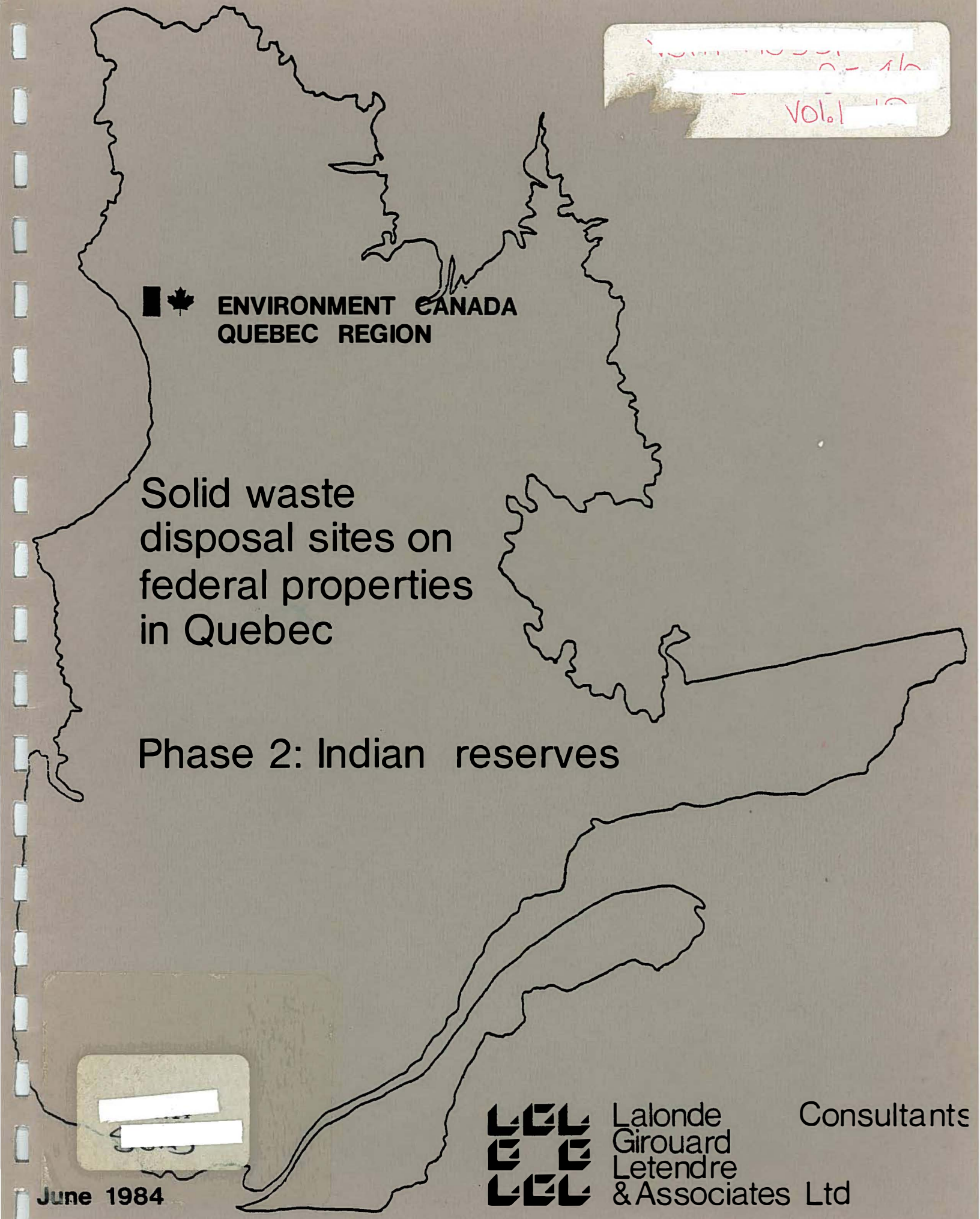

ENVIRONMENT CANADA
QUEBEC REGION

Solid waste disposal sites on federal properties in Quebec

Phase 2: Indian reserves

Lalonde Girouard Letendre & Associates Ltd Consultants

June 1984

ENVIRONMENT CANADA

QUEBEC REGION

SOLID WASTE DISPOSAL SITES ON FEDERAL PROPERTIES IN QUEBEC

PHASE 2: INDIAN RESERVES

FILE NO. 14-SD KE303-3-001

JUNE 1984

PREPARED BY:

LALONDE, GIROUARD, LETENDRE & ASSOCIATES LIMITED

LALONDE, GIROUARD, LETENDRE & ASSOCIATES LTD.
Consultants

June 8, 1984.

Environment Canada
1550 de Maisonneuve Blvd. West
Room 410
Montreal, Quebec
H3G 1N2

Attention: Mr. Gérald Girouard, P. Eng.
Scientific delegate

Subject: Solid waste study on federal properties in Quebec.
Phase 2 on Indian Reserves.
Your ref.: 10SD.KE303-2-0017
Our ref. : 829-MBA

Dear Sir:

We are pleased to submit twenty five (25) copies in english and fifty (50) copies in french of our report on the Phase 2 control program for the Indian Reserves of Quebec.

The conclusions of the study show that many problems are present on the sites surveyed. We believe it is important to undertake Phase 3 of the federal control program for the Kahnawake Reserve sites. As for the Mistassini Reserve, the management methods need to be optimized but the sites do not present any major environmental problems.

We would like to thank the Environmental Protection Service of Environment Canada for their collaboration throughout the study. Our thanks go also to the people of the Department of Indian and Northern Affairs and the Band Councils representatives for the information provided and their assistance during field work.

Yours truly,

LALONDE, GIROUARD, LETENDRE & ASSOCIATES LTD.

Luc-G. Girouard, P. Eng. M.Eng.
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1.0 Introduction

1.0 INTRODUCTION

The existence of industrial and consumer societies entails the production of various types of waste whose elimination is bringing about an increasing number of problems regarding security and environment. Many environmental impacts can result from inadequate waste management, affecting soils, ground water and the ambient air. Consequently, these nuisances cause a decline in the quality of life and at times, occasion an often irreversible deterioration of more fragile habitats. There are also health hazards and security problems on the disposal sites which are generated, among others, by gas production and fires. When no appropriate corrective or compensative measures are applied, problems are likely to increase.

In such a perspective, the Environmental Protection Service of Environment Canada has decided to establish an identification, inspection and correction program for environmental nuisances associated with disposal sites on federal properties throughout Canada. The purpose of this program is to supplement waste management water plans developed by the provinces. It consists of three (3) major phases:

Phase 1: Identification and verification of closed, abandoned or active solid waste disposal sites; classification of sites according to intervention priority.

Phase 2: Preliminary assessment of existing or potential environmental impacts of each sites.

Phase 3: Detailed inspection of sites and development of corrective measures in order to reduce or eliminate existing or potential problems.

Phase 1 of this program was carried out in Quebec in 1982. It resulted in the identification and classification of sites according to criteria by which present and impending risks for public hygiene, public security and environment could be determined.

The present study is concerned with carrying out Phase 2 of the program, which consists of a preliminary assessment of existing, or potential environmental impacts of each site, and it deals with identified sites located on the Indian reserves of Quebec.

First are laid out the objectives and the realization phases of the project. Then will follow a description and an assessment of each site. Finally, conclusions and recommendations complete this report.

2.0 Objectives and scope of study

2.0 OBJECTIVES AND SCOPE OF STUDY

This study aims at making an in-depth inspection of each identified site in order to determine the observable or potential impact on the surrounding area. Its objectives are the following:

- To verify the geographical limits of each waste disposal site if it has not been carried out during Phase 1;

- To inspect waste disposal sites and their adjacent lands in order to detect any trace of percolation or gas migration;

- To analyze, according to selected parameters, surface waters and adjacent land wells (within a 300 m radius of site) in order to detect traces of contamination due to the disposal site;

- To determine the geological characteristics of site, cover layer and adjacent lands;

- To determine the hydrogeological characteristics of site and adjacent lands;

- To determine the nature and quantities of waste being deposited at each site;

- To assess leachate and gas concentrations which could be produced at each site by disposed waste;

- To identify sites in need of further detailed analyses in order to confirm the reality of possible problems.

For each site, the program must be adapted according to data collected during the first phase of site identification and classification. Furthermore, the mandate limits the inspection program on each site to six (6) drillings and six (6) water sampling stations.

The study is concerned with sites located on the Department of Indian and Northern Affairs (D.I.N.A.) in Quebec, which, during Phase 1, had been identified as presenting a high risk potential for hygiene and environment, and which needed an immediate assessment. These sites are:

02-01-01	Mistassini Reserve
02-01-02	Mistassini Reserve
06-01-02	Kahnawake Reserve
06-01-03	Kahnawake Reserve
06-01-05	Kahnawake Reserve
07-01-03	Manouane Reserve

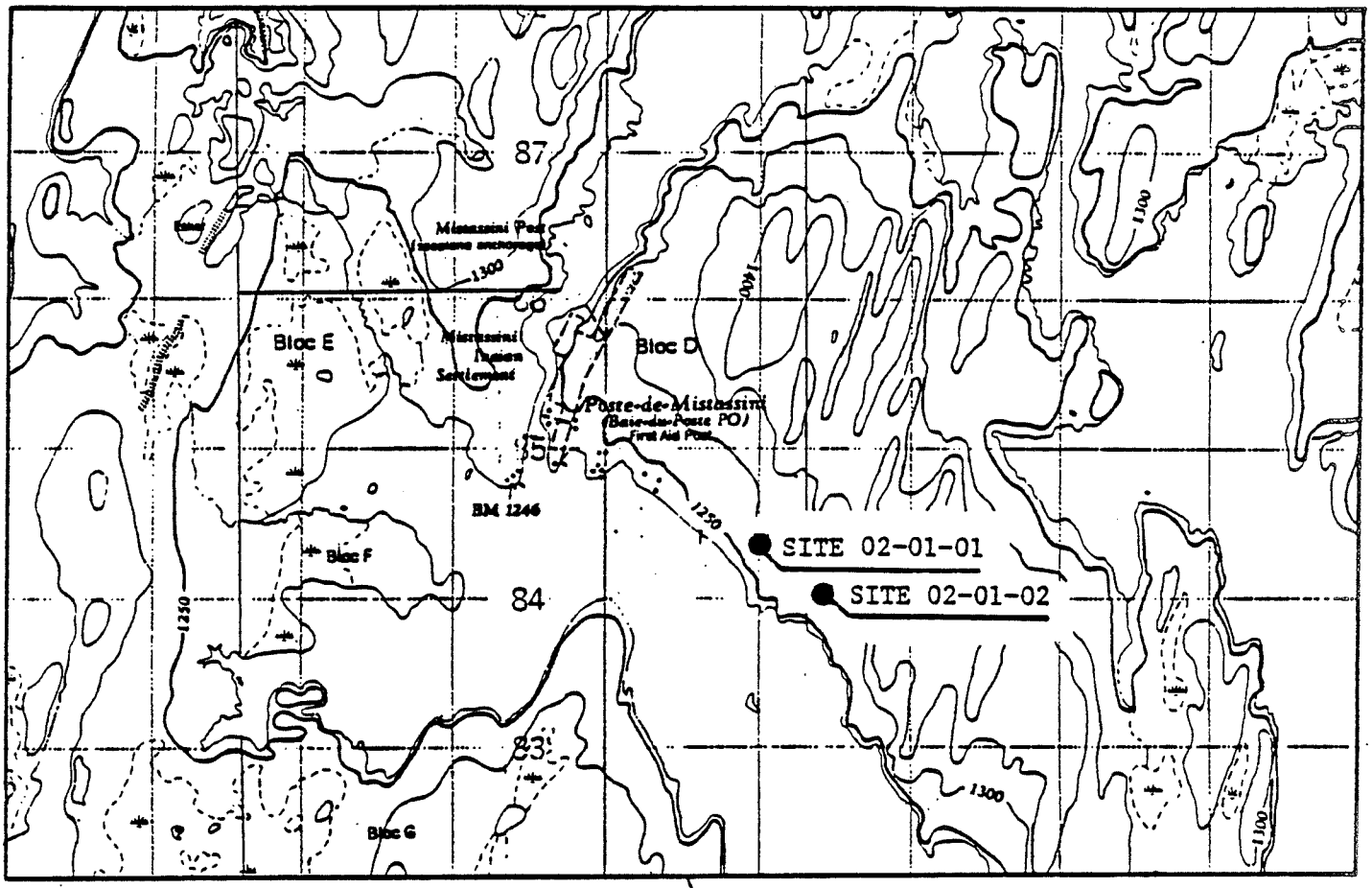
A visit at the Manouane Reserve site in August 1983 showed that work was being done by the D.I.N.A. to close the existing site and a new site was being opened. Thus Environment Canada, in agreement with the Department of Indian and Northern Affairs, then decided to exclude site 07-01-03 from the present mandate.

At the same time, the Band Council of the Kahnawake Reserve had asked expressively the two concerned departments to extend the Phase 2 study to two (2) other disposal sites located on the reserve, considering the waste volume and the site location. The request has been granted and the following sites were added to the mandate:

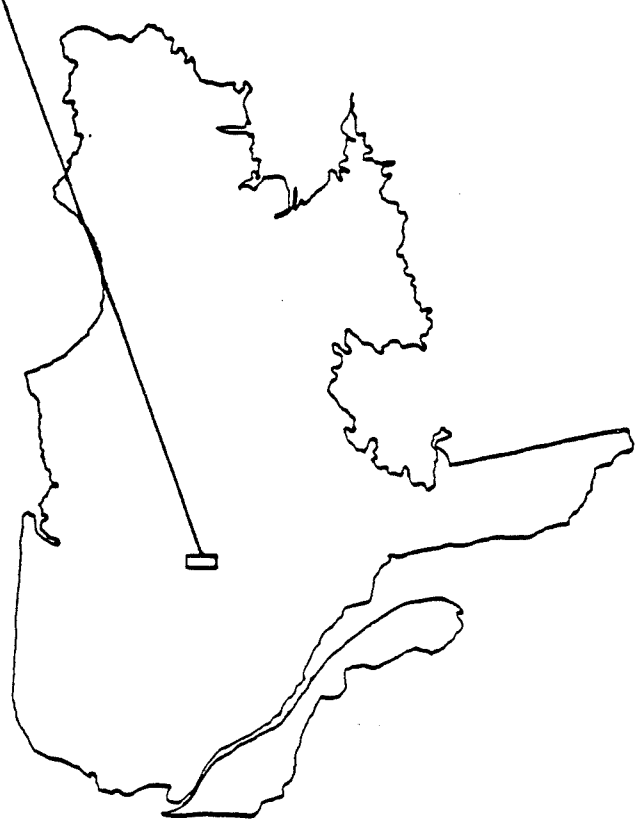
06-01-01 Kahnawake Reserve

06-01-04 Kahnawake Reserve

Consequently, this study deals with seven (7) waste disposal sites on two (2) Indian Reserves (Mistassini and Kahnawake). The location of each site is shown on figures 1 and 2.

