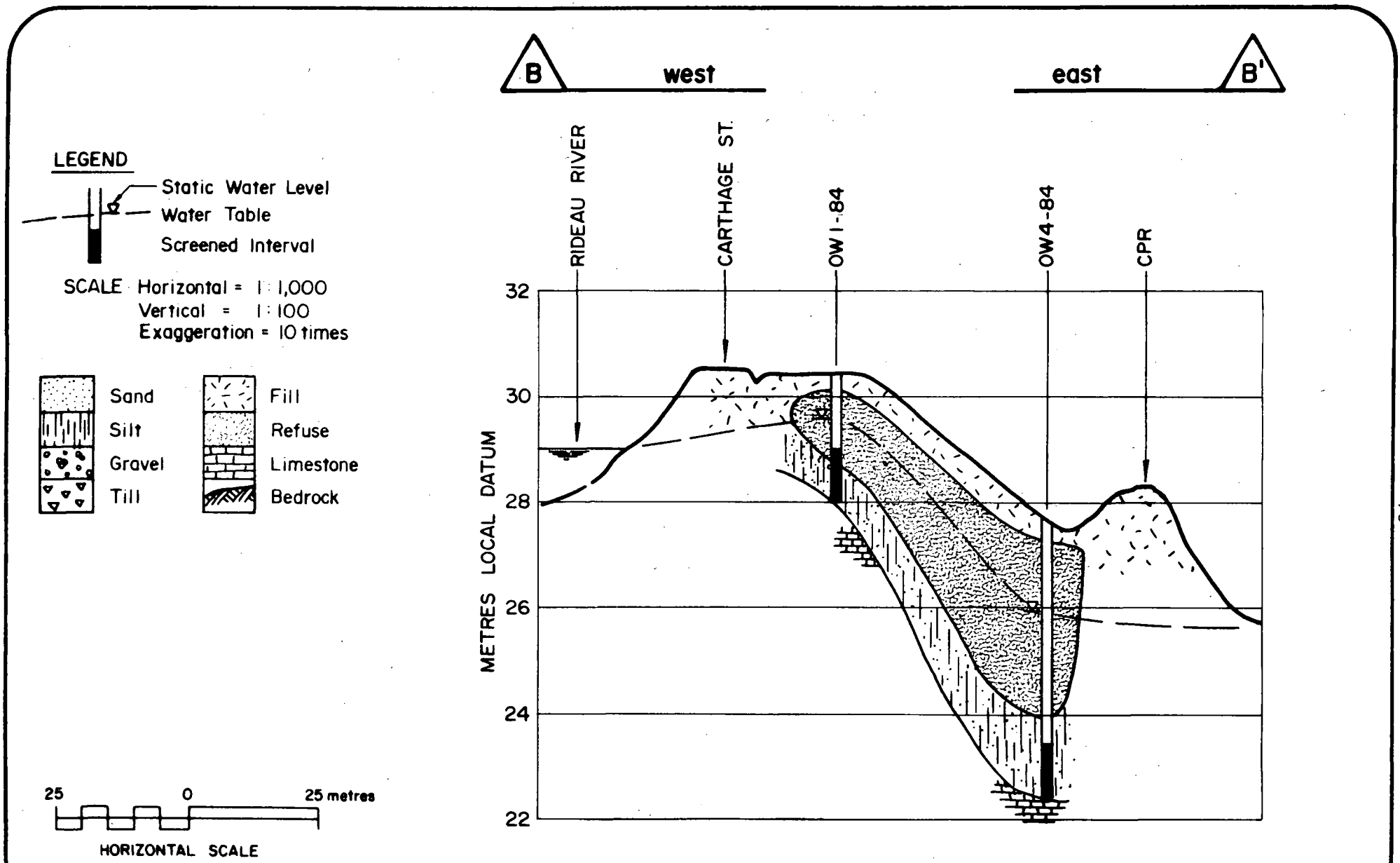
D4



CROSS-SECTION B-B'

(Refer to Figure D3)

ENVIRONMENT CANADA
Abandoned Waste Disposal Sites
Phase II
SITE: RIDEAU CANAL

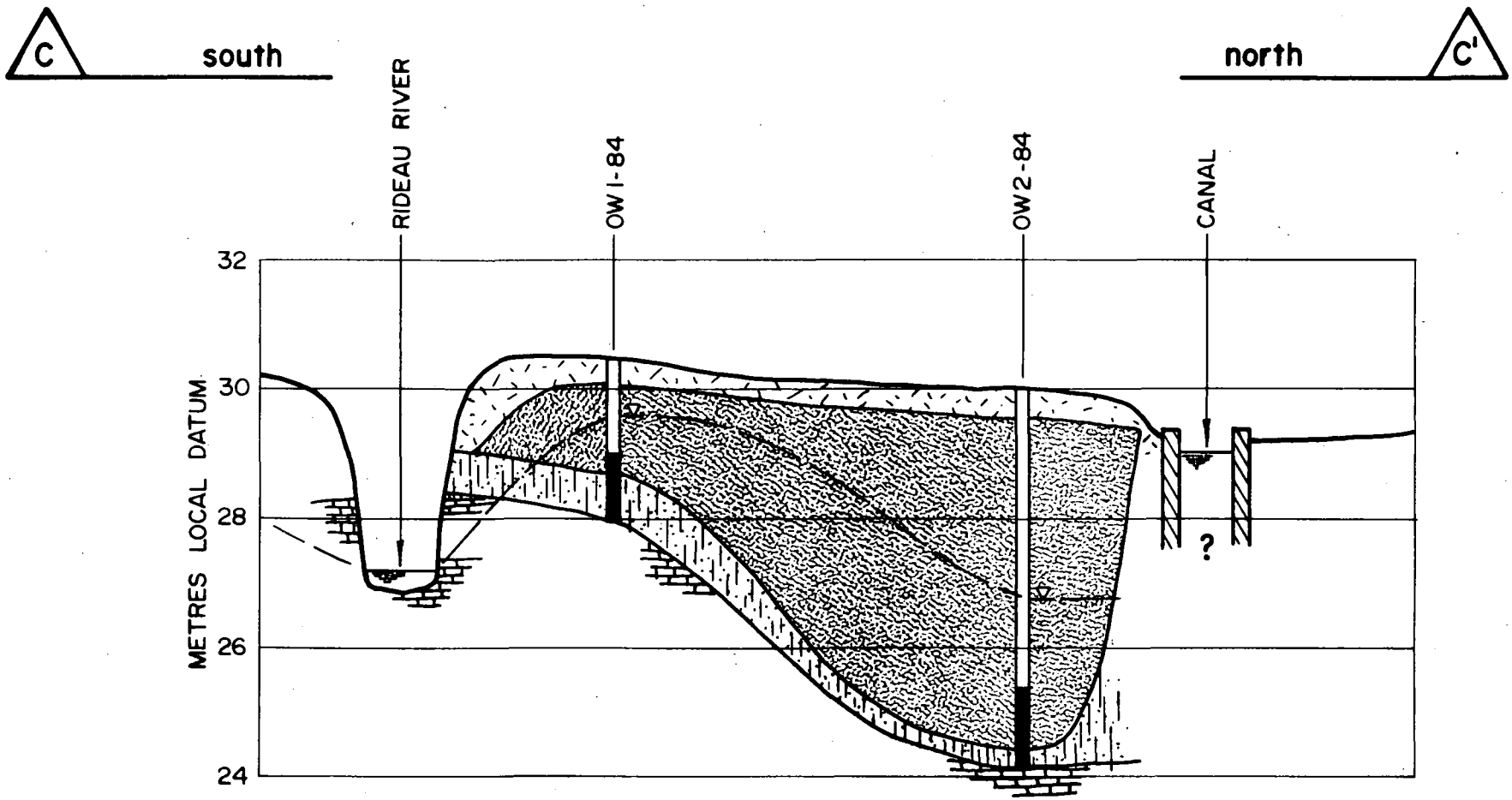
PROJECT NO. 390-841

MAR. 1984

MORRISON BEATTY LIMITED

PROCTOR & REDFERN LIMITED

D5



LEGEND

Static Water Level
Water Table
Screened Interval

Sand
Silt
Gravel
Till

Fill
Refuse
Limestone
Bedrock

SCALE Horizontal = 1 1,000
Vertical = 1:100
Exaggeration = 10 times

25 0 25 metres
HORIZONTAL SCALE

CROSS-SECTION C-C'

(Refer to Figure D3)

ENVIRONMENT CANADA
Abandoned Waste Disposal Sites
Phase II
SITE: RIDEAU CANAL

PROJECT NO. 390-841

MAR. 1984

MORRISON BEATTY LIMITED
PROCTOR & REDFERN LIMITED

D6

ii) Topography and Drainage

The site slopes gently to the east and south from Carthage Street. Maximum relief is about 6 m. The built-up bed of the CP railway has created a drainage divide along the east limit of the fill. Surface drainage therefore, is directly southeast into the river.

iii) Groundwater

The depth to water table ranged from 1.0 to 3.3 m below surface in the observation wells. The reservoir upgradient of the site is an obvious source of recharge water for the landfill. The configuration of the water table, shown on Figure D-3, reflects the recharge gradient.

All groundwater flow paths through the site are expected to terminate in the river. There are no groundwater uses on or adjacent to the site. Groundwater from the site will not migrate to groundwater resources beyond the Rideau River.

7.3.2 Water Budget

The Rideau Canal site receives an average of 782 mm precipitation annually, based on thirty year normals (1941-1970) for the Smiths Falls (Water Pollution Control Plant) Meteorological Station. This site is within the Lake Ontario Basin and can expect to lose 55% of the annual precipitation to evapotranspiration (The Climate of the Great Lakes Basin, 1972). This amounts to about 430 mm.

The landfill has a sandy fill cover. An infiltration rate of 200 mm/a can be expected for this type of cover material. Using this infiltration rate, about 152 mm/a will be lost in surface runoff. The annual average water budgets and leachate production rates are shown schematically on the following diagram, Figure D-7.

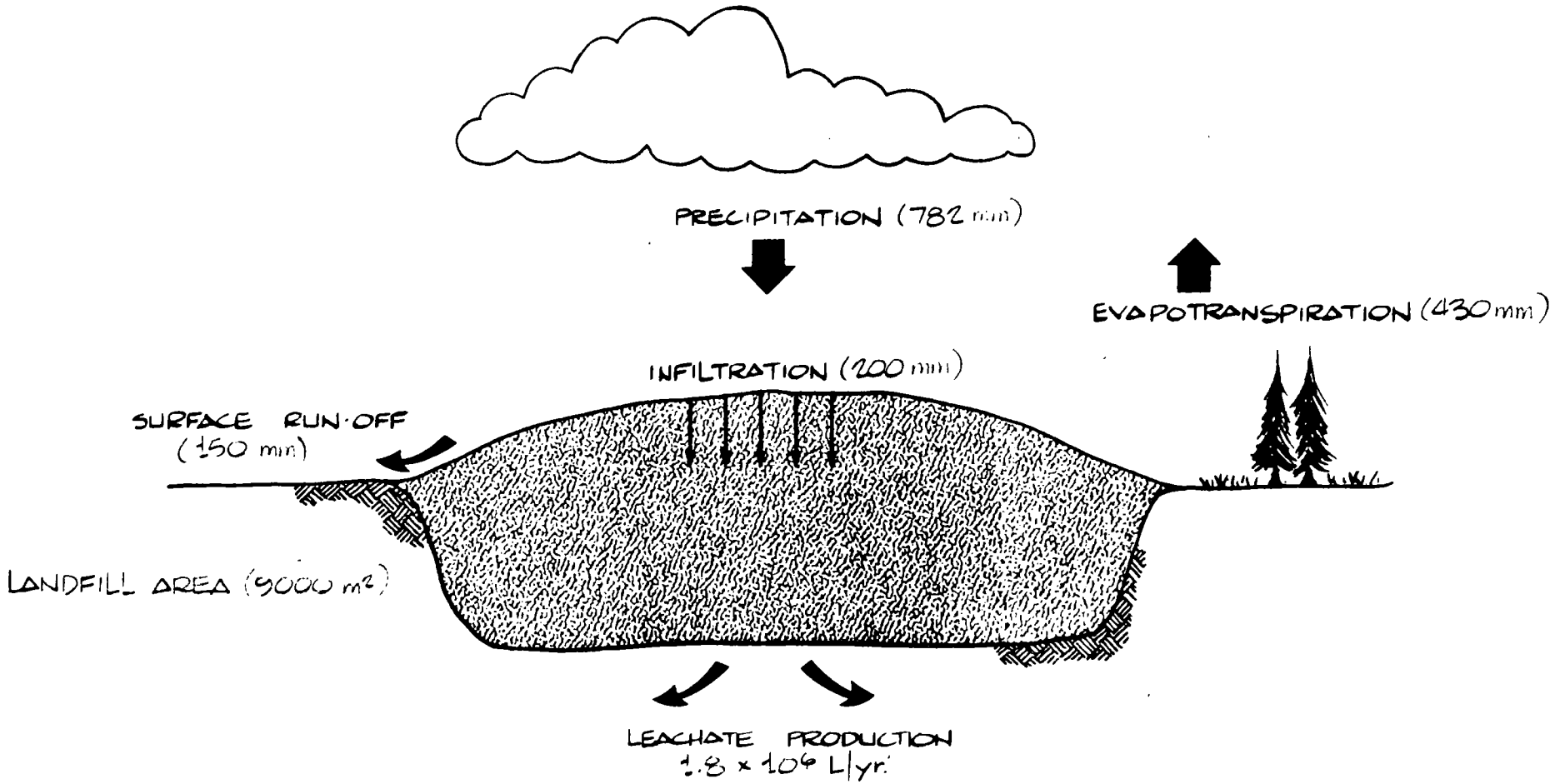
Leachate is produced when precipitation infiltrates into the refuse. The leachate production rate can be calculated using the annual infiltration rate of 200 mm and the landfill's area, which in this case is about 9000 m^2. The average annual leachate production rate expected at this site is 1.8×10^6 L/yr or 0.06 L/s.