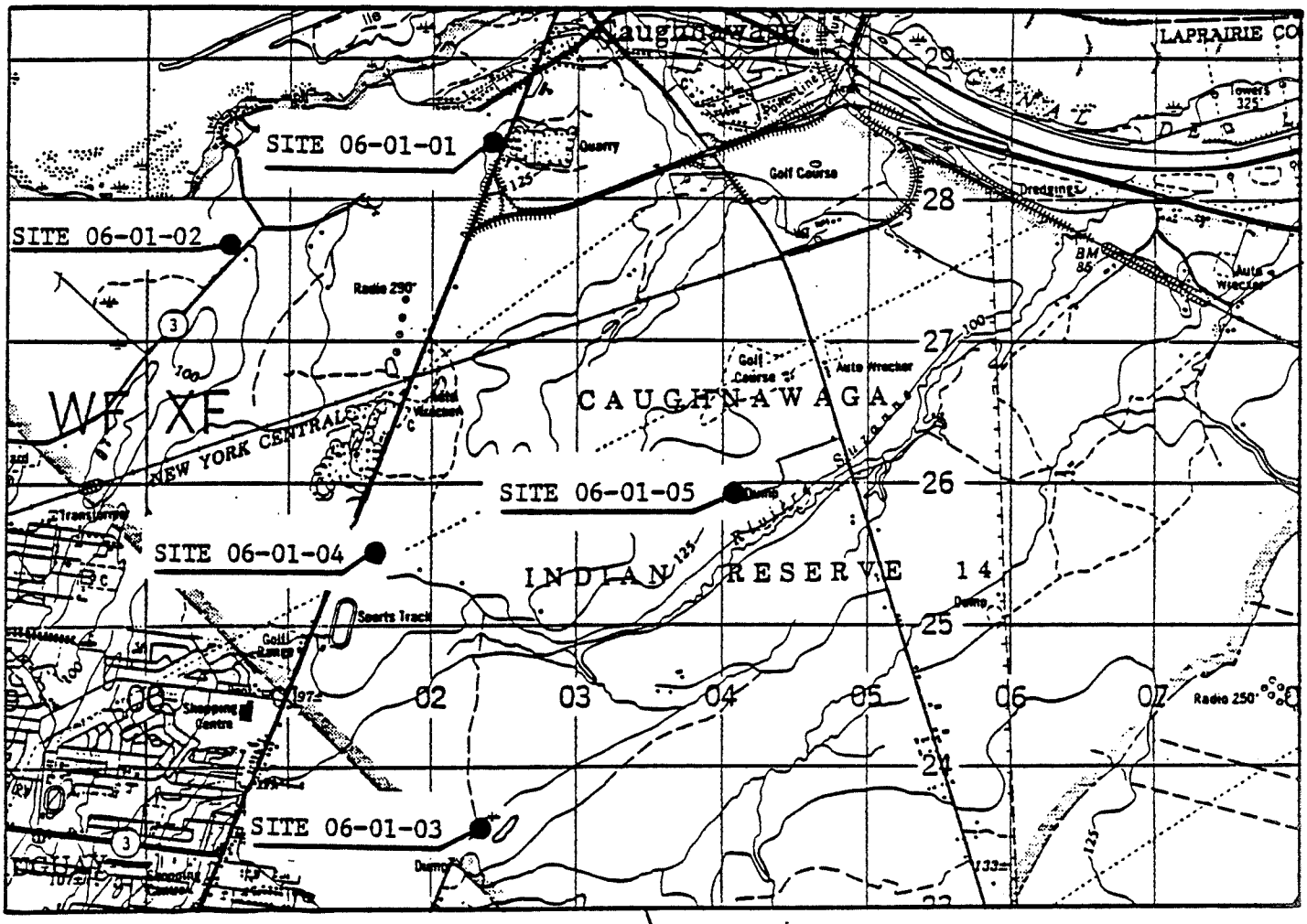


LOCATION OF SITES
MISTASSINI RESERVE



SOURCE: Topographical Map
32-I/5, 1967
1:50,000

FIGURE:I



LOCATION OF SITES
KAHNAWAKE RESERVE

SOURCE: Topographical Map
32-H/5, 1971
1:50,000

FIGURE:II

3.0 Description of each realisation phase of the project

3.0 DESCRIPTION OF EACH REALIZATION PHASE OF THE PROJECT

The methodology used in carrying out this study consists of three (3) steps: collection of existing data and preparation of surveys, on-site surveys and finally, analysis and interpretation. The work has been spread over an 8-month period, from July 1983 to March 1984.

3.1 Collection of Existing Data and Preparation of Surveys

The first step consisted in revising data collected in 1982 (1) at the time of the inventory and classification of the studied sites. Later, contacts were made by telephone in each reserve in order to obtain approval for access to the various sites and authorization to carry out drilling and sampling work.

It was decided, for this step, to keep an inspection sheet for each site containing data from the previous inventory as well as from the considered survey program. The inspection sheet, which has been revised by Environment Canada, includes six (6) different sections:

1. General Information
2. Physical Characteristics of Site
3. Waste Disposal
4. Analysis Results
5. Impact on the Environment
6. Recommendations

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(1) Étude des sites de disposition de déchets solides sur les terres fédérales au Québec, Environment Canada, Québec Region, prepared by Lalonde, Girouard, Letendre & Ass. Ltd, November 1982.

An example of a data sheet is to be found in the appendix. The decision to fill out one inspection form per site was taken in order to gather data on a common basis, which could eventually be used as a detailed file of each site.

3.2 On-site Surveys

The land surveys have been executed over a 4 month period between September and December 1983. They usually consisted of three (3) steps: a first visit of the land to locate drilling and determine restraints, the drilling program as such (including the determination of water wells, permeability tests and surveying) and the water and gas sampling program. Normally, these steps should have been carried out consecutively and separately, but due to restraints on site, they sometimes have been realized concurrently. For example, all surveys of the Mistassini sites have been realized on the same trip, the reserve being relatively far. In other cases, several visits of the same site have been necessary in order to complete the survey program (lack of water in wells, work authorization delayed, additional information, repeat of sampling because of aberrant results, etc). The following paragraphs will describe the various components of the land survey program.

3.2.1 Location of Drillings

The location of the necessary drillings for soil and water table characterization and sampling was determined after a first visit to the site, during which data was collected on observable charactersitics of the surface of sites.

After having estimated the maximum slope of the original land and the probable direction of the ground water flow, the methodology used called for the location of four (4) boreholes per site, distributed in the following manner:

- one (1) borehole upstream from the disposal site according to the predetermined direction of the water table flow;
- two (2) boreholes downstream from the site, these three (3) holes forming a triangle;
- one (1) borehole on the site.

According to the importance of the site and the local conditions, additional drillings have been located. Also, because of some physical restraints, it has been necessary to modify the original pattern and number of drillings; among these restraints are fences, deep ditches, inaccessibility due to topographic features, existing woods and rock outcrops.

3.2.2 Drilling Methodology

All drillings were executed with a C.M.E. 55 rotary drill, equipped with an hydraulic head and mounted on a truck, from the Succession Forage George Downing Ltd. company in Calumet, Québec. The holes have been drilled by means of a 12.7 cm (5 in.) outer diameter conventional helicoidal auger, equipped with a toothed tungsten bit. This combined to the power of the drill made it possible to go throught the cobbles and blocks that could be present.

However, in cases where the hole would close again after taking out the auger, a 15.2 cm (6 in.) outer diameter hollowed mechanical auger was used in order to set up the piezometer.

When drilling through waste, it had been decided to drill to the bottom of the site if the water table was located in the deposited refuse and to 2 to 3 meters under the water table if it was located underneath the site. It was understood that no boreholes would enter into the bedrock.

Other drillings located outside the waste disposal area were supposed to reach a depth of 2 or 3 meters under the high water table. However, determining the depth of the various soil and waste layers during the drilling and assessing the water level were only approximative; it was difficult to be accurate because of the delay occurring during the rise of the material along the thread of the auger. This delay increased as the drilling deepened.

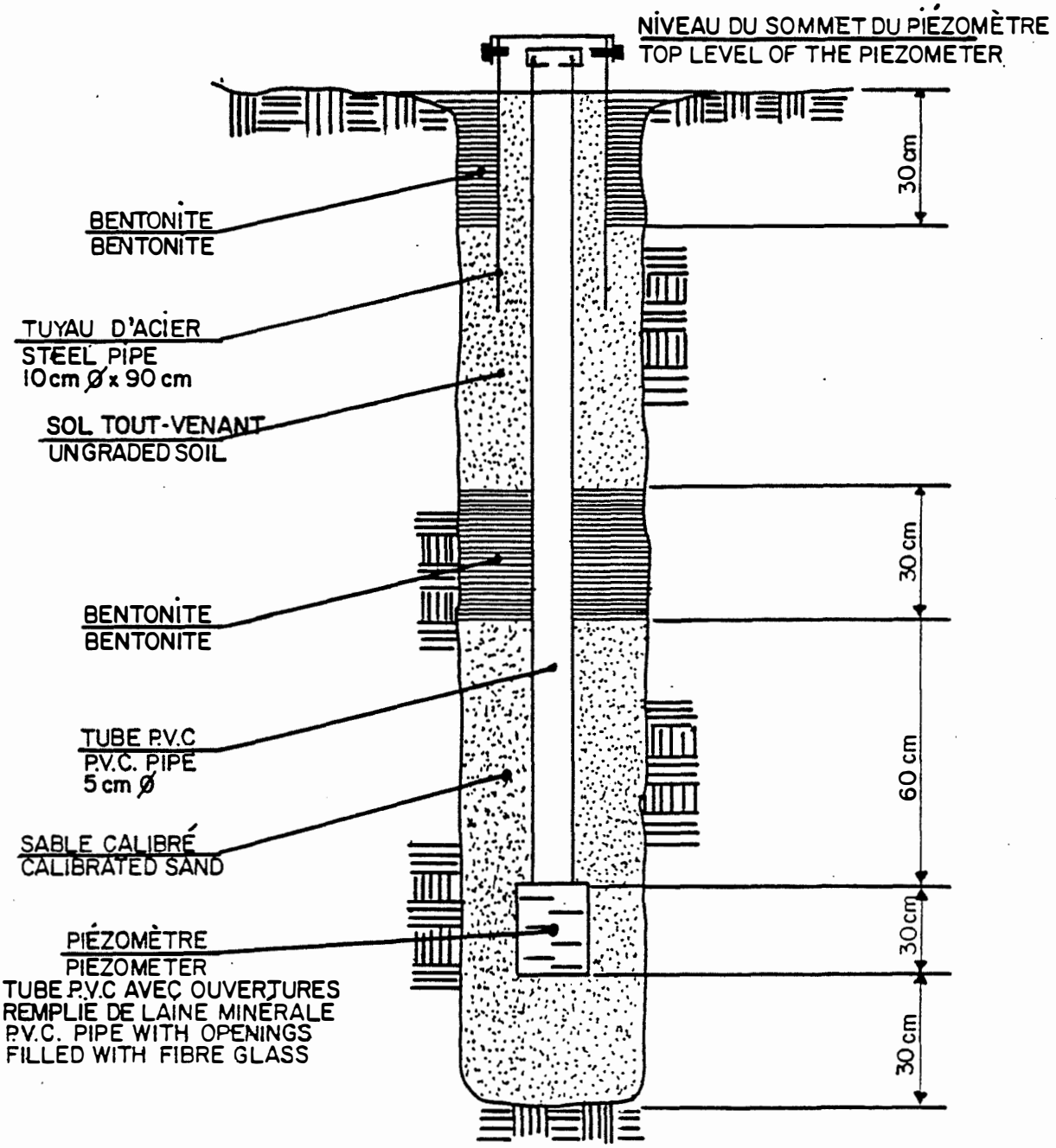
Because of the inaccuracy of the water table level assessment during the drilling, the deepness of surveys has been, in practice, of 1 to 7 meters underneath the waste (for table under sites) and of 0.5 to 5 meters under the water table (for drilling outside sites) instead of the 2 or 3 planned meters.

At the time of drillings, the description of the various materials bought to the surface by the auger was recorded. Afterwards, a piezometer consisting

of a P.V.C. tube perforated with lateral clefts and filled with fibre glass was installed in the hole once the high water table was reached. The piezometer was later used for the high water table level survey and for water sample taking. The advantage of such an installation is that it later constitutes a permanent network of measuring points in order to insure on environmental follow-up of the site.

The operation of setting up the piezometers was realized with great care; ultimately, the quality of water samples depends on it. Hence, each piezometer was installed, with its tubing up to the surface of the ground. A calibrated layer of sand, approximately 1 meter high, was disposed all around the piezometer in order to prevent clogging by fine particles in the soil. To avoid contamination of water in the piezometer by surface runoff water, it was sealed with two plugs of bentonite, one over the piezometer and another on the surface of the land. The filling matter between the two bentonite plugs came from the soil recovered from the boreholes. On the surface, the P.V.C. tube was closed by a plug and was further protected by a 0.9 m-long steel pipe fitted with a bolted-on steel cover. After the setting up was completed, we generally waited at least 1 or 2 days before any water sampling or permeability test was made so that the water level could stabilize. Water level surveys were regularly made in the piezometers; the survey's results are presented in the reference file.

INSTALLATION TYPE D'UN PIÉZOMÈTRE
TYPICAL INSTALLATION OF THE PIEZOMETER



The stratigraphic description of materials found in the boreholes, the water levels surveyed in the piezometers, the permeability test results and the piezometer setting up sketches are all summarized in the boreholes reports presented in appendix.

3.2.3 Permeability Tests

Permeability tests were conducted in the piezometers after the water level had stabilized.

These tests are of the same type as the "Lefranc" test. The method is described in the "Bulletin de Liaison du Laboratoire des Ponts et Chaussées - Spécial Hydraulique des Sols - Avril 1970". The test consisted in determining the coefficient of permeability "k" of the soil around a zone of permeable material (calibrated sand) which was placed around the perforated P.V.C. tube. The method of the downward variable water level was used. After having risen the water level in the piezometer tubing, taking into account the limits of water heads allowed, the water level variation in the tube was measured according to time. This measure allowed to calculate, by means of appropriate formulas and charts, the coefficient of permeability. The detailed calculation of the various permeability test can be found in the file of each site, which were handed over to Environment Canada.

Using the various test results, the mean permeability of the soil was established for each studied site. This mean permeability was then used to determine the water flow velocity in the ground.

Il should be noted that the water injection for the permeability tests was always done after the water was sampled, in order not to dilute the water.

3.2.4 Location of Water Sampling Stations

The water sampling program was concerned with surface and ground water. The ground water came from the piezometer set up on each site.

For surface water, it was first planned that samples would be taken from several points, analyzed on site by means of a Hack DR-EL portable laboratory and a pH meter, and then the more relevant points would be selected for laboratory analysis purposes. In practice though, the low number of surface sampling stations available and the inaccuracy of this type of on-site equipment have prevented us from selecting any stations. The portable laboratory analysis have been made anyway and all collected samples have been sent to the laboratory for detailed analyses. The on-site analyses were for pH, alkalinity, conductivity, hardness, chloride and sulphates.

3.2.5 Water Sampling

Surface water samplings have been made for all stations directly over the bank with sampling bottles. As most surface waters were shallow marshes or puddles, this sampling method was selected to prevent a possible water contamination by the field team while moving to the center of the surface water.

For ground water, it was at first mechanically extracted from the piezometer tubes by means of a vacuum pump connected on one part to a portable generator and the other part, to a 1-liter erlenmeyer. Water was collected by a 1-cm inner diameter semi-stiff Tygon pipe, directly connected to the erlenmeyer. When the pump is operating, a vacuum is created in the system and the liquid is introduced in the semi-stiff pipe and then into the vial. In theory, it is possible to obtain a perfect vacuum down to a 10 m-depth. Consequently, for depths reading more than 10 m, the water coming up in the pipe cannot reach the surface anymore. This system was used on the Mistassini Reserve sites but later on, it was abandoned and replaced by a manual system consisting of a 0.5 m long, 2.5 cm diameter copper tube, sealed at one end and connected to a rope at the other end. This tube was simply thrown down the piezometric tube where it would fill up. This basic procedure was the most efficient one. Easy to use, light and not cumbersome, this mechanism allowed for sampling in all piezometers where water had gathered, and at any required depth.

All collected samples were kept in bottles provided on one hand by the Captain Bernier Laboratory (Environment Canada) of Longueuil and on the other hand, by Eco-Recherches Inc. of Pointe-Claire. The first laboratory required a water volume of one (1) liter and Eco-Recherches Inc. required four (4) liters. It is to be noted that some ground water stations (piezometers) contained less water than required so sampling had to be done several times.

The water samples collected for chemical analyses required the addition of preservatives. Hence, the bottles which would serve to determine the chemical oxygen demand (COD), the total kjeldhal nitrogen (TKN), the presence of phosphates (PO_4), nitrate (NO_3) and ammonia (NH_3) required the addition of 1 ml of concentrated sulfuric acid (H_2SO_4); to determine the presence of calcium (Ca) and magnesium (Mg), it required the addition of 1 ml concentrated nitric acid (HNO_3); and to detect the total organic carbon (TOC), two (2) drops of chloridric acid 1:1 (HCL) were added. Finally, the following determinations did not require any preservatives: dissolved solids (DS), nitrites (NO_2) and redox potential. The samples collected for toxicological analyses did not require any preservatives.

All collected samples were kept in iceboxes until, the same day, they were forwarded to the two laboratories.

Finally, it can be mentioned that because it is a preliminary assessment, a single sample per station was to be collected for laboratory analysis. However, considering that some first analysis results were aberrant because of sampling or laboratory errors, it was decided with the laboratory to take some of the samples again for analysis purposes. The installation of permanent sampling stations (piezometers) has permitted the conduct of the analyses as required.

3.2.6 Gas Sampling

The first step called for the on-site determination of carbon monoxide and dioxide contents on each site by means of a "Gastec" gas detection system. This on-site apparatus is in fact a small pump which sucks the ambiant air and gives an immediate reading of its content on a detection tube. The scale used here for detecting CO and CO_2 gases was of 50 to 1 000 ppm for the CO and 300 to 5 000 ppm for the CO_2.

A second step consisted in putting in evidence the presence of methane in the air. It coul not be detected with the Gastec apparatus. An explosimeter was used instead to determine the percentage of combustible gas contained in the ambient air; these readings were systematically taken during all drillings. The explosimeter used, a model 2-A from MSA, gives readings from 0 to 100% of LEL (Lower Explosive Limits) with a precision of $\pm$ 5%.

The third and last step of this gas sampling, conducted only when the presence of gas was detected during the first two steps, consisted in taking specific quantities of gas into appropriate bags for a scanning analysis, by the laboratory, of gases present.

The gas sampling stations were selected in a sensible manner directly on site after a detailed inspection of the area. Therefore, these stations have been selected according to their protection against the wind, in order to avoid any interference. It is to be noted that this type of gas survey is highly inaccurate. They are valid mostly for security reasons (for example: presence of inflammable gases exiting from boreholes) but are not very representative of the surroundings.

3.2.7 Topographic Survey

The topographic surveys included soil elevation surveys at boreholes and at suface water sampling locations. Water level surveys in the piezometric tubes were also taken; by relating them to surface elevations, it was possible to know the high water table elevation. All collected levels were recorded on the data sheets and equipotential lines (lines of same water level) were drawn on site sketches.

All elevations were related to an arbitrary bench mark, identified on each site sketch. However, the elevation of the top of each piezometer protection

tube being noted on each borehole report, it was possible to conduct other water level surveys and to correlate them to this elevation without going back to the arbitrary bench mark.

The positionning of boreholes was made approximately, on site, by using identifiable landmarks on aerial photographies, when available.

3.3 Analysis and Interpretation

This step includes analyses of collected samples, calculations, data synthesis and finally, result interpretation.

3.3.1 Physicochemical Analyses

This study aims, among other goals, at determining the influence of waste disposal sites on the surrounding area. By analyzing surface and ground water and water from wells on adjacent lands, it becomes possible to detect traces of contamination due to landfill sites.

A total of seventeen (17) parameters were selected in order to assess if the sites could be responsible for an organic or inorganic contamination of surface and ground water, without specifying the nature of the contamination however. The analyzed parameters, presented in Table 1, were selected to be representative of the environment, based on the information collected during Phase 1 of the assessment program.

Analyses of water samples have been spread over six (6) different periods in time, which correspond to the surveying days:

1. October 13, 1983
2. October 21, 1983
3. October 28, 1983
4. November 22, 1983
5. November 23, 1983
6. December 22, 1983

It is important to take note of these periods because it was frequent to sample the stations at different times for the same site. Unfortunately, specially for ground water, it was impossible to standardize the surveys because the stabilization of water in the boreholes was not simultaneous in all stations.

The analyses have been conducted at the Eco-Recherches Inc. laboratories in Pointe-Claire, according to the methods presented in Table 1.

TABLE 1

Water Analysis Methods

pH and alkalinity	:	EPA 1979, Method 310,1, storet No. 00410
Hardness	:	EPA 1979, Method 130,2, storet No. 00900
Chloride	:	EPA 1977, Method 325,3, storet No. 00940
Conductivity	:	Standard Methods 14th Edition, 1975, page 71
Sulphate	:	Methods for chemical analyses of water and wastes EPA 1979
Phosphate	:	Standard Methods 14th Edition, 1975, page 475
Nitrite	:	EPA 1979, Method 354,1, storet No. 00615
Nitrate	:	Standard Methods 14th Edition, 1975, page 422
Redox potential	:	ASTM designation: D-1498-76
Dissolved solids	:	EPA 1979, Method 160,2, storet No. 00530
TKN nitrogen	:	Standard Methods 14th Edition, 1975, page 410
COD	:	EPA 1979, Method 410,4, storet No. 00340
TOC	:	Direct method using a Beckman model 915-B
NH_3	:	Environment Canada Naquadat No. 07506, October 1980
Ca and Mg	:	EPA 1979. Methods 215,1 and 242,1, storet No. 00916 and 00927

3.3.2 Toxicological Analyses

Toxicological analyses have been conducted at the Captain Bernier laboratories of the Environmental Protection Service, Environment Canada, in Longueuil. The analyses are basic toxicity tests which make it possible to detect if water at the disposal site constitutes a potential risk for the environment.

The biotests are conducted with living organisms. The "Microtox" test uses the Photobacterium phosphorium, which is a bioluminescent bacteria; and the algae test uses the Selenastrum capricornutum, a green alga. These are two (2) sublethal biotests; consequently, they indicate the volume of the sample water required to inhibit 50% of the light for the luminescent bacteria, and 50% of the growth for the green algae (CI50). The result of a sublethal biotest is expressed in toxic units (100%/CI50), which represent the ratio of the total volume of water required to inhibit growth or light (expressed in %). Therefore, the higher the number of toxic unit is, the greater the potential risk of the water will be; which means a smaller volume of water will be required to inhibit 50% of growth or light.

Example: If the algae biotest result on a water sample is 20 T.U., then:

$$20 \text{ T.U.} = \frac{tV = 100\%}{\text{required } V} = \frac{100\%}{5\%}$$

Therefore, 5% of the total volume of water is required to inhibit the growth of the green algae population.

According to the two biotests conducted, the potential danger to the environment is reached when the following limits are passed:

Biotest	No observable danger	Potential danger
Microtox	< 3 T.U.	> 3 T.U.
Algae	<10 T.U.	>10 T.U.

T.U. = Toxic units

These two indicators suggest the existence of an environmental perturbation of a toxic nature (lethal, sublethal or chronic) but do not indicate in any way other potential problems related to the ecotoxicity (for example, problems of mutagenicity, eutropic potential, bioaccumulation, presence of pathogenic germs, etc.).

3.3.3 Calculation of the Horizontal Velocity of Flow

Once the mean permeability of the soil at the site has been calculated, it can be related to the water table levels surveyed in the piezometer and be used to determine the horizontal velocity of flow.

The water levels surveyed in the piezometers have been used to draw the equipotential lines, which are lines connecting points of the same piezometric level. These lines can be seen on each site sketch presented within the date sheets, with the corresponding level rate. An example of the determination of these lines is shown on figure 4.

As for the average flow velocity, it is calculated according to the following formula:

$$V = \frac{K \times i \times 315\ 360}{Sy}$$

where V = average velocity of horizontal flow in m/year
K = coefficient of permeability of area in cm/s
i = mean hydraulic gradient (no units)
Sy = Specific yield (no units)
315 360 = conversion unit in m/year

The mean hydraulic gradient is evaluated from the equipotential lines, the Sy according to the type of material listed in Table 2.

DETERMINATION OF WATER TABLE CHARACTERISTICS

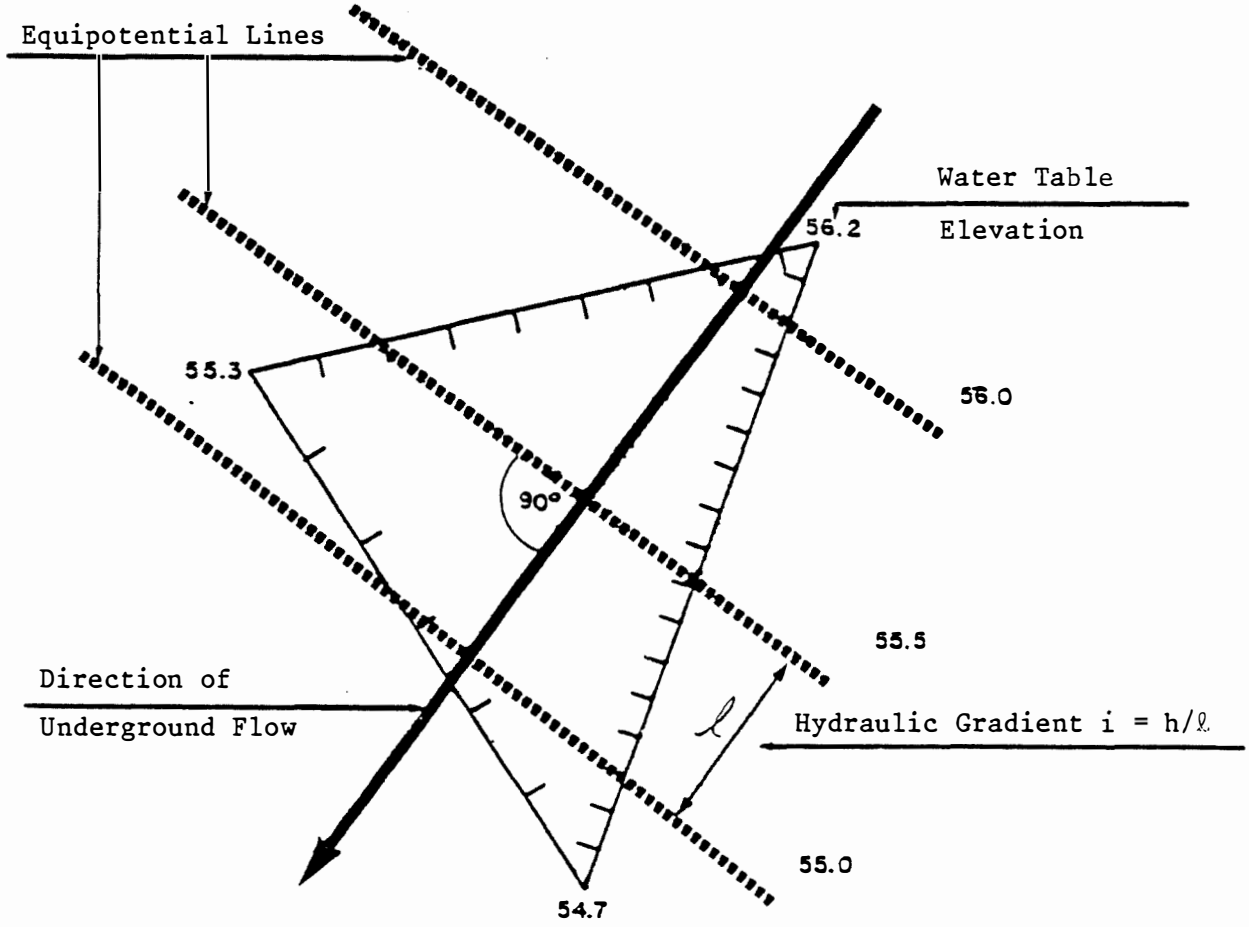


FIGURE 4

TABLE 2

SPECIFIC YIELD CAPACITY FOR
DIFFERENT ACQUIFEROUS DEPOSITS IN
SACRAMENTO VALLEY, CALIFORNIA
(from Pland and al)

Material	Sy (%)
Gravel	25
Sand, sand and gravel, gravel and sand	20
Fine sand, indurated sand, compact sand, grey and similar deposits	10
Clay and gravel, gravel and clay, cimented gravel and similar deposits	5
Clay, silt, sandy clay, effusive rocks and similar deposits	3

3.3.4 Assessment of Leachate Production Rate

In a solid waste disposal site, the contamination of ground water is produced by the washing of buried waste. The product of this washing, called leachate, can result from three (3) situations:

1. By vertical washing, due to rainwater infiltration and percolation into the deposit;

2. By horizontal washing, due to the passage of the regional water table;

3. By washing with water formed by waste decomposition within the deposit.

From these three mechanisms and their possible combinations, two major types of waste disposal can be established.