7.3.3 Groundwater Quality and Leachate Impacts

A detailed evaluation of key leachate indicators is presented in the following sections:

i) pH and Conductivity

Leachate generally has pH values in a range of 5.0 to 7.0. The range of pH within this site is 7.1 to 7.4. This is within the range expected in natural groundwater. Conductivity in the three observation wells ranges from 1060 to 1430 umhos/cm^2. Leachate conductivity is usually higher than these values (10,000 to 30,000 umhos/cm). The age of the site indicates that peak strengths have already been reached. Leachate strengths gradually decay to low levels after the peak is reached.



INFILTRATION = TOTAL PRECIPITATION - EVAPOTRANSPIRATION - RUNOFF
(200 mm) (782 mm) (430 mm) (152 mm)

SITE: RIDEAU CANAL	**ENVIRONMENT CANADA** Abandoned Waste Disposal Sites Phase II	PROJECT NO. 390-841	MAR. 1984
		MORRISON BEATTY LIMITED PROCTOR & REDFERN LIMITED	**D7**

ii) Major Ions

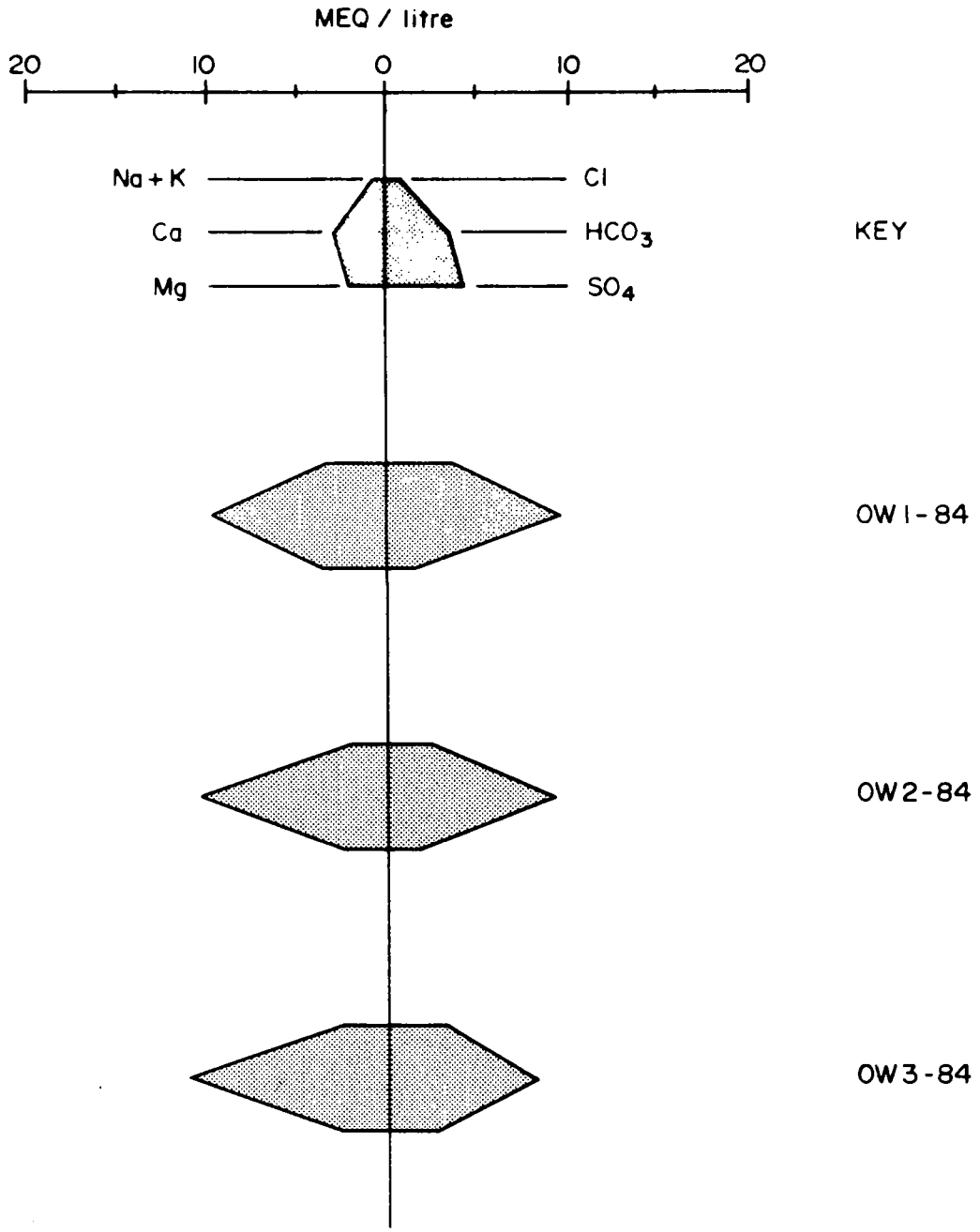
The ionic balance is listed in Table D-3 in Section 2 of the Appendix. Stiff diagrams showing the major anion and cation distribution are on Figure D-8 on the following page. All observation wells have similar ion distributions but do not appear to reflect typical concentrations of ions in leachate.

The chloride ion is relatively mobile in groundwater and is a good indicator of leachate. The chloride levels in the leachate at this site range from 65 to 130 mg/L. This is much lower than peak levels in other landfills. The age of this site suggests there has been a significant decay in leachate strength.

iii) Organics

COD (chemical oxygen demand) is the measure of oxygen required to oxidize organic and inorganic compounds. Concentrations in the leachate ranged from 80 mg/L in OW 2-84 to almost 1500 mg/L in OW 3-84.

TOC (total organic carbon) is one of the best measures of the organic content of leachate from landfills. TOC ranged from 32 mg/L in OW 2 to 424 mg/L in OW 3-84. These levels are very low, considering peak levels in the tens of thousands of mg/L are common. The ratio of COD/TOC is usually about 3 which is typical for landfill leachate. This again supports the previous observation that the age of the site has resulted in a decay in leachate strength.



Note: All wells are indicative of leachate within the site.

Major Anion and Cation Distribution

SITE: RIDEAU CANAL

D8

iv) PCB's

Samples were collected for two of the observation wells and analyzed for PCB's. There were no PCB's detected in either sample. The MOE laboratory detection limit is 20 ppt.

v) Summary of Leachate Characteristics and Impacts

The leachate strength in the landfill is weak compared to typical levels in young landfills. PCB's were not detected. The water table is mounded in the landfill due to recharge from the abutting reservoir. The leachate discharges directly to the river and canal. Little or no mixing would be expected in the groundwater regime beyond the limits of the site. Therefore, no impacts will occur on groundwater in the area.

The large flows in the river and canal will dilute the relatively small leachate discharge to insignificant levels. A local impact may occur at the actual leachate seepage points. Orange staining is evident on the canal structure and river sediments at the main seepage points. This is due to the precipitation of iron by oxidation.

7.3.4 Methane Impacts

Methane will be produced in the landfill until the organic wastes are completely decomposed. Venting of the methane through the surface is reported to have damaged young trees planted on the site. The methane reduces the amount of oxygen circulation through the root zone. The methane will be confined to the site by the surrounding surface waters.

Four permanent gas probes were installed for future methane monitoring. This would be important if any park facilities are planned. (eg - pavillion, washrooms, etc).

7.3.5 Potential Hydrogeologic Impacts

Leachate will continue to discharge into the river and canal. A potential hazard could occur where the public (especially children) have access to the near-shore areas. Although the leachate strength is weak there could be a minor impact on the surface water with public use.

7.4 Future Land Use Plans

The site is presently landscaped and open for public use. Day use of the park is expected to increase in the future since camp sites are planned for the perimeter of the upstream pond. The site is expected to remain as an historical park but some use of the surrounding water bodies can be expected.

7.5 Conclusions

The quality of leachate in this site is weak in comparison to young sites. It is apparent that a decay in leachate strength is occurring.

The site does not impact on groundwater resources. The impact on the overall quality in the river and canal is expected to be insignificant due to dilution in the streamflow; however, localized impacts could occur at shore discharge points. There is a visual impact caused by iron staining at the points of leachate discharge into the watercourses.

Methane venting through the landfill cover may cause some stress on the vegetation. It will not pose a public hazard providing building is restricted on the site.

7.6 Recommendations

The following recommendations are based on the Phase II field program:

1. Surface water samples should be obtained during low flow conditions to determine the maximum impact of leachate on the river and canal. The samples should be obtained at seepage points and in the mid-point of the watercourse.

2. If contaminants are found in the shore areas of the river and canal, where leachate seepage occurs, remedial measures should be taken to correct the problem.

3. If building is proposed on the site, the gas probes should be monitored to identify methane concentrations in the refuse.

APPENDIX

RIDEAU CANAL (SMITH FALLS) : SITE NO. P-103

SECTION 1 : OBSERVATION WELL LOGS

SECTION 2 : TABLES

SECTION 3 : SITE SUMMARY REPORT

SECTION 1 : OBSERVATION WELL LOGS

morrison beatty limited
consulting engineers and hydrogeologists
4500 dixie road, 12e, mississauga, ontario (416) 624 - 9306

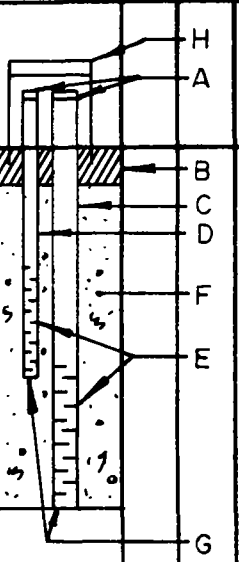
OW1/84

CLIENT ENVIRONMENT CANADA FILE NO. 390-841

PROJECT ENVIRONMENTAL IMPACT LOCATION RIDEAU CANAL, SMITHS FALLS

GEOLOGIST/ENGINEER T.H. DATE COMPLETED FEBRUARY 6,1984

DESCRIPTION	DEPTH metres	DEPTH feet	SAMPLE no.	SAMPLE type	SAMPLE "N"	WELL DETAIL	REMARKS BLOWS PER FOOT
SAND: fill							
REFUSE: wet, well decomposed, no strong odour	1	5					
SAND: saturated	2						
E.O.H. 2.4 metres (refusal- bedrock assumed)	3	10					
	4						
		15					
	5						
	6	20					
	7						
		25					
	8						
	9	30					