A. The sites which are crossed by the water table and thus where it is reasonable to predict that the second mechanism is involved.

B. The sites which are located higher than the water table and where it is reasonable to predict that the second mechanism will not be involved.

In Québec, water tables are relatively high and we can generally expect to find the first type of site, i.e. the site which is crossed by the water table. Most of the studied sites, however, are surface deposits, which leads to a local radial flow relatively independant from the regional flow. The regional drainage pattern, necessary to assess the leachate production according to mechanism (2), will be establish during Phase 3 of the program by means, among others, of water level surveys spreaded over at least one year (surveys carried out during the period of the study are presented in Appendix 3).

Mechanism (3), water formed by waste decomposition, can only be defined by a specific laboratory study in order to determine particular characteristics of the waste, such as its permeability, its humidity content, its detailed composition, etc. Nevertheless, the volume produced by this mechanism is relatively low compared to the washing described in the other mechanisms.

The assessment of the leachate production rate will therefore be based on mechanism No. 1 and the following hypotheses can be put forward:

- the volume of leachate produced by the deposit is equal to the volume of rainwater that infiltrates and percolates through the cover layer;

- the waste permeability is at least as high as the cover material permeability;

- the waste has reached its water retention capacity.

These are conservative hypotheses and they probably lead to maximum values. The leachate production rate is therefore very approximative because it is based on an estimate of the coefficient of infiltration for each site, which in turn, depends on several factors, including the slope of the deposit, the cover material and the waste permeabilities, the surface runoff and evaporation.

3.3.5 Synthesis and Interpretation

All collected data and calculation results are recorded for each site on separate questionnaires. Each drilling is described on a separate sheet showing the stratigraphic profile, the type of soil, the level of water table and calculation results. To facilitate comprehension and interpretation, each physicochemical parameter that was analyzed is the subject of a chart representation in the form of a histogram of concentrations superimposed on sampling stations identified on each site sketch. All this information is presented in a separate report including files and questionnaires of each site.

4.0 Disposal sites

4.0 DISPOSAL SITES

In this chapter, we are presenting a summary of results collected for each site. The following items will be discussed for each site:

1. History
2. Location and Access
3. Work on Site
4. Physical Characteristics
5. Geological Characteristics
6. Hydrological Characteristics
7. Disposal Method and Nature of Waste
8. Analysis Results
   a. Water Quality
   b. Gas Analyses
   c. Leachate Production
9. Summary - Conclusions
10. Recommendations

In appendix are to be found individual boreholes reports and water level surveys for different periods. Complete and detailed information is given in another report containing files and questionnaires of each site.

4.1 Mistassini Reserve - Site 02-01-01

1. History

This site used to be the disposal area of the Mistassini Reserve; it is located near Lake Mistassini. It has been closed since 1975 because of its small size (450 m^2). It was and still is owned by the Reserve Council Band.

Today, the site is completely covered, and herbaceous vegetation covers part of the site. Metallic remains are partially visible.

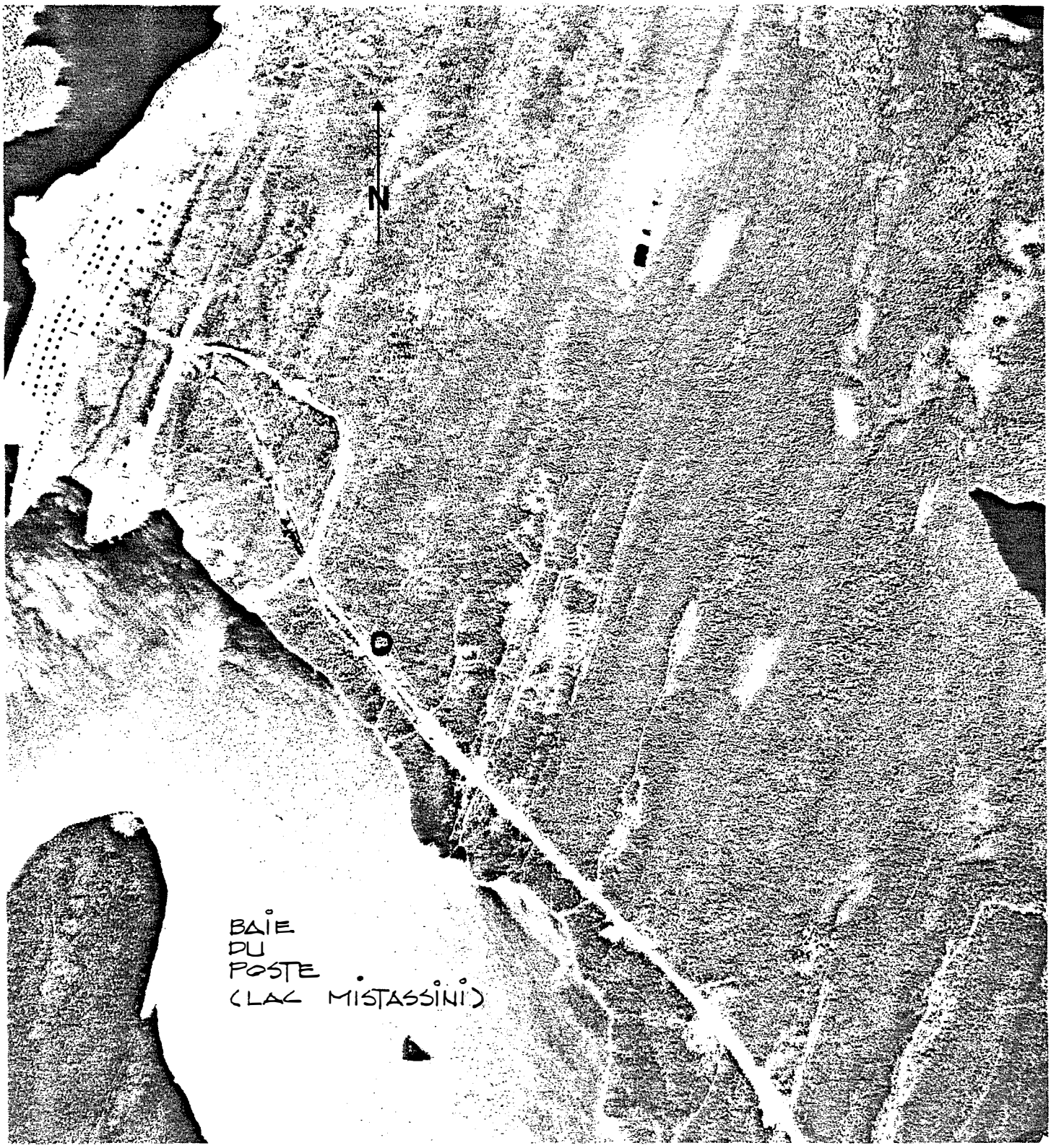
At the time of the 1982 inventory of disposal sites located on federal properties in Quebec, the site had received an intervention priority 1 for the following reasons: proximity of a municipal water supply source (1 km), of Lake Mistassini (150 m), of a housing project at less than 300 m from the site and finally the shallowness of the water table (0.5 m).

The municipal water supply source is in fact the water intake pipe located in the lake Mistassini.

The houses mentioned in the 1982 inventory as being less than 300 m from the site are still in the project phase and not yet built. The rating system developed by Environment Canada for the classification of sites gives the same rating to housing and a housing project.

2. Location and Access

The site is located approximately 1.5 km from the village, along a road joining the reserve and Route 167. Its access was and still is free in the absence of a gate or fence. A strip of land about 150 to 200 m wide with a slight slope divides Lake Mistassini and the village road, which follows more or less parallely the lakeshore. The following map presents the site location.



MISTASSINI - ANCIEN DÉPOTOIR 02-01-01 OLD DUMP

ÉCHELLE 1:15840
SCALE

3. Work on Site

Four (4) boreholes have been drilled with the mechanical auger in the inner limits of the dump. Boreholes reached depths of 4.27 to 10.21 m. A piezometer was set up in each one of them.

Two (2) ground water samples have been taken in stations located within limits of site, one upstream, the other downstream. Because of the deepness of the water table in two boreholes (#1 and #3), it was impossible to sample these stations with the vacuum pump brought on the site (1).

Surface water was characterized by means of four (4) samples respectively taken upstream and downstream from site on each of the two (2) creeks running along the waste disposal area.

The arbitrary bench mark used for surveying corresponds to a point above a rock which is lying on the ground besides the electrical post at the site entrance.

A site sketch with the location of the work on site is presented on the following page.

4. Physical Characteristics

The layers of waste and cover material form a 450 m^2 plateau, about 3.0 m higher than the original ground. The top of this plateau is at the same level as the road of the reserve where is located the site entrance. Two (2) small creeks run along each side of the site, from north-east to south-west; they cross the road underneath it and later reach Lake Mistassini located at about 1 200 m, by crossing an uninhabited zone with a light slope.

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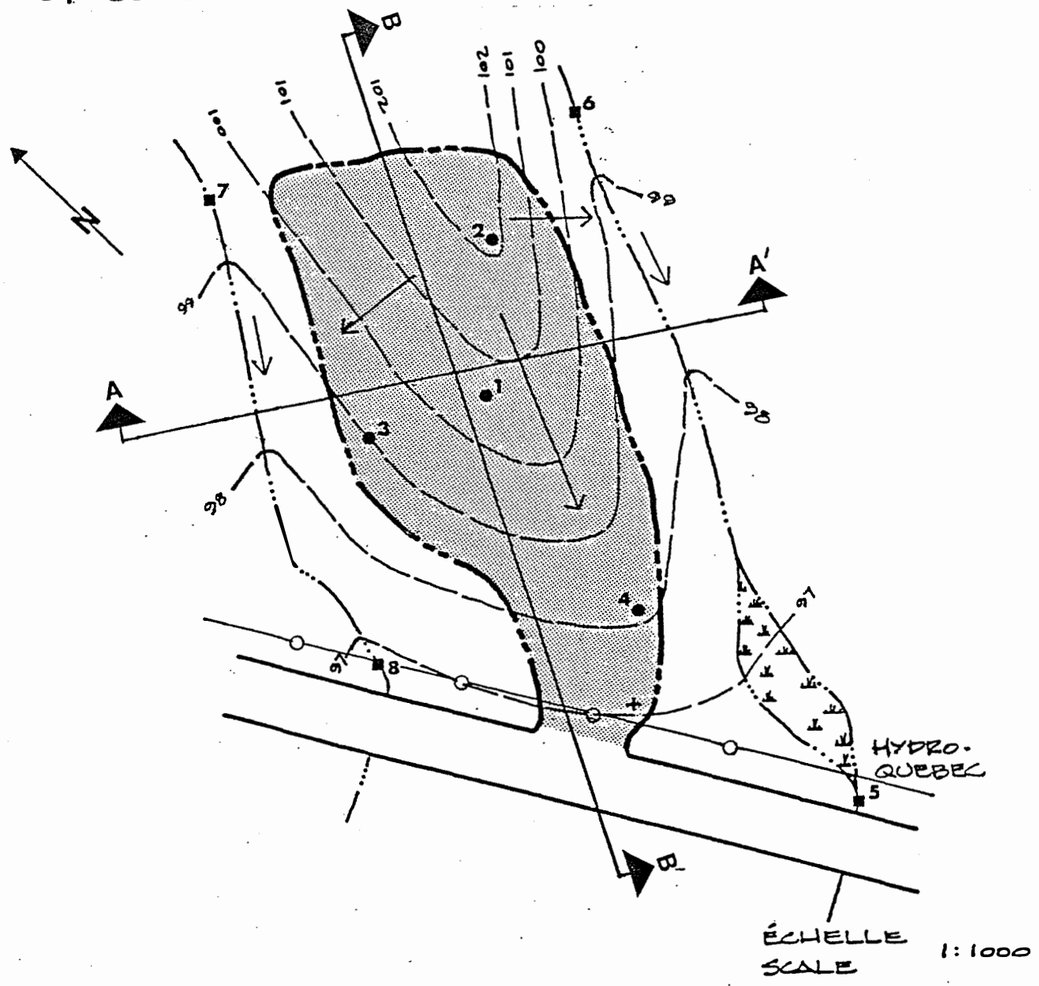
(1) This sampling system was later replaced by another method for subsequent reserves (see Chapter 3).