10 20 30 40 50 60 70 80 90

GS- GRAB SAMPLE SS- SPLIT SPOON ST- SHELBY TUBE "N" BLOWS PER FOOT WATER LEVEL ▽

18000-TM

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OW2/84

CLIENT ENVIRONMENT CANADA FILE NO. 390-841

PROJECT ENVIRONMENTAL IMPACT LOCATION RIDEAU CANAL, SMITHS FALLS

GEOLOGIST/ENGINEER T.H. DATE COMPLETED FEBRUARY 6,1984

DESCRIPTION	DEPTH metres	DEPTH feet	SAMPLE no.	SAMPLE type	SAMPLE "N"	WELL DETAIL	REMARKS BLOWS PER FOOT 10 20 30 40 50 60 70 80 90
FILL						H, A, B, D, E, G, C, F, E, G	
REFUSE: well decomposed glass, wood, some boulders	1	5					
	2						
	3	10					
	4						
		15					
	5						
SAND, SILT: saturated	6	20					
E.O.H. 5.8 metres (refusal - bedrock assumed)							
	7						
		25					
	8						
	9	30					

GS - GRAB SAMPLE SS - SPLIT SPOON ST - SHELBY TUBE "N" BLOWS PER FOOT WATER LEVEL ▽

WL-040881

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OW3/84

CLIENT ENVIRONMENT CANADA FILE NO. 390-841

PROJECT ENVIRONMENTAL IMPACT LOCATION RIDEAU CANAL, SMITHS FALLS

GEOLOGIST/ENGINEER T.H. DATE COMPLETED FEBRUARY 6,1984

DESCRIPTION	DEPTH metres	DEPTH feet	SAMPLE no.	SAMPLE type	SAMPLE "N"	WELL DETAIL	REMARKS BLOWS PER FOOT
FILL						H, A, B, D, E, G, C, F, E, G	10 20 30 40 50 60 70 80 90
REFUSE: well decomposed, wet	1	5					
	2						
	3	10					
	4						
		15					
	5						
E.O.H. 5.4 metres (refusal - bedrock assumed)	6	20					
	7						
		25					
	8						
	9	30					

GS - GRAB SAMPLE SS - SPLIT SPOON ST - SHELBY TUBE "N" BLOWS PER FOOT WATER LEVEL ▽

WL-040811

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consulting engineers and hydrogeologists
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OW4/84

CLIENT ENVIRONMENT CANADA FILE NO. 390-841
PROJECT ENVIRONMENTAL IMPACT LOCATION RIDEAU CANAL, SMITHS FALLS
GEOLOGIST/ENGINEER T.H. DATE COMPLETED FEBRUARY 6,1984

DESCRIPTION	DEPTH metres	DEPTH feet	SAMPLE no.	SAMPLE type	SAMPLE "N"	WELL DETAIL	REMARKS BLOWS PER FOOT 10 20 30 40 50 60 70 80 90
FILL							
REFUSE	1	5					
	2						
	3	10					
SAND: gravel, silt and some clay, possible fill	4						
		15					
	5						
E.O.H. 5.2 metres (refusal - bedrock assumed)	6	20					
	7						
		25					
	8						
	9	30					

WELL DETAIL: H, A, B, D, E, G, C, F, E, G

GS- GRAB SAMPLE SS- SPLIT SPOON ST- SHELBY TUBE "N" BLOWS PER FOOT WATER LEVEL ▽

LEGEND

Well Detail Remarks

A WELL CAP

B PELTONITE SEAL

C 1.5" DIA. PVC PIPE

D .75" DIA. PVC PIPE

E SLOTTED PORTION OF PIPE

F NATIVE SOIL BACKFILL

G END PLUG

H 5" DIA. STEEL PROTECTION COVER WITH HINGED AND LOCKED CAP

I

J

K

L

Stratigraphy

- TOPSOIL
- PEAT OR MUCK
- CLAY
- TILL
- SILT
- LIMESTONE
- SAND
- DOLOSTONE
- GRAVEL
- SHALE
- COBBLES, BOULDERS
- BEDROCK
- FILL
- REFUSE

SECTION 2 : TABLES

Table D1 - Water Level
Table D2 - Chemical Water Analysis
Table D3 - Ionic Balance

PT-080383

PROJECT ENVIRONMENT CANADA **TABLE** D - 1 **SHEET** Site No. P-103, Rideau Canal

OBSERVATION WELL	WELL DETAILS						GROUNDWATER ELEVATIONS (metres A.S.L. /local datum)						
	Nest No.	ø cm	Type	ELEVATIONS			Feb 7, 1984						
				Ground	Top of pipe	Top of screen							
OW 1		4	PVC	30.43	31.49		29.56						
OW 2		4	PVC	29.94	30.72		26.63						
OW 3		4	PVC	27.69	28.65		25.83						
OW 4		4	PVC	27.67	28.50		25.93						

Piezometer Standpipe

TABLE D - 2
CHEMICAL WATER ANALYSIS

Client: Environment Canada
Project Description: Waste Disposal Sites: Smith Falls
Project No.: 390-841

Date Sampled: February 7, 1984
Date Analyzed: February 29, 1984
Analyzed by: IEC Beak

Parameter	OW 1-84	OW 2-84	OW 3-84	OW 4-84			
Major Ions							
Cations							
Calcium	250/200	215	225	N.S			
Potassium	25/26	13.3	21	N.S			
Magnesium	40/40	29	34	N.S			
Sodium	62/66	42	44	N.S			
Anions							
Chloride	130/95	85/65	112/80	N.S			
Sulphate	51/50	82	130	N.S			
Bicarbonate	603	570	492	N.S			

Concentrations in mg/ℓ excepted as noted N.S - no sample

TABLE D - 2
CHEMICAL WATER ANALYSIS

Client	Environment Canada	Date Sampled	February 7, 1984
Project Description	Waste Disposal Sites: Smith Falls	Date Analyzed	February 29, 1984
Project No.	390-841	Analyzed by	IEC Beak

Parameter	OW 1-84	OW 2-84	OW 3-84	OW 4-84			
pH	7.1	7.2	7.2	7.4			
Conductivity (umhos/cm^2)	1430	1280	1300	1060			
Alkalinity	735	695	600	N.S			
COD	231	80	1490	N.S			
TOC	84	32	424	N.S			
PCB's (ppt)*	0	0	N.S	N.S			

Concentrations in mg/ℓ excepted as noted
* detection limit of 100 ppt

N.S - no sample

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IONIC BALANCE

D-3

Area of Survey: Site No. P-103, RIDEAU CANAL (SMITH FALLS)

Sample : Groundwater

Date: February 7, 1984

	CATIONS													ANIONS									
Ion	Ca			Mg			Na			K			Na + K	Total Cations	Alkalinity			SO_4			Cl			Total Anions	Diff.
Conversion Factor	ppm x .0499			ppm x .0822			ppm x .0435			ppm x .0256					HCO_3 ppm x .0164 CO_3 ppm x .0333			ppm x .0208			ppm x .0282				
Well No.	ppm	epm	%	ppm	epm	%	ppm	epm	%	ppm	epm	%		epm	ppm	epm	%	ppm	epm	%	ppm	epm	%	epm	%
OW 1-84	200	9.98		40	3.29		62	2.70		25	0.64		3.34	16.61	735	9.89		51	1.06		130	3.66		14.61	12%
OW 2-84	215	10.73		29	2.38		42	1.83		13.3	0.34		2.17	15.28	695	9.35		82	1.71		85	2.40		13.46	12%
OW 3-84	225	11.23		34	2.79		44	1.91		21	0.54		2.45	16.47	600	8.07		130	2.70		112	3.16		13.93	15%

SECTION 3 : SITE SUMMARY REPORT

SITE REPORT SUMMARY

BACKGROUND:

1. General

Site Name: Rideau Canal

Site Area: 0.9 ha (2.22 ac)

Site Owner: Parks Canada

Date of Operation: 1961 to 1969

Site Location: Smiths Falls

Name of Operator: Town of Smiths Falls

2. Land Uses

Original - vacant

Present - parkland

Future Potential Land Use -

3. Present Development

On-Site - none

Abutting (distance) - Carthage Street to west; CPR tracks to east; Rideau River to south and Rideau Canal Locks to north

FIELD INVESTIGATION RESULTS:

1. Type of Investigation Performed

- site reconnaissance, test drilling, observation well installation, water level monitoring, leachate sampling.

2. Site Chacteristics

Site Access - from Carthage Street

Site Visibility - can be seen from the street and from CPR tracks

Site Security - public access allowed, since is Park Canada property

Vegetation on Site - grass and recently planted trees

3. Waste Disposal Practices

Quantity of Refuse - approximately 36,000 m^3 (using an average depth of 4.0 m)

Thickness of Waste - maximum of 5.5 m thick

Type of Waste (confirmation) - domestic

Cover Material and Thickness - sand cover approximately 0.3 m thick

4. Hydrogeologic Setting

Overburden type and thickness - very thin layer (0.5 m) of sand and silt above bedrock and beneath waste

Bedrock type - dolostone and limestone of the Beekmantown Formation

Local topography - gentle slope to the east and south

Drainage Patterns (regional and local) - regionally towards southeast
- local towards southeast

Surface water bodies - Rideau River and Canal abutts site

Depth to Water Table - ranges between 1.0 and 3.3 m below ground level in observation wells

Direction of Groundwater Flow - southeast

5. Identified Impacts

Leachate characteristics - typical leachate indicators: elevated chloride, and high organics (TOC and COD); however very dilute compared to other landfills

Evidence of Leachate seepage - orange staining was noted in previous (summer) field programs along banks of Rideau Canal & River

Evidence of leachate migration and attenuation - leachate from site is migrating into the Rideau River and Canal; dilution factors are not known, but are expected to be more than 100 to 1

Evidence of gas generation and migration - vegetation stress indicates methane production; since site is surrounded by water, methane cannot migrate

Vegetation stress - in summer months the park's grass shows signs of methane stress; recently planted trees are also showing stress

Settlement and erosion - none noted; there is a maintained high water table mark on the north and south edges of the site

Other potential sources of contamination - none

POTENTIAL IMPACTS:

1. Leachate

Water Supplies within 500 m - none

Potential human hazard - there will be no impact on groundwater resources, there will be a slight impact on surface water resources which may be of some concern if there is public use immediately downstream of the site

Potential environmental hazard - slight downstream impact on stream, dilution is expected to reduce any elevated parameters to background within a short distance of the site

2. Methane

Nearby buildings - all buildings are separated from the site by surface water bodies

Potential human hazard - none unless building development takes place on site

Potential environmental hazard - methane could continue to damage vegetation on the site for many decades