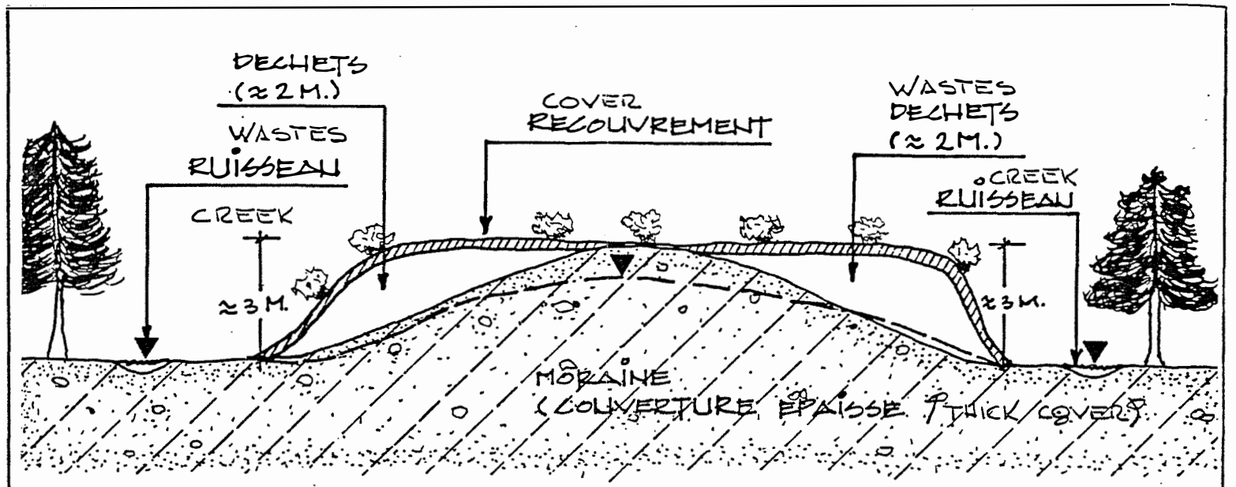
SCHÉMA DU SITE
SITE SKETCH

MISTASSINI - ANCIEN DÉPOTOIR 02-01-01 OLD DUMP

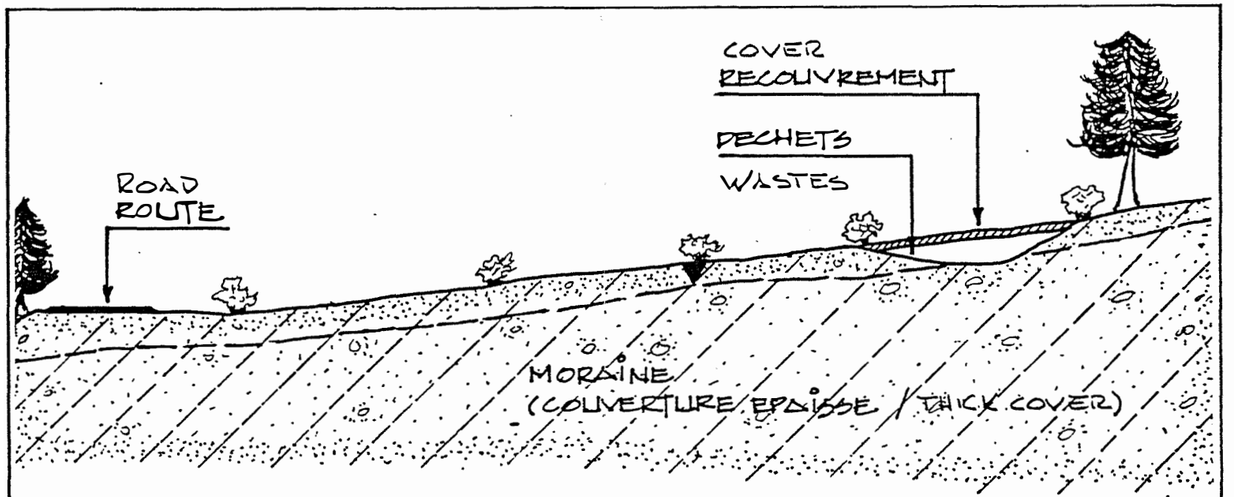


LÉGENDE — LEGEND

LIMITE DU DÉPOTOIR	DUMP LIMIT
ROUTE	ROAD
MARÉCAGE	SWAMP
RUISSEAU	CREEK
(ÉL. 100,00 m) B.M. ARBITRAIRE	ARBITRARY B.M. (EL 100.00 m)
FORAGE	BOREHOLE
ÉCHANTILLON D'EAU DE SURFACE	SURFACE WATER SAMPLE
LIGNE ISOPIÈZE	EQUIPOTENTIAL LINE



COUPE A-A'
SECTION



COUPE B-B'
SECTION

A pionner vegetation can be found on the site, a shrubby stratum near the site and trees all around. Only the site and its immediate surroundings had been deforested to allow waste disposal.

5. Geological Characteristics

The ground consists of a thick till cover. This till is mostly composed of sandy silt resting on silty sand with traces of gravel to gravelly. No boreholes have reached the bedrock.

A permeability test, taken in the piezometer of borehole #4, gives a 7.8×10^{-5} cm/s value for the till, which therefore is a material of little permeability, encouraging surface runoff instead of infiltration.

6. Hydrological Characteristics

The drainage of the dump flows in a south-west direction; the two (2) creeks running along each side seem to capture part of the ground water coming from the site. All boreholes have reached the water level. During the drilling of borehole #1, a perched water table was encountered. The water level surveys obtained in the piezometers of boreholes #1 and #3 are questionable, been noticeably too low compared with the local hydrological environment. Because of the very short time between the drillings and the water level surveys, it is possible that the water in these piezometers did not have time to stabilize. Consequently, the results of these surveys have not been included in the calculation of the equipotential lines presented in the site sketch. These lines show that the ground water flows in a south- west direction with an average horizontal velocity of 30 m/year.

The water in the area has the same flow direction, that is towards Lake Mistassini, located about 200 m from the site. Results of borehole #4 indicate that waste is in direct contact with the water table at that place.

7. Disposal Method and Nature of Waste

Until 1975, the site was operated by disposing waste directly on the ground in a deforested area. In this matter, about 2 m of waste was accumulated; it has been covered with a 0.3 to 0.5 m layer of sand and soil. The waste material was composed of domestic waste, construction materials and a few bulky objects (stoves, etc.). It was occasionally burned, usually before a rain fall.

8. Analysis Results

a. Water Quality

Results of ground and surface water analyses are presented on the following page. They indicate that the ground water is very hard and highly charged with organic matter (high TKN, NH3, COD and TOC values), which is typical of leachate usually found in landfill sites. Because a portion of the waste is in contact with the water table, an increase in the analyzed parameters can be noted from upstream to downstream, which represents a south-west direction, towards Lake Mistassini.

Name of site: MISTASSINI

Site number : 02-01-01

SURFACE AND GROUND WATER
ANALYSIS RESULTS

ANALYSES	SAMPLING STATIONS ● 2	● 4	■ 5	■ 6	■ 7	■ 8
SAMPLING DATE	21-10-83	21-10-83	21-10-83	21-10-83	21-10-83	21-10-83
pH	8,2	7,4	7,4	7,0	7,1	7,0
Alkalinity (mg/l)	250	510	90	70	80	100
Conductivity (µ mhos/cm)	320	440	174	138	152	160
Hardness (mg/l)	230	460	80	70	90	70
Chloride (mg/l)	0,30	<0,1	<0,1	<0,1	<0,1	<0,1
SO_4 (mg/l)	12	230	6	8	6	7
PO_4 (mg/l)	-	-	-	-	-	-
NO_2 (mg/l)	0,008	0,008	0,006	0,006	<0,005	0,006
NO_3 (mg/l)	1,76	1,11	0,88	0,84	0,49	0,58
Redox potential (millivolts)	454	476	R	500	498	492
Dissolved solids (mg/l)	393	670	122	359	130	129
TKN (mg/l)	1,1	2,0	0,63	0,42	0,63	2,4
NH_3 (mg/l)	0,38	0,42	0,24	0,18	0,14	0,25
COD (mg/l)	412	913	23	15	19	23
TOC (mg/l)	58	200	8,7	7,8	6,9	7,5
Ca (mg/l)	4,8	14	12	12	17	15
Mg (mg/l)	-	-	-	-	-	-
BIOTEST						
Algae (toxic units)	<1,1	1,1-2,2	<1,1	<1,1	<1,1	<1,1
Microtox (toxic units)	1,67	1,54	1,0	<2	<2	<2

● Borehole
■ Surface Water

-: N.A.
R: Analysed but rejected by the laboratory

Surface water shows a much lower concentration of organic matter. It respects the guidelines on the protection of aquatic life (Environment Canada, 1980) except for TKN and NH3. It should be said though, that the samples taken upstream reveal relatively high contents, which means that natural contents are important. Hence, the concentrations found at stations #5 and #8, located downstream, could be explained on one hand by the presence of the site (organic matter) and on the other hand, by the natural contents in the area.

The biotests conducted on the collected samples indicate that the water does not present a potential risk for the environment.

b. Gas Analyses

No Co nor Co_2 analyses were carried out on site. The explosimeter did not detect any inflammable gases. Considering the small volume of buried waste, the fact that they were often buried before their landfill, the site's age (closed 9 years ago) and the available surface for gas migration, we can expect not to have a notable presence of gas on this site.

c. Leachate Production

Considering the infiltration rate of the rainwater in the site as equal to the exit rate of leachate from waste, only a very approximative estimate of the leachate production can be given.

According to the Canadian Hydrological Atlas, the average annual rainfall in the Mistassini area is 800 mm. The dump area is about 450 m^2. Starting from a coefficient of infiltration of 0.5 which takes into account a gentle slope and a cover layer made of sand and soil, the annual quantity of leachate produced by the site could be in the range of 200 m^3. Most of this leachate is directly captured through surface run-off by the two adjoining creeks, the remaining leachate going by infiltration into the ground water also in contact with the creeks.

9. Summary - Conclusions

The site 02-01-01 used to be the disposal site for the residents of the Mistassini Reserve. A relatively small volume of waste (675 m^3 of domestic waste, construction waste, hulks, etc.) was deposited, burned and then covered with sand and earth. The site was closed 9 years ago and the waste is considerably decomposed.

The underlying ground is constituted of a thick layer of little permeable till. A portion of the waste is directly in contact with the water table. The leachate is mostly found in the two creeks bordering the site and flowing in a south-west direction towards Lake Mistassini, located about 200 m from the site.

The analysis of the water quality shows that the surrounding area is only slightly influenced by the site's presence. Therefore, this site is not a problem and does not require any action to be taken on the basis of the analysis results obtained.

The site has been properly closed except for some remains which are partially visible. Its access though, like any closed disposal site, should be restricted.

In the light of the collected data, this site does not deserve anymore its intervention priority 1, which it has received during the 1982 inventory. Phase 3 of the federal control program does not apply for this site.

10. Recommendations

Even though the site does not require immediate attention, it is recommended to make another quality control of the water in order to follow the evolution of the organic charge. Also, considering the doubtfull water level surveys recorded in the boreholes, they should be taken again and the equipotential lines of the site sketch should be verified.

A few recommendations concerning the closing of the dump: first, a fence should be erected at the site entrance and "No Enter" and "No Salvage" signs should be posted; the metallic remains should be recovered or transported to an active site.

Finally, local authorities should notify Environment Canada before carrying out the housing project planned in the surroundings of the site.

4.2 Mistassini Reserve - Site 02-01-02

1. History

Active since 1975, this site is presently used as a waste disposal area by the Mistassini Reserve's 2 200 residents. The site is owned and operated by the Reserve Band Council.

The disposal site is a deforested area where domestic waste, metallic hulks, tires, wood, etc. are buried.

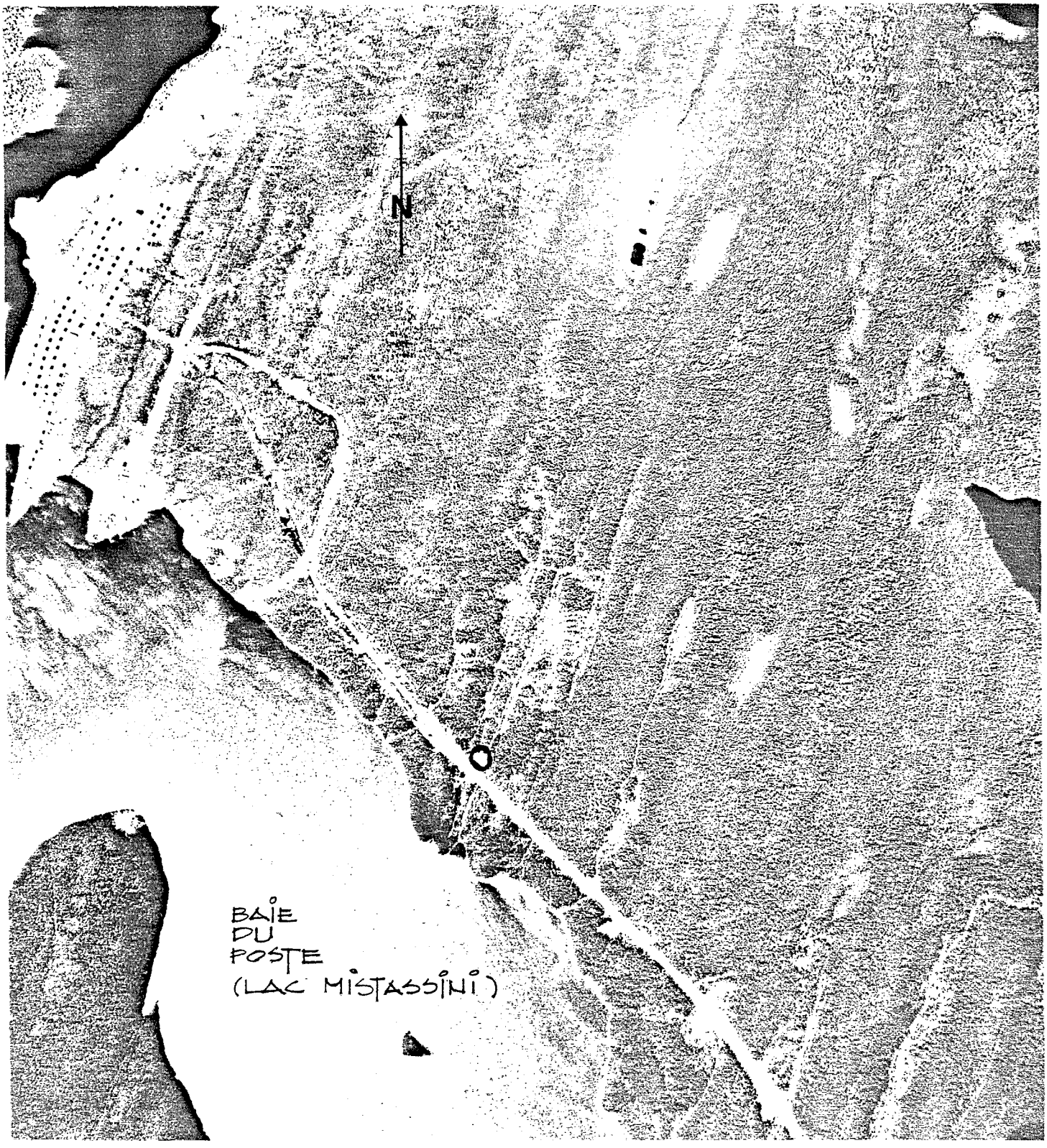
At the time of the 1982 inventory, the site had been classified as an intervention priority 1 for the following reasons: proximity of a drinking water source (1 km) and of Lake Mistassini (200 m), and the presence of an observable percolation on the site. The drinking water source is in fact the water intake pipe located in lake Mistassini.