8.0 POINT PELEE: SITE NO. P-105

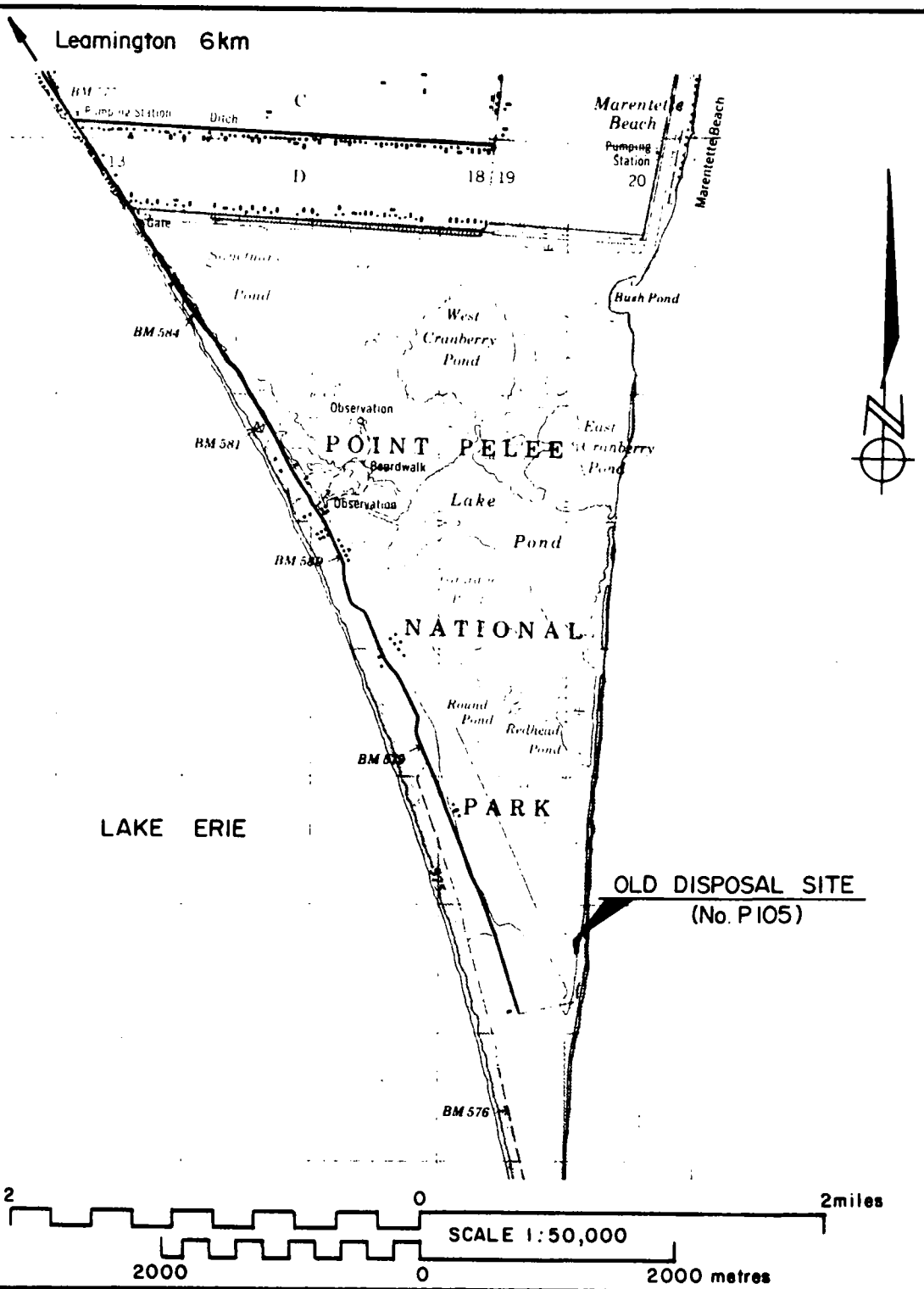
8.1 Introduction

The Point Pelee site is located within Point Pelee National Park in Essex County. The site served as a disposal site between 1960 and 1965. It was operated by Parks Canada personnel and was used by the Park staff and local farmers. The regional location is shown on the topographic map, Figure E-1 on the following page.

The operation consisted of the disposal of construction rubble, inert refuse, some incinerator ash and a small amount of domestic waste. The site was closed when local garbage pick-up service began.

The site is approximately 3000 m^2 in size and is situated on the eastern edge of the Point Pelee spit. The site was originally vacant marsh (parkland). Park staff report the waste was deposited into the marsh to a depth of about one metre. The site is surrounded by marsh to the west and north; beach ridges and Lake Erie to the east; and undeveloped parkland immediately to the south. A public washroom area is situated about 200 m south of the site. The site location is shown on the following air photo, Figure E-2.

Access to the site is from a closed road known as the "Old Fire Trail". It is almost invisible from view due to its small size, isolated location and dense vegetation cover.



ENVIRONMENT CANADA
Abandoned Waste Disposal Sites
Phase II

SITE: POINT PELEE

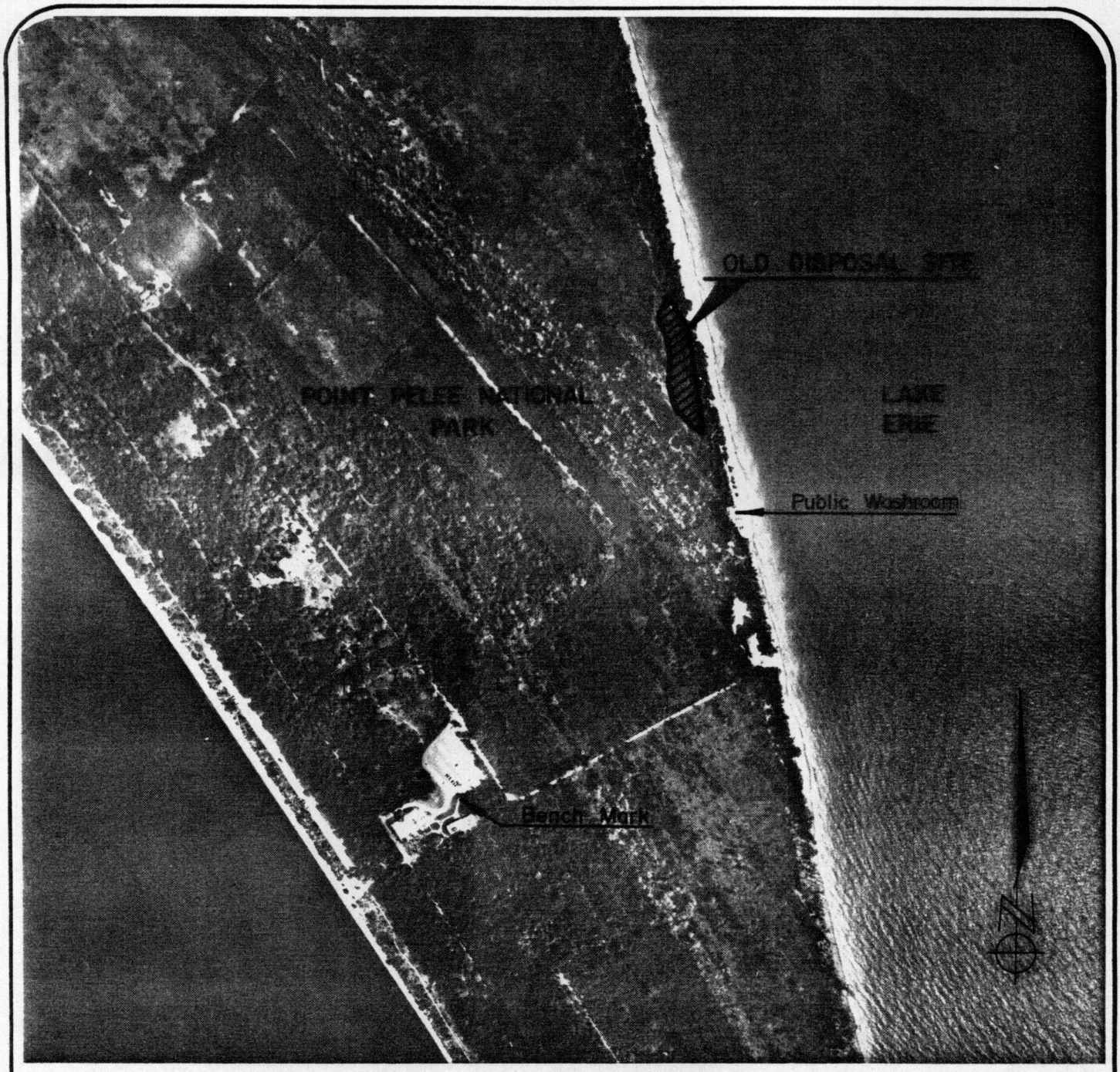
TOPOGRAPHIC LOCATION

MORRISON BEATTY LIMITED

PROCTOR & REDFERN LIMITED

MAR. 1984

E1



1/2 0 1/2 mile

SCALE 1:10,000

500 0 500 metres

ENVIRONMENT CANADA
Abandoned Waste Disposal Sites
Phase II

SITE: POINT PELEE

AIR PHOTO LOCATION

MAR. 1984

MORRISON BEATTY LIMITED

PROCTOR & REDFERN LIMITED

E2

8.2 Site-Specific Studies

The general field study methods carried out for this site are outlined in Section 3.0. The field program for Point Pelee involved the following:

- A site reconnaissance was carried out at the time of the test drilling program.

- Test drilling was performed to confirm overburden stratigraphy and obtain soil samples.

- Four observation wells and four gas probes were installed. These are located along the eastern side of the site since marsh abutts the site to the west. The well locations are shown on the following site plan, Figure E-3.

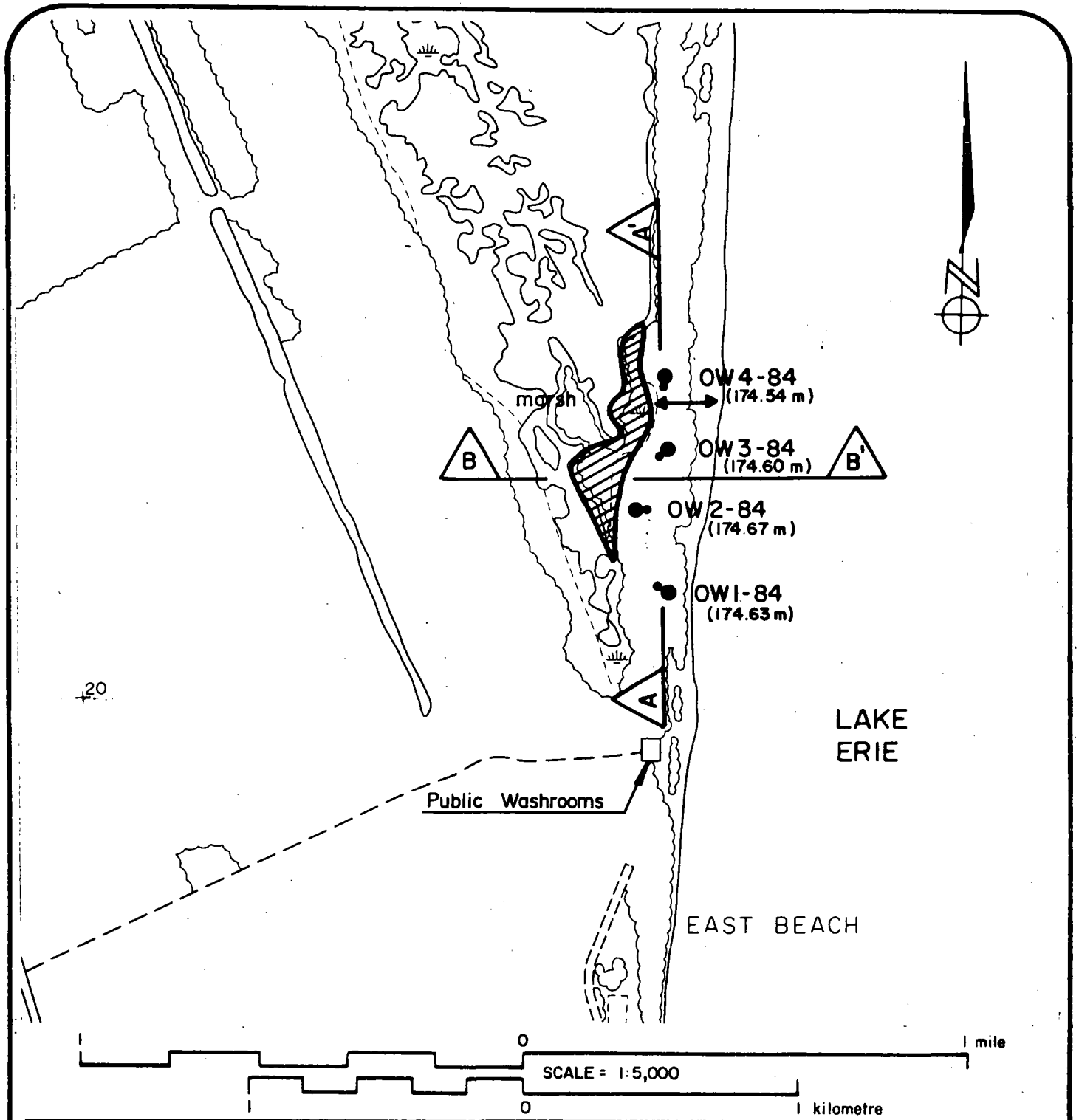
- Observation well and gas probe construction details are included in Section 1 of the Appendix.

- Elevations were obtained for all wells using a geodetic bench mark. The bench mark is located about 16 m from the northeast corner of the Park building at the south end of the main Park road. This is on the west side of the spit.

- Permeability tests were conducted on OW 1 and OW 4-84.

- Water levels were monitored in all wells. The Lake Erie ice level was also measured. The groundwater elevations are included in Table E-1 (Section 2 of the Appendix).

- The groundwater in all wells was tested for field conductivity. OW 1, OW 2 and OW 4-84 were sampled and analyzed in a private laboratory for pH, alkalinity, COD, TOC, iron and major ions. The results of these analyses are included in Table E-2 (Section 2 of the Appendix).