2. Location and Access

The site is located 2 km south-east of the Mistassini Reserve village and 0.5 km of the old site (02-01-01). It can be reached by the village road from which it is visible, being about 10 m off the road. Lake Mistassini is located about 300 m north-west of the site. There is free access to the site and no fence to limit it. The following map presents the site location.

3. Work on Site

Only two (2) drillings were made on this site. The borehole #1 is located within the limits of the disposal site while borehole #2 is located upstream near the site entrance. The respective depths of each drilling are 8.53 and 7.16 m. A piezometer was set up in each borehole.



MISTASSINI - DÉPOTOIR ACTUEL NO 02-01-02 EXISTING DUMP

ÉCHELLE
SCALE 1:15840

Ground water could not be sampled in spite of the installation of piezometers; the water level had stabilized itself too deep, which made it impossible to collect any.

Three (3) samples were used to characterize the surface water. The first one came from a station located upstream and the two others were taken downstream from the site near the road of the reserve.

Surveying was done according to an arbitrary bench mark located on the left of the site entrance, which consisted in the bottom of a big rock.

A site sketch with the location of the work on site is presented on the following page.

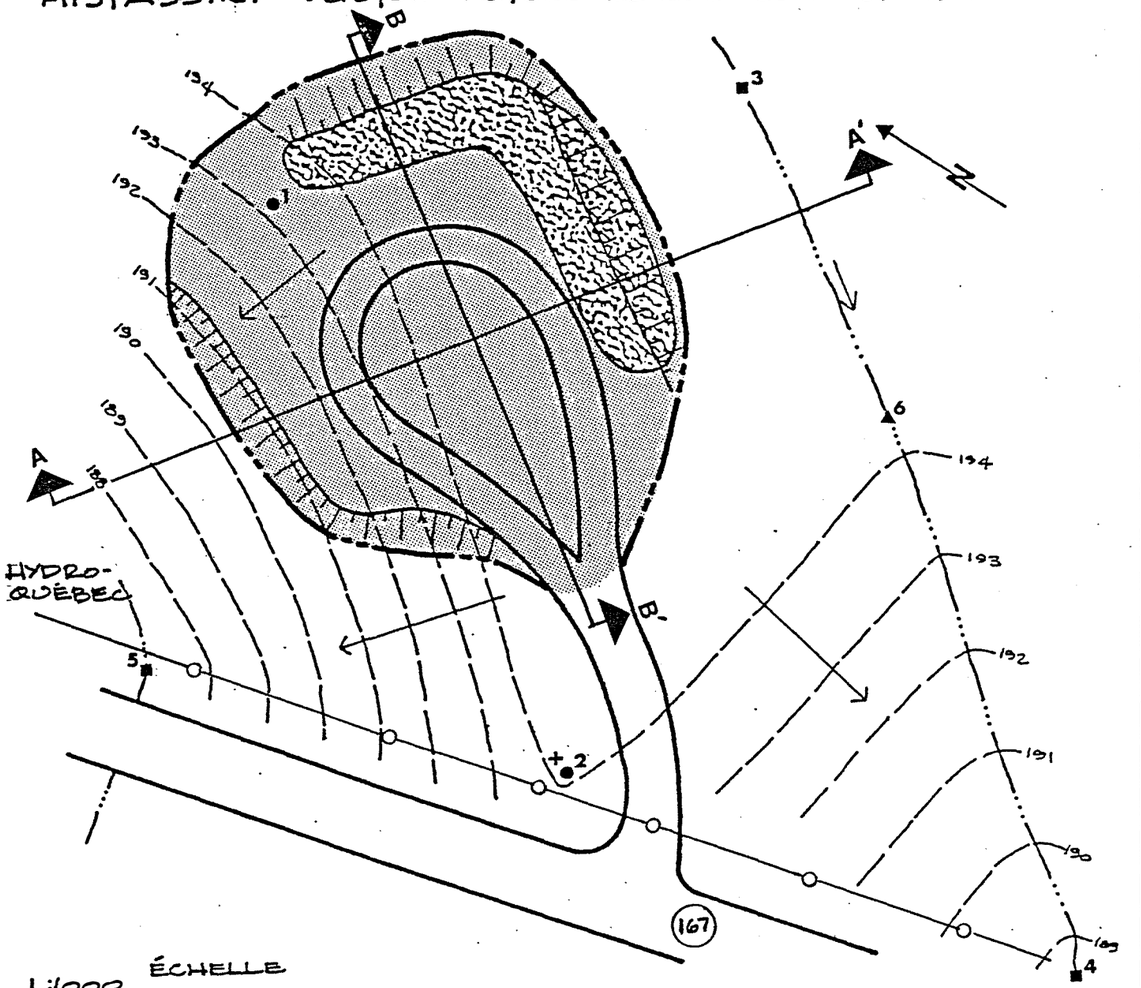
4. Physical Characteristics

The site occupies a 1 500 m^2 surface. The disposal area forms a plateau about 2.5 m higher than the original ground, but of the same level as Route 167. The disposal area and the original ground are very slightly sloping from north-east towards south-west. At the lowest point starts a small creek which crosses under the road and leaks through an uninhabited forested area towards lake Mistassini located 300 m away. Another small stream follows the site in its eastern section.

The site is surrounded on the north side by arborescent vegetation; its undergrowth is characterized by the presence of Groenland lichen and sphagnum; and on the east side, by a strip of gramineous plants followed by original woods. The natural ground is relatively marshy and peaty.

SCHÉMA DU SITE
SITE SKETCH

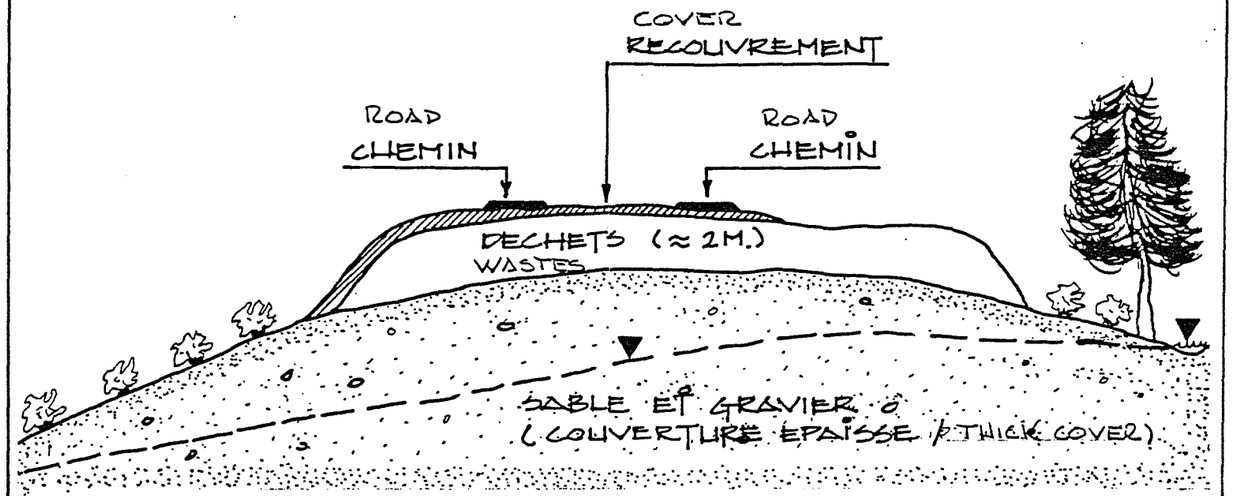
MISTASSINI - DÉPOTOIR ACTUEL No 02-01-02 EXISTING DUMP



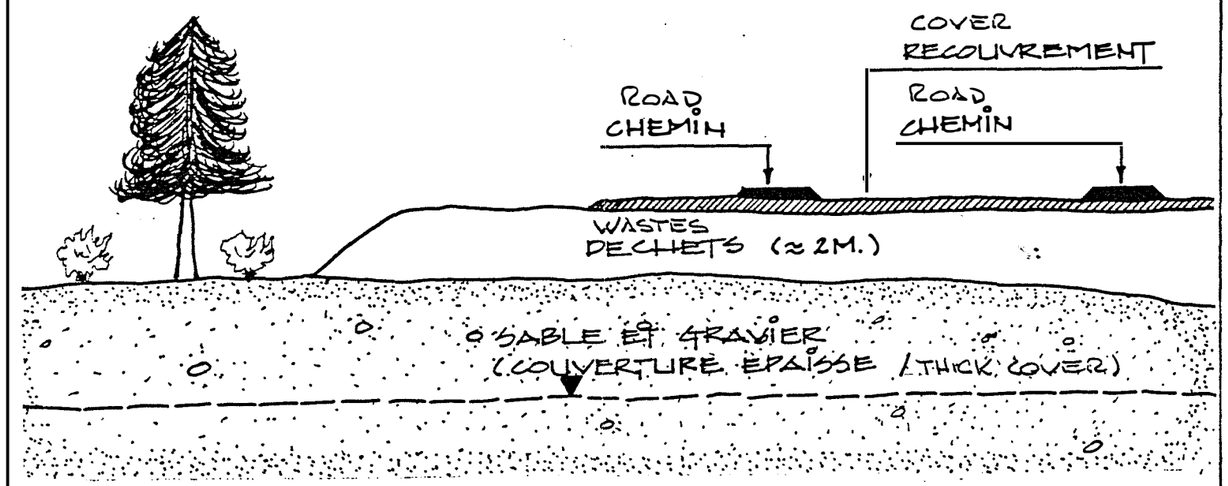
1:1000 ÉCHELLE SCALE

LÉGENDE LEGEND

LIMITE DU DÉPOTOIR	▬▪▬	DUMP LIMIT
ROUTE	═══	ROAD
ESCARPEMENT	┬┬┬	ESCARPMENT
DÉCHETS NON RECOUVERTS	▒▒▒	WASTES NOT COVERED
RUISSEAU	——··——	CREEK
(ÉL 200,00 m) B.M. ARBITRAIRE	+	ARBITRARY BM (EL 200,00 m)
FORAGE	●	BOREHOLE
ÉCHANTILLON D'EAU DE SURFACE	■	SURFACE WATER SAMPLE
LIGNE ISOPIÈZE	—190—	EQUIPOTENTIAL LINE
NIVEAU D'EAU DE SURFACE MESURÉ	▲	190 m SURFACE WATER MEASURE LEVEL



COUPE A-A
SECTION



COUPE B-B'
SECTION

5. Geological Characteristics

None of the drillings reached the bedrock. They went throught granulated material composed of sand and gravel.

The average value resulting from permeability tests conducted in the piezometers is 6.1×10^{-5} cm/s. However, considering the coarse nature of the soil, the validity of the these results are questionable. We think that the permeability tests should be conducted again, now that a reasonable period of time has gone by since the drillings. With the nature of material involved, a permeability in the region of 10^{-3} cm/s should be expected.

6. Hydrological Characteristics

The drillings have reached the water table, at depths of respectively 5.8 and 6.2 m. There does not seem to be any direct contact between the waste and the water table.

The surface is drained by two (2) depressions, one on each side of the site. An outflow source of ground water has been noticed at the water sampling station #5. The equipotential lines, which were drawn from water level survey results obtained in the boreholes and on the site, show that the ground water underneath the disposal area locally flows in a north-west direction. The calculation of the average horizontal velocity of the water gives a value in the region of 10 m/year. As this value depends on the coefficient of permeability, it is also questionable. In the case where new permeability tests would indicate higher permeability, the flow velocity would be proportionally as high, considering the important hydraulic gradient observed at this place.

The general water flow in the area goes in a south-west direction towards lake Mistassini.

7. Disposal Method and Nature of Waste

The site was first opened by deforesting the planned area. Then, the disposal began according to the bank method, pouring a 2 m-thick layer of waste from the access road towards the north-east.

Today, two (2) disposal methods are used. The first one consists in pouring the waste along the road of the site. Later, the waste is partially burned then pushed with a loader along the slope of the bank. It is thus accumulated in the open until recovered with sand and gravel. This recovering operation is usually done twice a year. The second method requires the digging of a trench which is then progressively filled with waste. The trench is recovered when it is full. The total volume of waste accumulated in the site is approximately 3 000 m^3.

The access to the site is not yet restricted and the site is visible from Route 167 which leads to the reserve. There is no water or gas control or retention system.

No problem as such is created by the use of two disposal methods (bank and trenches) but the recovering of waste is deficient, specially on the banks (recovered two times per year).

Also, waste should not accumulate on top of the site for more than a day. At the end of each day, it should be disposed with one method or the other and recovered. Waste combustion is dangerous for health and security reasons when it is carried out in the open as on this site; therefore, this practice should be abandoned. Finally, access to the site should be limited, at least during darkness, in order to avoid accidents.

8. Analyses Results

a. Water Quality

Water analysis results are presented on the following page.

The site being located on sand and gravel and the water being at 4 m under the waste, it could be expected to find a relative contamination of the water table by infiltration through the waste (with an outflow at the north-western station #5) or by surface run-off towards the creek at the east.

However, analysis results of surface water show that generally, the contents recorded respect the guidelines on the protection of aquatic life and that the site is not a problem as such. This can be said because the results indicate that contents do not increase from upstream to downstream in the creek bordering the site. It can also be noticed that, as it has been mentioned for site 02-01-01, the natural contents of nitrogen in water found in the undergrowth are superior to those deriving from the presence of the site. Consequently, these contents are probably part of the reason why such values were recorded for the COD at stations #4 and #5.

b. Gas Analyses

No gas was detected by the explosimeter. No CO nor CO_2 survey was taken with the manual pump. A small gas production must be expected because of the limited depth of waste in relation to the available migration area that creates an almost nil retention of gas in the ground.

Name of site: MISTASSINI
Site number : 02-01-02

SURFACE AND GROUND WATER
ANALYSTS RESULTS

ANALYSES	SAMPLING STATIONS ■ 3	■ 4	■ 5				
SAMPLING DATE	21-10-83	21-10-83	21-10-83				
pH	6,8	7,0	6,8				
Alkalinity (mg/l)	20	40	30				
Conductivity (µ mhos/cm)	72	84	83				
Hardness (mg/l)	20	40	50				
Chloride (mg/l)	<0,1	<0,1	<0,1				
SO_4 (mg/l)	7	8	7				
PO_4 (mg/l)	-	-	-				
NO_2 (mg/l)	0,010	0,010	0,010				
NO_3 (mg/l)	0,64	3,68	6,25				
Redox potential (millivolts)	485	478	494				
Dissolved solids (mg/l)	72	76	85				
TKN (mg/l)	2,4	0,98	0,7				
NH_3 (mg/l)	0,16	<0,14	<0,14				
COD (mg/l)	31	31	38				
TOC (mg/l)	11	11	13				
Ca (mg/l)	5,0	6,0	5,0				
Mg (mg/l)	-	-	-				
BIOTEST							
Algae (toxic units)	<1,1	<1,1	<1,1				
Microtox (toxic units)	<2	<2	<2				

■ Surface Water

-: N.A.

c. Leachate Production

The leachate production rate on the site can only be calculated approximately, the available data being insufficiant and uncertain.

Supposing that the only percolation water supply comes from the infiltration due to rain and that the leachate production rate is equal to the infiltration rate, a volume of 700 m^3 per year can be produced by this site. The annual mean precipitation averages 800 mm and the surface of the site is 1 500 m^2. Taking into account a gently sloping land and a partial cover of sand and gravel on the site, the coefficient of infiltration used was 0.6.

Considering the coarse nature of the underlying ground, most of this leachate is found gradually during the year in ground water; an overflow source was noted near the road (station #5).

9. Summary - Conclusions

The site 02-01-02 is the disposal area presently in use in the Mistassini Reserve. Since 1975, domestic waste, metal hulks, tires, wood, etc. has been deposited on the site by the reserve's 2 200 residents. The waste is burned in open air and occasionally covered, then, it is buried following the bank and trench methods. To improve the site's operation, it is necessary to eliminate combustion, cover the waste daily and finally, to control the access to the site which, for now, is free.

The site was laid out on sand and gravel. The high water table is located about 4 m underneath the waste. On the east side, a creek drains part of the runoff coming from the site towards the south. Water that becomes contaminated by infiltration through the waste is discharged into the subjacent high water table which, at that place, flows in a north-west direction with a high hydraulic gradient.

However, water analysis results show that generally, the contents recorded do respect the guidelines on the protection of aquatic life and thus, the site in itself is not a problem.

In short, the site does not present any imminent environmental dangers (priority 1), as noted at the time of the inventory, but its operation should be optimized. There is no need to proceed to phase 3 of the federal control program for this site.

10. Recommendations

Permeability test and water level results are questionable and they should be redone to verify their validity. There is reason to keep a follow-up on water quality, specially at station #5, which seems to be an outflow source of ground water.

Recommendations on site management are the following:

- set-up a fence at the entrance to limit its access;
- stop the combustion of waste before its burying;
- bury the waste every day and cover it efficiently.

4.3 Kahnawake Reserve - Site 06-01-01

1. History

Since 1968, this site has been used by the Kahnawake Reserve population to dispose of domestic waste. Known as the "Municipal Dump", it is presently the only official site in operation on the reserve. It is owned by the Band Council, which has hired a permanent guard for the daytime and a pile driver operator.

About half of the area is already full and disposal is now taking place in the southern part of the site.

At the time of the 1982 inventory of landfill sites located on federal properties in Quebec, the site had received an intervention priority 2 because of the presence of a quarry filled with water at 120 m, and of an active private well at 300 m. Following a request by the Mohawk Band Council, approved by Environment Canada, the Phase 2 of the study program on waste disposal sites located on federal properties was applied to this site at the same time as intervention priority 1 sites.

2. Location and access

The site is located at the south-western limit of the village of the reserve, on the other side of Route 138, opposite an abandoned quarry, near the interchange of Route 132 connecting Châteauguay and the Mercier Bridge. At night, when the guard is absent, access to the site is free because there are no doors at the entrance. The site location on the reserve is presented on the following page.

KAHNAWAKE - SITE MUNICIPAL No 06-01-01 MUNICIPAL SITE

ÉCHELLE 1:40 000
SCALE

3. Work on site

There have been two (2) boreholes drilled with the mechanical auger (see site sketch). No piezometer were set up as the drillings were refused on the bedrock at less than 1.4 m deep, before reaching the high water table. Two (2) other drillings were tried around borehole #1 but they were refused at depths of 0.6 m.

Because the ground water was not reached during drillings, no sampling could be realized on the site. However, the active well located 300 m from the site was analyzed. Water in the quarry located on the other side of Route 138 was also sampled for analysis.

The arbitrary bench mark used for surveying corresponds to a point on a large cement block located on the left of the entrance dump.

The work on site is located on the following sketch.

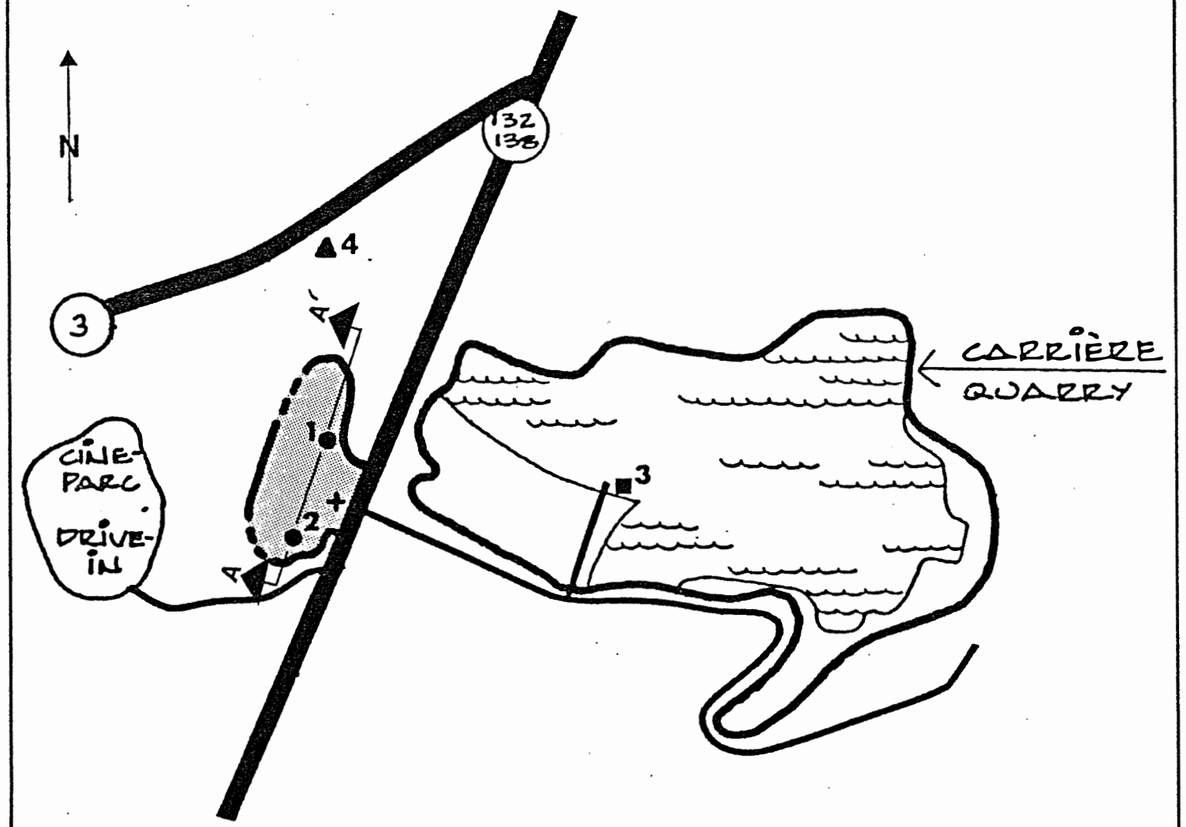
4. Physical Characteristics

The site is a piece of slightly sloping rectangular land located 2 or 3 meters lower than the bordering Route 138. It is surrounded by a barrier of shrubby and herbaceous vegetation and a few trees.

West of the site is a flat area where the rock is outcropping in several places. It may be added that this area was once used as a drive-in; the main building has burned down a while ago. About 120 m east from the site starts an important quarry whose activities have now ceased; the difference in level between the site and the water level of the quarry reaches about 20 m.

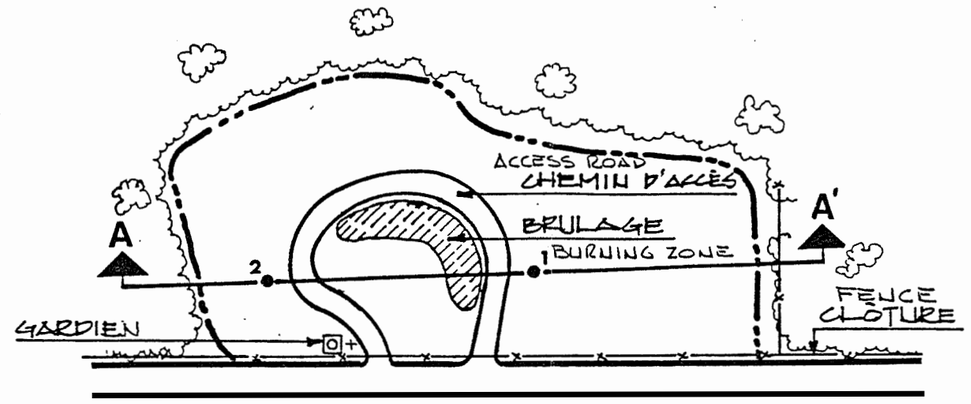
SCHÉMA DU SITE
SITE SKETCH

KAHNAWAKE - SITE MUNICIPAL No 06-01-01 MUNICIPAL SITE

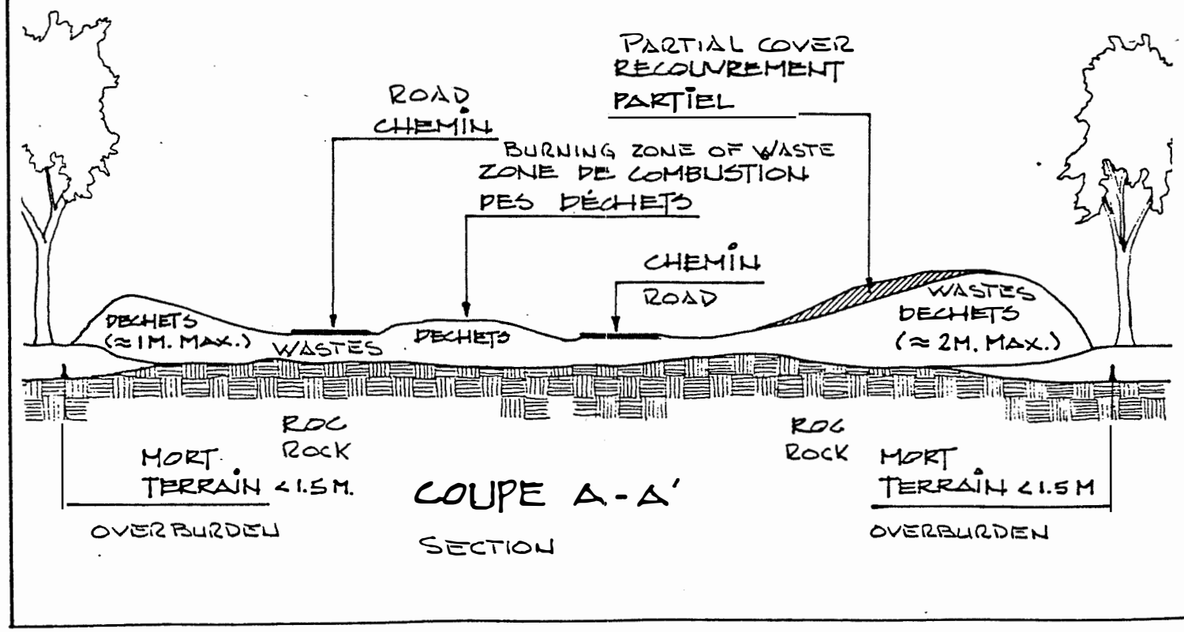


ÉCHELLE 1:7500
SCALE

LÉGENDE		LEGEND
LIMITE DU DÉPOTOIR	—·—·—	DUMP LIMIT
ROUTES	▬▬▬	ROADS
ZONE INONDÉE	▭	FLOOD ZONE
(ÉL. 300.00 m) B.M. ARBITRAIRE	+	ARBITRARY B.M. (EL. 300,00m)
FORAGE	●	BOREHOLE
ÉCHANTILLON D'EAU DE SURFACE	■	SURFACE WATER SAMPLE
PUITS	▲	WELL



VUE EN PLAN
PLAN VIEW



COUPE A-A'
SECTION

There are houses along Route 3 about 300 m north from the site and a few others north-east from Route 138 (> 250 m).