LEGEND

- Observation Well (1984)
- Landfill Area
- (174.63 m) Groundwater Elevation (metres A.S.L.)
- Direction of Groundwater Flow
- Gas Probe

ENVIRONMENT CANADA
Abandoned Waste Disposal Sites
Phase II
SITE : POINT PELEE

SITE PLAN

MORRISON BEATTY LIMITED

PROCTOR & REDFERN LIMITED

MAR. 1984

E3

8.3 Study Results

8.3.1 Hydrogeologic Setting

i) Geology

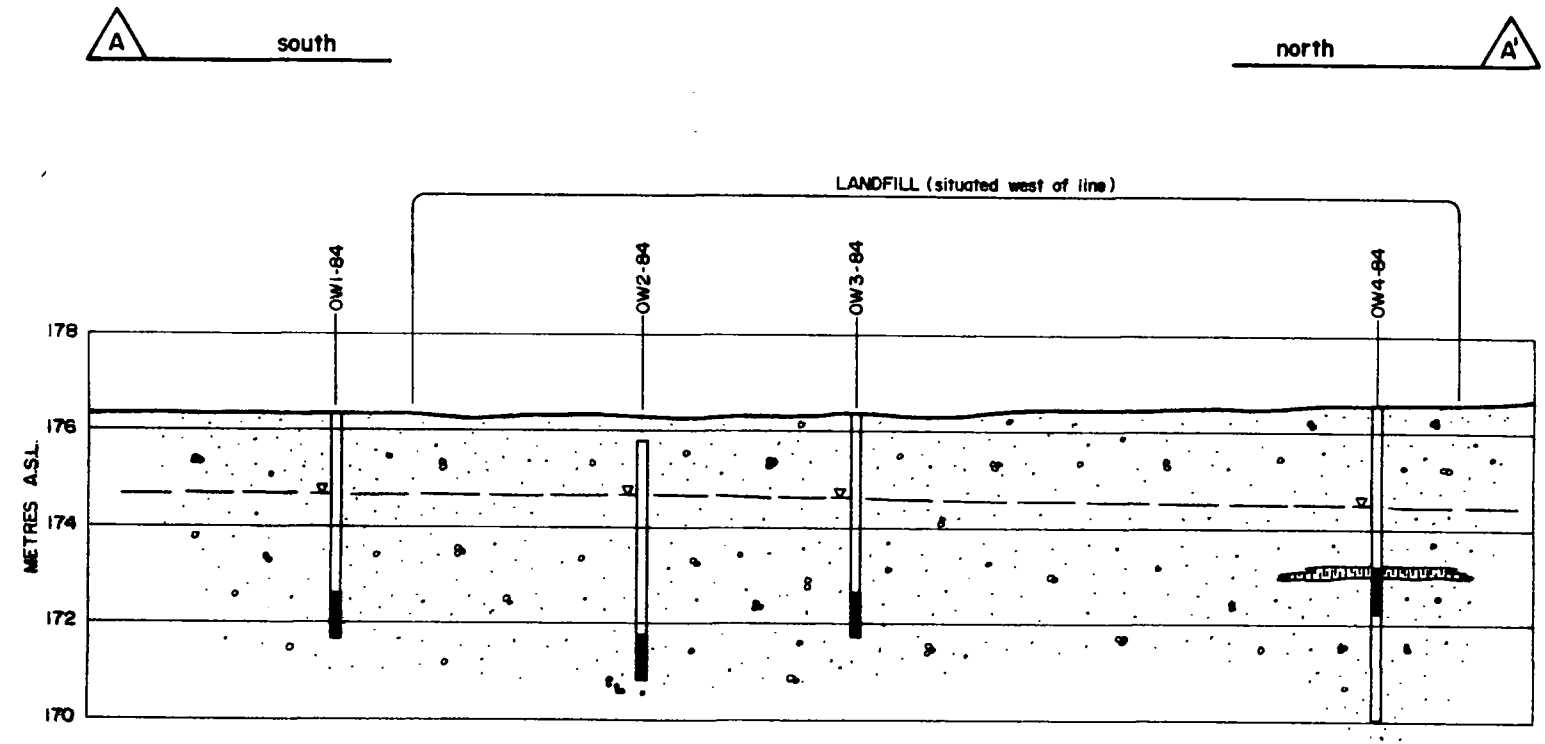
Point Pelee is the most westerly of the three Lake Erie spits. The configuration of the spit is constantly being modified by sand erosion and deposition. Point Pelee extends perpendicular from the north shore. Both sides of the spit have been built up over many centuries by wave action. In recent years, some parts of the east shore have eroded raising concerns that the landfill will become exposed.

Test drilling at the site confirmed sand and gravel overburden. A silt lense was encountered in OW 4-84 at about 3.5 m. Specific details of the overburden stratigraphy are listed in the borehole log sheets (Section 1 of the Appendix) and are shown on the cross-sections in Figures E-4 and E-5. Grain-size distribution curves for two representative samples are included in Figures E-6 and E-7. The material is very uniform in gradation and ranges from fine to coarse sand. The stratification is typical of beach deposits.

The organic analysis is listed below.

Well	Sample Depth, m	% Organics
OW 3-84	3	0.86
OW 4-84	5	0.82

Bedrock in the area is limestone of the Dundee Formation. Deep well logs in the area show the bedrock is about 30 m below surface.



LEGEND

Static Water Level
Water Table
Screened Interval

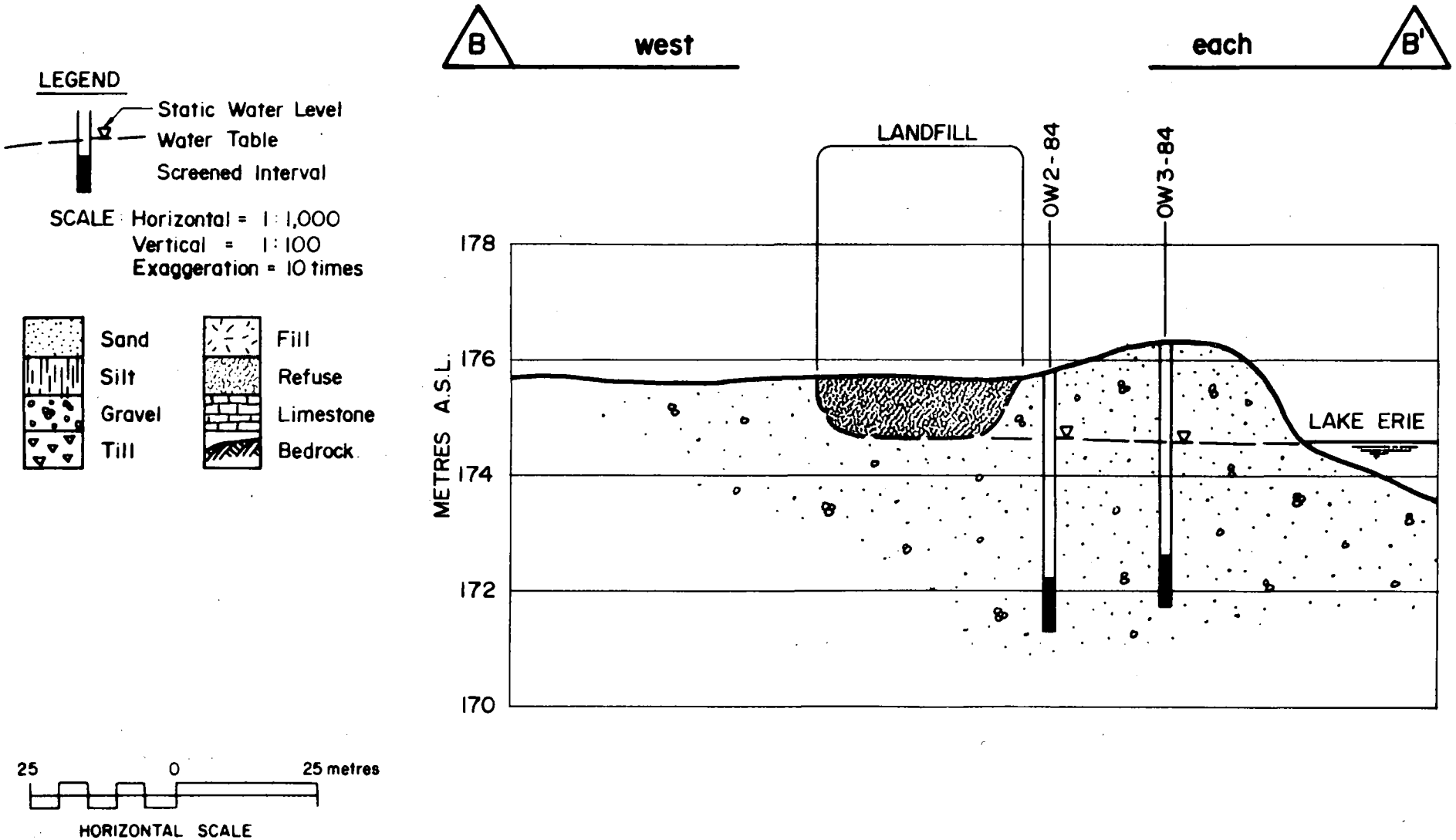
SCALE Horizontal = 1:1,000
Vertical = 1:100
Exaggeration = 10 times

Sand
Silt
Gravel
Till

Fill
Refuse
Limestone
Bedrock

25 0 25 metres
HORIZONTAL SCALE

SITE: **POINT PELEE**	**Cross-Section A-A'** (Refer to Figure E3)	**ENVIRONMENT CANADA** Abandoned Waste Disposal Sites Phase II	PROJECT NO. 390-841	MAR. 1984
			MORRISON BEATTY LIMITED	**E4**
			PROCTOR & REDFERN LIMITED	



CROSS-SECTION B-B'

(Refer to Figure E3)

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Abandoned Waste Disposal Sites
Phase II
SITE: POINT PELEE

PROJECT NO. 390-841

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E5

GS - 860781

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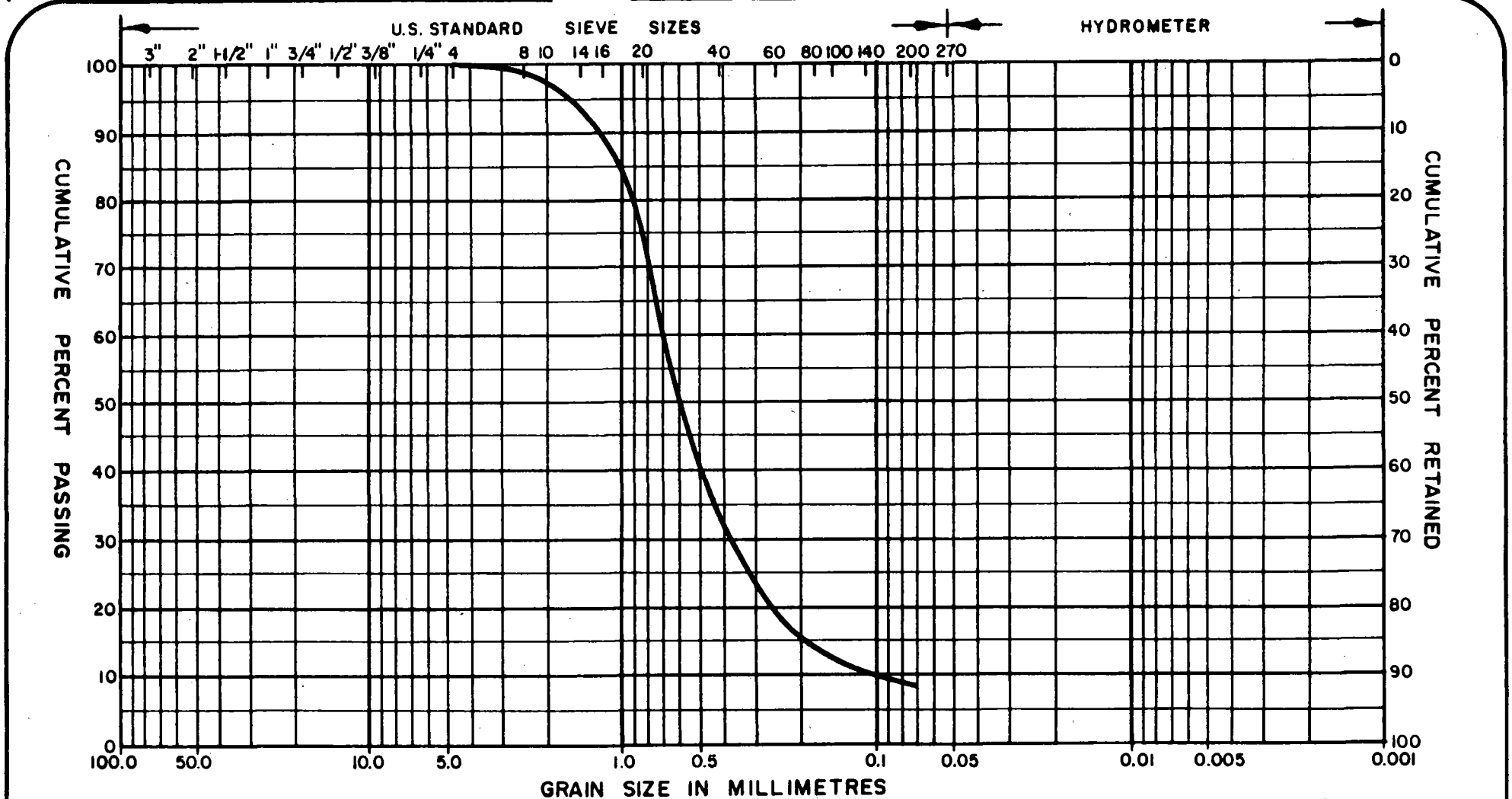
GRAIN SIZE DISTRIBUTION CURVE

ENVIRONMENT CANADA - POINT PELEE

E6

OW3-84 SS2 3.0 - 3.5 m Project No. 390-841



UNIFIED	GRAVEL		COARSE	MEDIUM	FINE		SILT & CLAY			
			SAND							
M.I.T.	STONES	GRAVEL	COARSE	MEDIUM	FINE		COARSE	MEDIUM	FINE	CLAY
			SAND				SILT			
U.S. BUREAU	GRAVEL		COARSE	MEDIUM	FINE	V. FINE	SILT			CLAY
			SAND							

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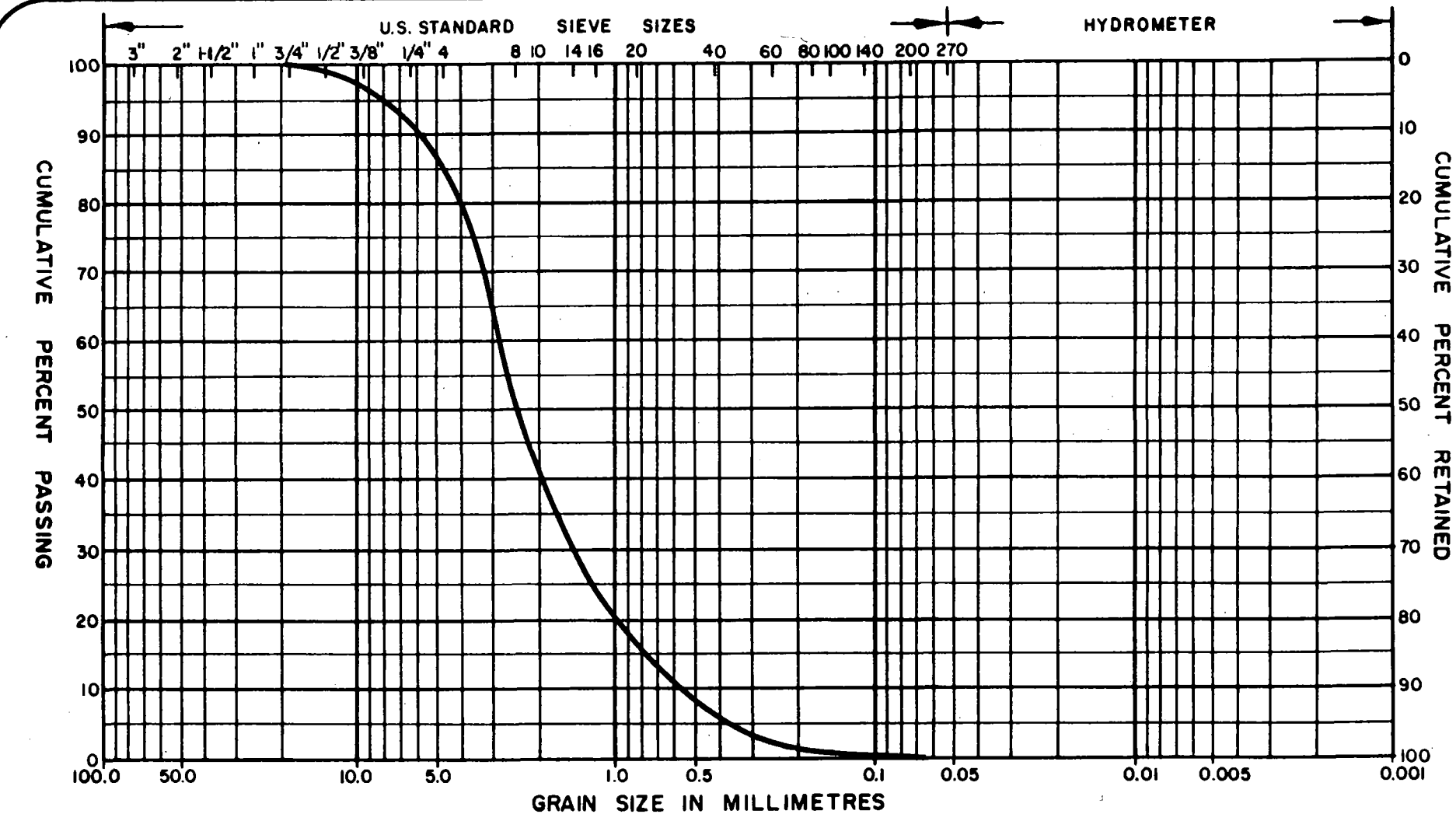
GRAIN SIZE DISTRIBUTION CURVE

ENVIRONMENT CANADA - POINT PELEE

E7

OW4-84 SS3 4.5 - 5.0 m Project No. 390-841



UNIFIED	GRAVEL		COARSE	MEDIUM	FINE		SILT & CLAY			
			SAND							
M.I.T.	STONES	GRAVEL	COARSE	MEDIUM	FINE		COARSE	MEDIUM	FINE	CLAY
			SAND				SILT			
U.S. BUREAU	GRAVEL		COARSE	MEDIUM	FINE	V. FINE	SILT			CLAY
			SAND							

ii) Topography and Drainage

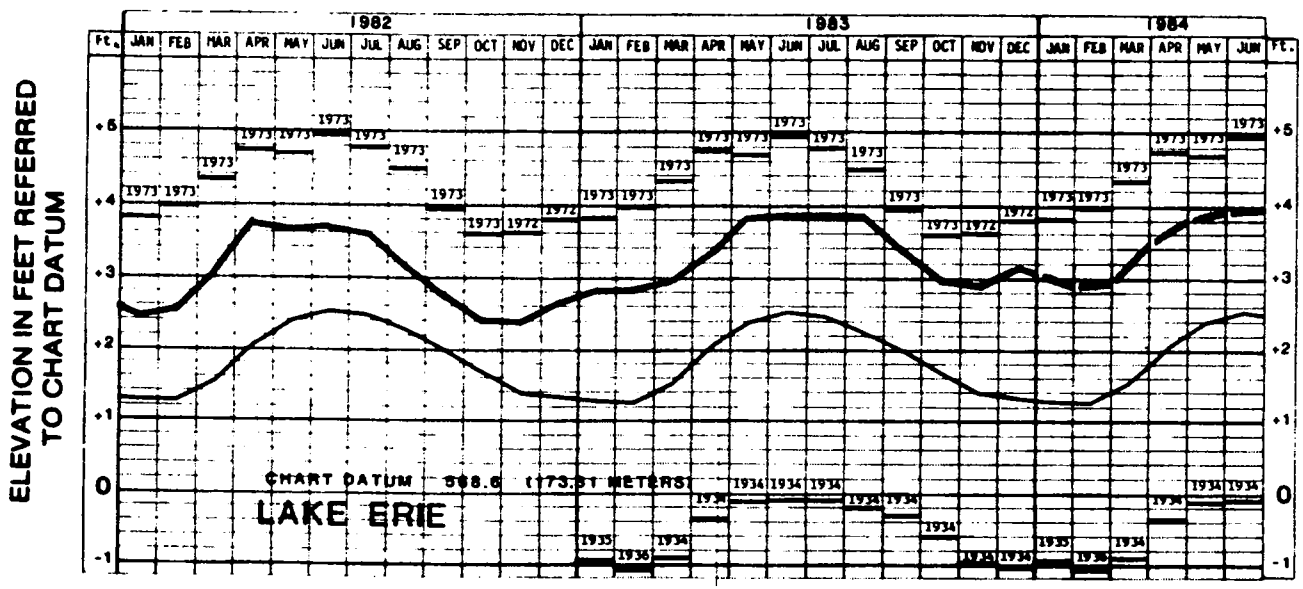
The site is situated in a low-lying area with a marsh to the west and north and a series of beach ridges to the east and south. Drainage is mainly westward to the marsh since there is a beach ridge between the site and Lake Erie. Some overland drainage may reach Lake Erie.

iii) Groundwater

Groundwater uses are limited in the area since the site is within a national park. There is one well within 200 m which is used as a water source for public washrooms. The closest private wells are located north of the park, about 5.5 km from the landfill site.

The water table at the edge of the site ranges from ground surface in the marsh west of the site to 1.65 m below surface to the east. The water table will be deeper than 1.65 m in the beach ridges between the site and the lake. The groundwater gradient is flat as shown on Figures E-4 and E-5. The water elevations are found in Table E-1, in Section 1 of the Appendix. Groundwater movement is expected to be very slow due to the flat gradients.

Groundwater flow patterns in the vicinity of the site will be strongly influenced by annual fluctuations in the level of Lake Erie. The following graph, Figure E-8, shows the Lake Erie hydrography for the past two years. It shows that the water level in Lake Erie fluctuates about 0.3 m annually, with the peak in June and the low in November through to February.



LEGEND

LAKE LEVELS

RECORDED

PROBABLE

1900-1982 AVERAGE

MAXIMUM 1974 1974 1973 73

MINIMUM 1936 1934 1926 1934

Hydrographs are in feet above (+) or below (-) Chart Datum, the plane on each lake to which navigation chart depths and Federal navigation improvement depths are referred.

Reproduced from: "Monthly Bulletin of Lake Levels for the Great Lakes", Dec. 1983
Department of the Army, U.S. Army Corps of Engineers.

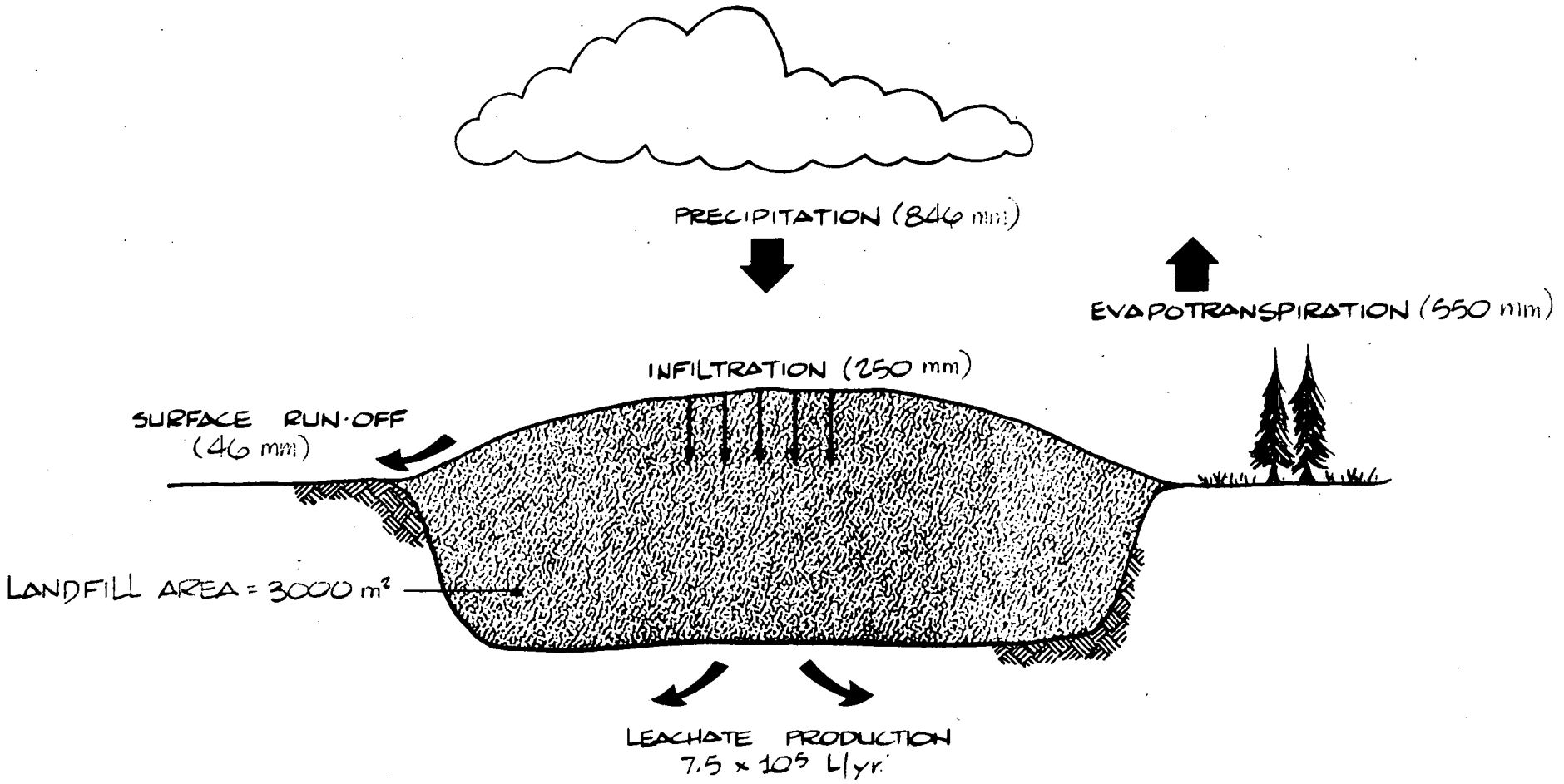
LAKE ERIE HYDROGRAPH	**ENVIRONMENT CANADA** **Abandoned Waste Disposal Sites** **Phase II** SITE: POINT PELEE	PROJECT NO. 390-841	MAR. 1983
		MORRISON BEATTY LIMITED **PROCTOR & REDFERN LIMITED**	**E8**

The water table will respond to the fluctuating lake levels. When lake levels begin on the downward cycle (July to November), water levels in the sand overburden will start to decline. A lag in the decline will create a flow gradient toward the lake. Alternatively, when lake levels rise, flow gradients will be reversed. Groundwater will then move from the shore toward the landfill. As a result of this seasonal reversal, the net leachate migration away from the site is expected to be limited to a few metres from the landfill.

8.3.2 Water Budget

The site receives an average of 846 mm precipitation annually, based on thirty year normals (1941-1970) for the Point Pelee Meteorological Station. Evapotranspiration accounts for approximately 65% of the total annual loss of precipitation in the Lake Erie Basin (The Climate of the Great Lakes Basin, 1972). Although this is for the average for inland areas, it is the best average estimate available to us. Evapotranspiration amounts to about 550 mm.

The cover material at the site is local sand and gravel fill. An infiltration rate of about 250 mm/yr can be expected in these permeable soils. Therefore, only 46 mm can be expected to be lost annually through surface runoff. The annual average water budget and leachate production rate for the Point Pelee site are shown on the following diagram, Figure E-9.



INFILTRATION = TOTAL PRECIPITATION - EVAPOTRANSPIRATION - RUNOFF
(250 mm) (846 mm) (550 mm) (46 mm)

SITE: POINT PELEE	ENVIRONMENT CANADA Abandoned Waste Disposal Sites Phase II	PROJECT NO. 390-841	MAR. 1984
		MORRISON BEATTY LIMITED PROCTOR & REDFERN LIMITED	E9

Leachate is produced by precipitation which infiltrates into the refuse. A leachate production rate can be calculated from the infiltration rate and surface area. The Point Pelee landfill is about 3000 m^2 in area. The average annual leachate production would be in the order of 7.5 x 10^5 L/year or about 0.024 L/s.

8.3.3 Groundwater Quality and Leachate Impacts

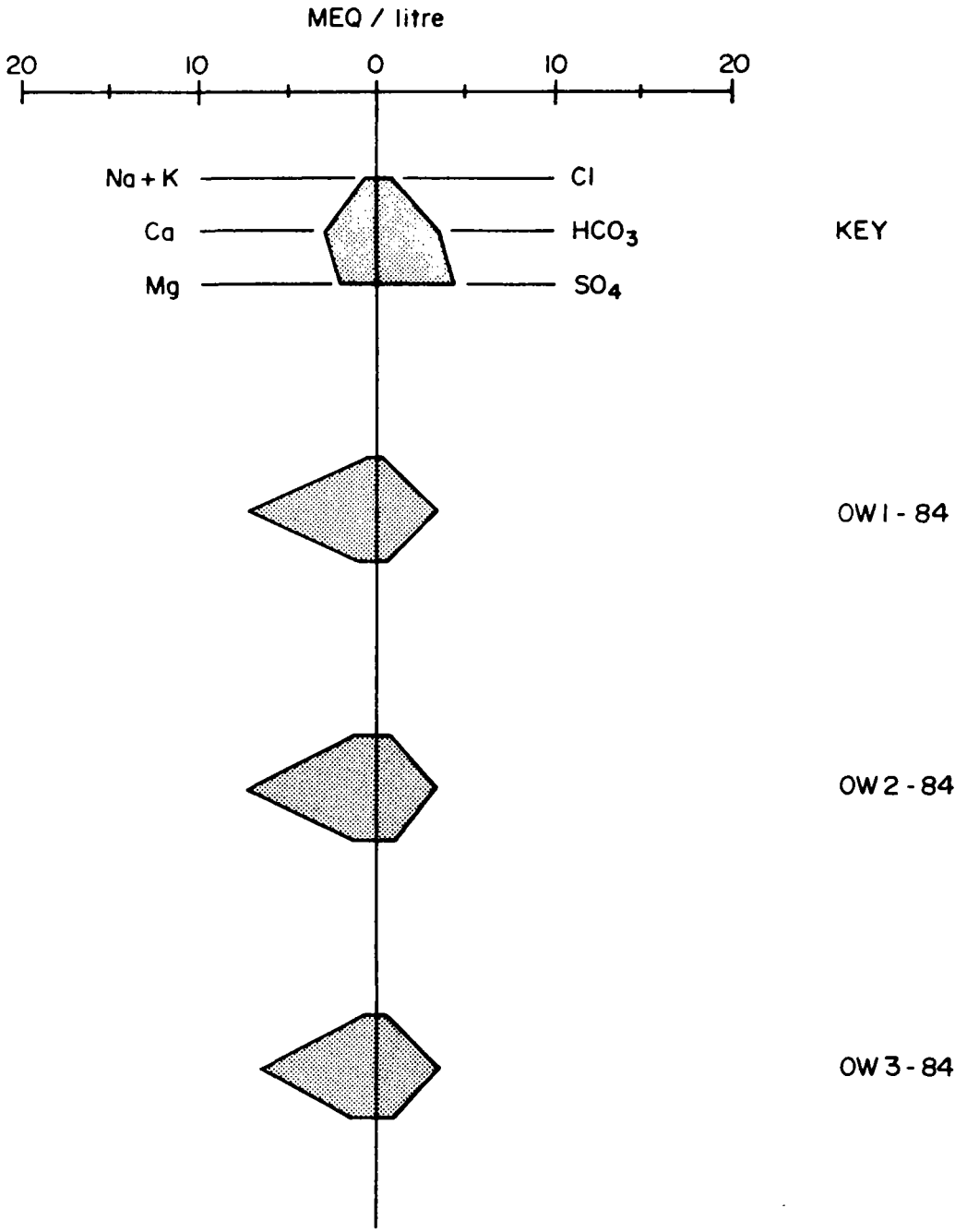
The leachate production rates calculated in the previous section give an indication of the quantity of leachate produced by the site; however, in order to determine the site's impact leachate quality must be identified. All four wells were tested for conductivity using a field meter. Water samples were collected from three of the observation wells on January 31, 1984. The results are listed in Table E-2 in Section 2 of the Appendix.

i) pH and Conductivity

All wells show normal levels of pH and conductivity. The pH of the groundwater is about 7.4 to 7.5. Conductivity ranges from 250 to 350 umhos/cm^2. The landfill has no impact on these parameters.

ii) Major Ions

The ionic balance is listed in Table E-3 in Section 2 of the Appendix. Stiff diagrams showing major anion and cation distribution are on Figure E-10 on the following page.



Major Anion and Cation Distribution

SITE: POINT PELEE | **E10**

The diagrams show almost identical distribution of the major ions in all wells. The chloride ion is relatively mobile in groundwater and is a good indicator of leachate migration; however, all levels at this site are well below the Ontario drinking water objectives of 250 mg/L. All other ion concentrations are also at background levels. There are no leachate impacts based on the major ion chemistry.

iii) Organics

COD and TOC were the two organic parameters measured. COD is the measure of oxygen required to oxidize organic and inorganic compounds. All three wells, OW 1, OW 2 and OW 3-84 had levels of 28 and 29 mg/L. These are well within the levels normally found in shallow groundwaters. The COD data does not indicate any impact from the disposal site.

TOC (total organic carbon) is one of the best indicators of the organic content of leachate from landfills. It ranges up to 30 mg/L in shallow groundwaters. None of the wells sampled showed TOC levels above typical background values.

iv) Iron

Iron is often present in leachate and migrates readily through sandy soils. Iron was not detected in any of the sampled wells. All measurements were less than 0.01 mg/L which is the detection limit.

v) Summary of Leachate Characteristics and Impacts

None of the wells were located within the landfill material, so actual leachate strengths could not be determined. The relatively thin deposit of waste and permeable cover favours rapid leaching of soluble constituents from the waste. This reduces the time required to stabilize the waste. Also, the type of waste (inert building materials and ash) would result in reduced strengths of organic and nutrient constituents in leachate than would be expected at conventional landfill sites.

The observed and measured impacts of this site on groundwater and surface water in the area is insignificant.

8.3.4 Methane Impacts

Gas probes were installed in all four boreholes for future methane monitoring. Soil conditions should be allowed to stabilize around the probes prior to taking readings; however, in this case readings were taken during the field program. The readings are listed below:

Probe	Methane Concentration (per cent by volume)
GP 1-84	0
GP 2-84	0
GP 3-84	0
GP 4-84	1%

The explosive range for methane gas is between 5 and 15% by volume. The methane concentration in GP 4-84 is below the explosive limit. The low level of methane in GP 4-84 could be due to the landfill but it is more likely to be due to decomposition of roots in the soil zone. Low levels of methane commonly occur in shallow soils.

Methane will migrate easily in the granular overburden at this site. However, the site is isolated from buildings. It is over 200 m from the public washrooms which are only used in the summer months. In the summer, methane will vent through the granular cover and not migrate laterally. Migration away from the site will only occur during frozen surface conditions.

Methane is not considered a public hazard at this site. The impact on vegetation on the site has been negligible judging from the dense vegetative cover.

8.3.5 Potential Hydrogeologic Impacts

The potential for future impacts from this site is limited. There is very little potential for leachate migration via groundwater. Despite the permeable overburden, groundwater movement is very slow due to the flat water table gradients and the reversal of groundwater flow due to the changing lake levels.

Leachate production is small and the present leachate strength is probably weak due to the type of waste and rapid leaching expected in the early years. Leachate strength will continue to decay with time.

Methane production at the site should be small since the amount of organic matter is limited. As long as building construction does not occur on the site, methane should not present a hazard.

There is a potential for erosion of the eastern shoreline to expose the landfill material in time. The inert waste will have only an aesthetic impact on the lake. The quantity of other waste material (ash, domestic and agricultural wastes) should not produce a measurable impact on the lake due to the very large dilution factor. However, for aesthetic reasons remedial action may be warranted.

8.4 Future Land Use Plans

The Point Pelee disposal site is expected to remain as open space. The surrounding areas will remain in their natural state.

This area of the spit is designated as Special Designation due to its natural heritage values by Parks Canada. The Parks planning indicates that the public washrooms (located south of the landfill) and the access road to them will be phased out in the next 10-15 years. This means that public use of the area will decrease in time.

8.5 Conclusions

In its present state the site poses no threat to public health and safety or the environment. This site is small in volume and will have a low leachate production rate. No evidence of leachate was identified in this study. A major portion of the waste deposited here is reported to be inert material.

The groundwater flow paths are determined by the fluctuating lake levels. There is probably very little net migration away from the site. Shore erosion could eventually expose the wastes.

8.6 Recommendations

The following recommendations are a result of the Phase II preliminary field study.

1. No further hydrogeologic impact study is required; however, the rate of shore erosion in the vicinity of the site should continue to be assessed by Parks Canada to determine the possible rate of waste exposure.

2. If exposure of the waste is inevitable, further testing as to the nature of the waste should be carried out and remedial measures should be developed.

Respectfully submitted,
MORRISON BEATTY LIMITED

Brian W. Beatty, P.Eng.

Study Management and
Report Preparation ..... B.W. Beatty, P.Eng.
N.J. Rennie, B.E.S.

Field Investigations ..... D.R. Duncan, Senior Technologist
C.A. Hawke, Geological Technologist
J.W. Wilson, Geological Technologist

APPENDIX

POINT PELEE : SITE NO. P-105

SECTION 1 : OBSERVATION WELL LOGS

SECTION 2 : TABLES

SECTION 3 : SITE SUMMARY REPORT

SECTION 1 : OBSERVATION WELL LOGS

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OW1/84
GP1/84

CLIENT ENVIRONMENT CANADA FILE NO. 390-841

PROJECT ENVIRONMENTAL IMPACT LOCATION POINT PELEE

GEOLOGIST/ENGINEER T.H. DATE COMPLETED JANUARY 30,1984

DESCRIPTION	DEPTH metres	DEPTH feet	SAMPLE no.	SAMPLE type	SAMPLE "N"	WELL DETAIL	REMARKS BLOWS PER FOOT 10 20 30 40 50 60 70 80 90
SAND: medium to course with some gravel and silt, brown	1	5	1	GS		A, C, E	
-saturated at 6 feet	2					B	
	3	10	2	GS		D	
	4					E	
		15	3	GS			
E.O.H. 15 feet	5						
	6	20					
	7						
		25					
	8						
	9	30					

GS- GRAB SAMPLE SS - SPLIT SPOON ST - SHELBY TUBE "N" BLOWS PER FOOT WATER LEVEL ▽

WL-040281

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OW2/84
GP2/84

CLIENT ENVIRONMENT CANADA FILE NO. 390-841

PROJECT ENVIRONMENTAL IMPACT LOCATION POINT PELEE

GEOLOGIST/ENGINEER T.H. DATE COMPLETED JANUARY 30,1984

DESCRIPTION	DEPTH metres	DEPTH feet	SAMPLE no.	SAMPLE type	SAMPLE "N"	WELL DETAIL	REMARKS BLOWS PER FOOT 10 20 30 40 50 60 70 80 90
						C	
SAND & GRAVEL: with some silt (beach deposit) brown, fine and medium sand lenses, saturated, loose	1	5	1	SS	3	A, E, D, A	
	2					B	
	3	10	2	SS	60	D	
	4	15				E	
	5						
E.O.H. 16 feet	6	20					
	7	25					
	8						
	9	30					

GS - GRAB SAMPLE SS - SPLIT SPOON ST - SHELBY TUBE "N" BLOWS PER FOOT WATER LEVEL ▽

WL-040281

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OW3/84
GP3/84

CLIENT ENVIRONMENT CANADA FILE NO. 390-841

PROJECT ENVIRONMENTAL IMPACT LOCATION POINT PELEE

GEOLOGIST/ENGINEER T.H. DATE COMPLETED JANUARY 30,1984

DESCRIPTION	DEPTH metres	DEPTH feet	SAMPLE no.	SAMPLE type	SAMPLE "N"	WELL DETAIL	REMARKS BLOWS PER FOOT 10 20 30 40 50 60 70 80 90
						C	
SAND: medium to coarse with some gravel and silt, brown, moist	1					A	
						D	
						E	
		5	1	GS		A	
Grey at approx. 6 feet	2						
						B	
	3	10	2	SS	10	D	
	4						
						E	
		15	3	GS			
E.O.H. 15 feet	5						
	6	20					
	7						
		25					
	8						
	9	30					

GS - GRAB SAMPLE SS - SPLIT SPOON ST - SHELBY TUBE "N" BLOWS PER FOOT WATER LEVEL ▽

WL-040381

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OW4/84
GP4/84

CLIENT ENVIRONMENT CANADA FILE NO. 390-841
PROJECT ENVIRONMENTAL IMPACT LOCATION POINT PELEE
GEOLOGIST/ENGINEER T.H. DATE COMPLETED JANUARY 30,1984

DESCRIPTION	DEPTH metres	DEPTH feet	SAMPLE no.	SAMPLE type	SAMPLE "N"	WELL DETAIL	REMARKS BLOWS PER FOOT
SAND: coarse grained with some gravel, brown, moist, dense, some fine sand lenses	1	5	1	SS	32	C, A, E, D, A	
	2						
	3	10	2	SS	11	B, E	
PEAT: black, light, some odour	4						
SAND & GRAVEL: coarse sand with varying sizes of gravel	5	15	3	SS	31	D	
	6	20	4	SS	45		
E.O.H. 21.5 feet	7						
	8	25					
	9	30					

GS- GRAB SAMPLE SS - SPLIT SPOON ST - SHELBY TUBE "N" BLOWS PER FOOT WATER LEVEL ▽

WL-040881

LEGEND

Well Detail Remarks

A PELTONITE SEAL

B 1.5" DIA. PVC PIPE

C .38" DIA. CPVC PIPE

D NATIVE SOIL BACKFILL

E SLOTTED PORTION OF PIPE

F

G

H

I

J

K

L

Stratigraphy

- TOPSOIL
- PEAT OR MUCK
- CLAY
- TILL
- SILT
- LIMESTONE
- SAND
- DOLOSTONE
- GRAVEL
- SHALE
- COBBLES, BOULDERS
- BEDROCK
- FILL
- REFUSE

SECTION 2 : TABLES

Table E1 - Water Level
Table E2 - Chemical Water Analysis
Table E3 - Ionic Balance

PT-080383

PROJECT ENVIRONMENT CANADA **TABLE** E - 1 **SHEET** Site No. P-105, Point Pelee

OBSERVATION WELL	WELL DETAILS						GROUNDWATER ELEVATIONS (metres A.S.L. /local datum)						
	Nest No.	ø cm	Type	ELEVATIONS			Jan 31, 1984						
				Ground	Top of pipe	Top of screen							
OW 1		4	PVC	176.30	177.20		174.63						
OW 2		4	PVC	175.74	176.53		174.67						
OW 3		4	PVC	176.32	177.52		175.60						
OW 4		4	PVC	176.55	177.55		174.54						

Piezometer **Standpipe**

Note: Lake Erie (ice level) 174.59 m

TABLE E - 2
CHEMICAL WATER ANALYSIS

Client: Environment Canada
Project Description: Waste Disposal Sites: Pt. Pelee
Project No.: 390-841

Date Sampled: January 31, 1984
Date Analyzed: February 28, 1984
Analyzed by: Technical Services Laboratory

Parameter	OW 1-84	OW 2-84	OW 3-84	OW 4-84			
pH	7.4	7.5	N.S	7.5			
*Conductivity (umhos/cm^2)	305/270	300/250	320	370/350			
Alkalinity	255	265	N.S	256			
COD	28	29	N.S	28			
TOC	10.0	13.0	N.S	13.0			
Fe	<.01	< .01	N.S	< .01			

Concentrations in mg/ℓ excepted as noted

N.S - no sample

TABLE E - 2
CHEMICAL WATER ANALYSIS

Client: Environment Canada
Project Description: Waste Disposal Sites: Pt. Pelee
Project No.: 390-841

Date Sampled: January 31, 1984
Date Analyzed: February 28, 1984
Analyzed by: Technical Services Laboratory

Parameter	OW 1-84	OW 2-84	OW 3-84	OW 4-84			
Major Ions							
Cations							
Calcium	142	151	N.S	135			
Potassium	6.4	11.0	N.S	8.3			
Magnesium	11	13	N.S	16			
Sodium	5.6	21	N.S	9.7			
Anions							
Chloride	12	29	N.S	24			
Sulphate	30	54	N.S	41			
Bicarbonate	209	217	N.S	210			

Concentrations in mg/ℓ excepted as noted N.S - no sample

morrison beatty limited
consulting engineers and hydrogeologists

IONIC BALANCE

E-3

Area of Survey Site No. P-105, POINT PELEE

Sample : Groundwater

Date January 31, 1984

CATIONS

ANIONS

Ion	Ca			Mg			Na			K			Na+K	Total Cations	Alkalinity HCO_3 ppm x .0164 CO_3 ppm x .0333			SO_4			Cl			Total Anions	Diff. %
Conversion Factor	ppm x .0499			ppm x .0822			ppm x .0435			ppm x .0256					ppm x .0208			ppm x .0282							
Well No.	ppm	epm	%	ppm	epm	%	ppm	epm	%	ppm	epm	%		epm	ppm	epm	%	ppm	epm	%	ppm	epm	%	epm	
OW 1-84	142	7.09		11	0.90		5.6	0.24		6.4	0.16		0.4	8.39	255	3.43		30	0.62		12	0.34		4.39	48%
OW 2-84	151	7.53		13	1.07		21	0.91		11.0	0.28		1.19	9.79	265	3.46		54	1.12		29	0.82		5.4	44%
OW 4-84	135	6.74		16	1.32		9.7	0.42		8.3	0.21		0.63	8.69	256	3.44		41	0.85		24	0.68		4.97	43%

SECTION 3 : SITE SUMMARY REPORT

SITE REPORT SUMMARY

BACKGROUND:

1. General

Name: Point Pelee National Park

Site Area: approx. 3000 m^2

Site Owner: Parks Canada

Date of Operation: 1960 to 1965

Site Location: 375125 4644000

Name of Operator: Parks Canada

2. Land Uses

Original - vacant parkland (marsh)

Present - vacant parkland

Future Potential Land Use - Special Designation due to its natural heritage values (parkland)

3. Present Development

On-Site - none

Abutting (distance) - public washroom to south (approx. 150 m)
- marsh to west and north
- sand dunes and Lake Erie to east

FIELD INVESTIGATION RESULTS:

1. Type of Investigation Performed - site reconnaissance, test drilling, split-spoon sampling, observation well and gas probe installation, water level monitoring, permeability tests, groundwater sampling, methane gas monitoring, soil analyses

2. Site Chacteristics

Site Access - access is by the "Old Fire Trail" south of the site and north of the road to the public washroom area

Site Visibility - almost invisable due to size, location and vegetation overgrowth

Site Security - park

Vegetation on Site - shrubs, grasses and weeds

3. Waste Disposal Practices

Quantity of Refuse - approximately 3000 m^3

Thickness of Waste - approximately 1 m (maximum)

Type of Waste (confirmation) - domestic, cottage waste and building material from demolished cottages, incinerated waste

Cover Material and Thickness - sand cover material was used

4. Hydrogeologic Setting

Overburden type and thickness - sand and gravel with some silt content

Bedrock type - Dundee Formation limestone

Local topography - marsh to west; remnant beach ridges to the east

Drainage Patterns (regional and local) - both west to the marsh and easterly to Lake Erie

Surface water bodies - marsh west of site within the Point
- Lake Erie is located about 35 to 40 m east of site

Depth to Water Table - at surface west of site to 1.65 m below surface adjacent the site to the east (will exceed 1.65 m in beach ridges to east)

Direction of Groundwater Flow - direction of groundwater flow will fluctuate with lake levels
- movement will be very slow due to flat gradients

5. Identified Impacts

Leachate characteristics - there was no evidence of leachate constituents in the observation wells placed around the landfill site

Evidence of Leachate seepage - none

Evidence of leachate migration and attenuation - none

Evidence of gas generation and migration - a trace amount of methane (1%) was noted in one gas probe (GP 4); quantities of methane produced will be very small due to small quantities and type of waste (burned)

Vegetation stress - none

Settlement and erosion - no settlement noted
- erosion may eventually be a problem as the eastern shoreline erodes westward

Other potential sources of contamination - seepage beds from comfort station located south of the site

POTENTIAL IMPACTS:

1. Leachate

Water Supplies within 500 m - one well used (within 150 m) for public washroom water
- well depth is about 7.5 m deep within shallow sand aquifer

Potential human hazard - none

Potential environmental hazard - none due to leachate; however, debris may become exposed by erosion of the east shoreline

2. Methane

Nearby buildings - closest building is a public washroom located approximately 150 m to the south

Potential human hazard - slight due to isolation and nature of wastes

Potential environmental hazard - may have a slight impact on vegetation immediately on or adjacent the site; no off-site impact anticipated.