Finally, it should be mentioned that the site is partially visible from Route 132 and completely visible from Route 138.

5. Geological Characteristics

The two (2) boreholes drilled on the site have reached the bedrock at 0.91 and 1.37 m, going only through domestic waste.

The overburden is generally less than 1.5 m and consists principally of fill material. Rock is outcropping all around the site. It is constituted of sedimentary rocks of the Chazy group, which are generally good aquiferous for ground water. These rocks contain mostly stratified shale and grey limestone.

6. Hydrological Characteristics

The high water table was not reached by boreholes drilled on the site. The water contaminated by the site is drained in the stone quarry located east on the other side of Route 138. An hydraulic gradient is created in that direction by the quarry, the bottom of which is covered with water.

Several houses along Route 3 have a well. Only two (2) of these wells are still in use, one of which is owned by Mr. Ronald Deer and located 300 m north from the site. Water is drawn at less than 11 m deep. Based on the available information, the high water table should be located between 5 and 15 m underneath the site.

Because of their position according to the site and the quarry, these wells should not be contaminated by the waste.

7. Disposal Method and Nature of Waste

The site is a disposal area where waste is burned, and ashes and a few non-comestible remains are buried.

The preparation of the site consists in the removal of a 1- or 2-m layer of surface vegetation and material, which is then pushed on the sides of the site where it forms a scanty screen on the southern and western sides. The side, which occupies a 3.25-hectare surface, is fenced on the north side and along Route 138 where the entrance is. A guard in a cabin is on duty during daytime.

The residents of the reserve deposit at the center of the site mostly domestic waste which is burned in the open. This combustion causes odors and smoke which can sometimes affect the visibility on the adjoining road. The wind also scatters papers and rubbish in the surroundings.

A small bulldozer driver, permanently on the dump, is used to push ashes and remains at the end of the site and to occasionally recover them with soil. In the northern part, the site is already full and the waste is 2-m thick while in the active southern part, burned material is 1-m thick. A shrubby and herbaceous vegetation is regenerating on the recovered section.

Site operation does not meet environmental standards. Waste cover is deficient and the combustion in inacceptable from a security and a pollution point of view. The site is well delimited by vegetation and a section of fence but this fence is too low to prevent papers from crossing over. It's access should be controled when no guard is present.

8. Analysis Results

a. Water Quality

Analysis results are presented on the following page.

Analysis results of the water in the quarry, which drains the water table, does not reveal any contamination. It is to be noted however that considering the important volume of water found at the bottom of the quarry, the sample is not representative of ground water outflowing from site. The well located north of the site along Route 3 respects quality standards for drinkable water. Consequently, the site does not appear to present any imminent risk for potable water quality, as sampling does not show any contamination induced by the site. To ascertain these results, it should be necessary to drill into the rock in order to reach the water table.

b. Gas Analyses

Gas concentrations surveyed with manual pump were 350 ppm for the CO_2 and nil for the CO. All measures given by the explosimeter were negative.

Considering the small volume of waste, their combustion and the available migration surface, an almost nil retention of gas in the ground should be expected.

c. Leachate Production

An approximative estimate of the leachate production can be made by supposing that the volume of leachate produced by the deposit is equal to the volume of rain which infiltrates and percolates through it.

Name of site: KAHNAWAKE
Site number : 06-01-01

SURFACE AND GROUND WATER
ANALYSTS RESULTS

SAMPLING STATIONS

ANALYSES	■ 3	▲ 4					
SAMPLING DATE	28-10-83	22-11-83					
pH	8,0	-					
Alkalinity (mg/l)	130	-					
Conductivity (µ mhos/cm)	590	-					
Hardness (mg/l)	190	277					
Chloride (mg/l)	1,70	-					
SO_4 (mg/l)	200	30					
PO_4 (mg/l)	-	-					
NO_2 (mg/l)	<0,005	<0,002					
NO_3 (mg/l)	0,77	9,9					
Redox potential (millivolts)	302	-					
Dissolved solids(mg/l)	503	364					
TKN (mg/l)	0,80	<0,14					
NH_3 (mg/l)	<0,14	<0,14					
COD (mg/l)	7	<4					
TOC (mg/l)	2,9	2,5					
Ca (mg/l)	43	99					
Mg (mg/l)	-	7,2					
BIOTEST							
Algae (toxic units)	<1,1	<1,1					
Microtox (toxic units)	<2	<2					

■ Surface Water

▲ Well

-: N.A.

Considering the hypotheses presented in section 3.3.4, a disposal area of 22 500 m^2, a coefficient of infiltration of 0.5 which takes into account the slope of the ground, the partial recovering of waste and an average annual precipitation of 950 mm, taken from the Canadian Hydrological Atlas, a volume of leachate in the order of 10 000 m^3 can be produced each year by the site. Most of this leachate probably runs with a high vertical gradient underneath the site to eventually reach the high water table located in the rock.

9. Summary - Conclusions

The site 06-01-01 has been the "municipal dump" of the Kahnawake Reserve for the last 12 years and is the only one operating officially. The waste brought on the site by the population is burned, the pushed in a bank by means of a small bulldozer. During daytime, a guard supervises the site.

The site is established almost direclty on bedrock. Waste remains do not have any contact with the high water table, which should be located 5 to 15 m deep. Rainwater contaminated by contact with the site infiltrates through the fracture network of the rock down to the water table where it is diluted and probably forwarded towards the quarry located east, immediately on the other side of Route 138.

No contamination was detected by analyses of the water in the quarry and in a drinking water well located near the site. However, as there is a high hydraulic gradient towards the quarry, only boreholes in the rock would allow to find any contamination resulting from the site.

Site management is unacceptable from an environmental point of view. The combustion of the waste provoques air pollution and is dangerous (fires, reduced visibility on the adjoining road, etc.). The burned waste is deposited on a fractured rock and leachate cannot be recovered. Furthermore, the covering of the waste is insufficient, specially the final cover, as can be seen in the area already filled. The site is well fenced and delimited by the earth bank, but access should be monitored when the guard is absent.

In short, the intervention priority 2 given to the site at the time of the 1982 inventory is still valid regarding immediate danger; the site management, however, should be modified as soon as possible in order to meet environmental standards.

10. Recommendations

Taking into account the uncertainty concerning contamination generated by the site, waste management and the type of site as such, a short-term closure is recommended. If no other site is available on the reserve, an environmental impact should be expected; however, this impact could be reduced by eliminating combustion in the open by burying the waste and by recovering it every day, and by limiting access to the site. Nevertheless, a middle term solution should be planned and the life of the site considerably reduced.

To assess the contamination level of the water table would necessitate the setting up of piezometers in the rock. In view of drilling costs involved for such an installation, a regular monitoring of active wells could constitute an acceptable solution.

4.4 Kahnawake Reserve - Site 06-01-02

1. History

This site is an open dump owned by the Morris estate and located on the Kahnawake Reserve. It appears that the site was operated by Mr. Tom Morris from 1975 until his death in 1981. Officially, the site is closed, but between 1981 and 1982, the widow of Mr. Morris would allow waste disposal, with no regard for its contents, and collected a fee for each load. Since then, activity appears to have completely ceased.

The site was classified as an intervention priority 1 at the time of the 1982 inventory mainly because it is adjacent to a creek, to a swamp and to the owner's house whose water is supplied by a well.

Since then, the residents have left the house and consequently, the well is not used anymore.

2. Location and Access

The site is located along the St-Bernard road about 6 km west from the village of the Kahnawake Reserve. It is delimited on each site by two parallel dirt roads leading to houses located along Lake Saint-Louis, about 2 km from the site. Acces to the site is free and easy by the St-Bernard road. Site location is presented on the following map.

KAHNAWAKE - SITE MORRIS No 06-01-02 MORRIS SITE

ÉCHELLE
SCALE 1:40000

3. Work on Site

Four (4) boreholes have been drilled on the border of the site by means of a mechanical auger (see site sketch). A piezometer was set up in each borehole, except in borehole #2A.

Ground water analyses were conducted on samples from three (3) stations with piezometers, one upstream and the two others downstream. Two (2) stations were used for surface water sampling, the first one located at the swamp in the northern part of the site, and the second one in the creek crossing west. No sampling of the domestic well was taken because the house located near the site has been abandoned a year ago and two summer cotages located along Lake St-Louis, downstream from the site, were closed during the sampling period.

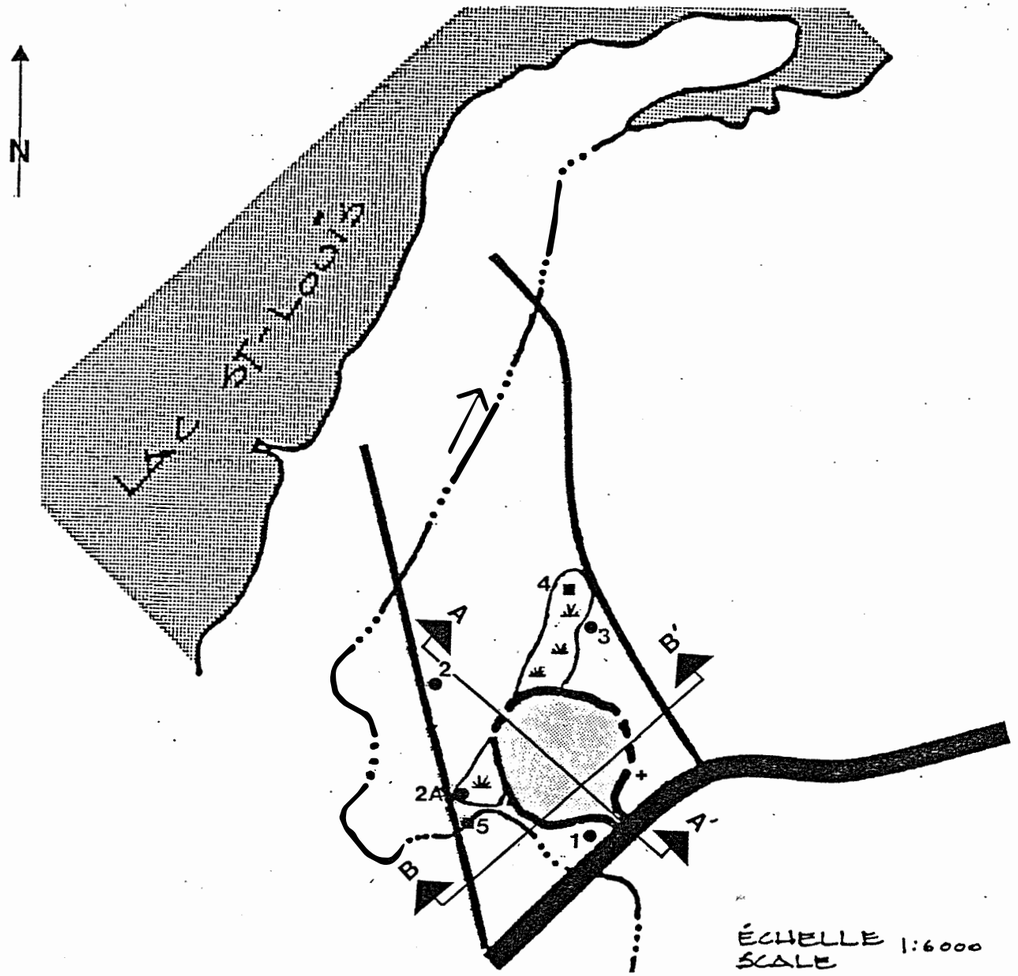
The top of a rock, located in front of Mrs Morris' house, south-east from the site, has been used as the arbitrary bench mark for surveying.

4. Physical Characteristics

Previously, the site was probably a marshland depression bounded by the three (3) roads mentioned above. A small creek with a very low flow goes through the site from south to north, and crosses the roads leading to Lake Saint-Louis.

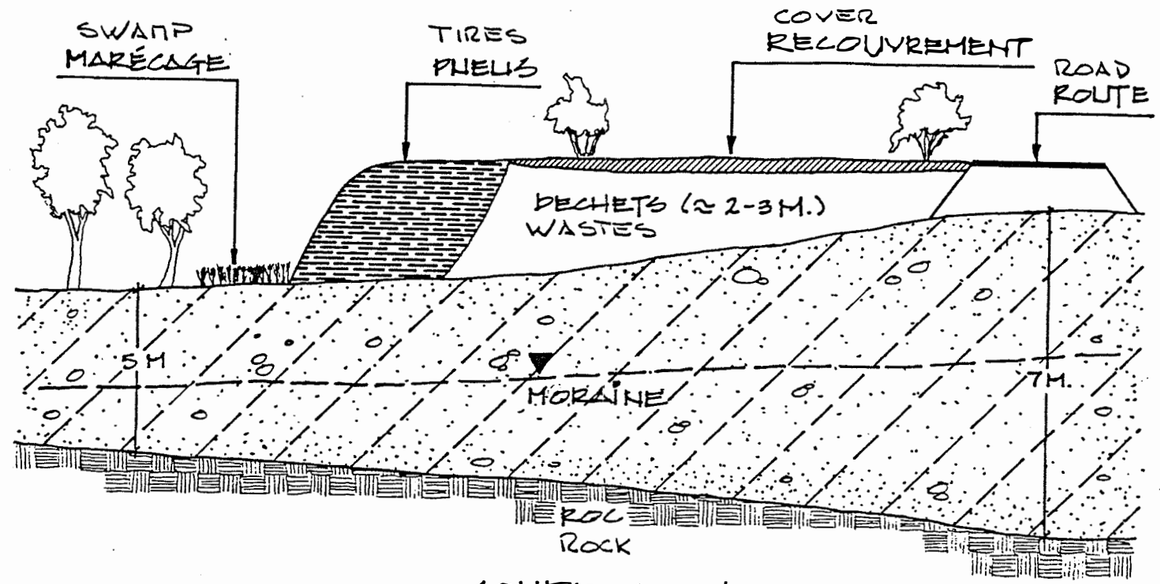
The actual land consists of a flat area with the same elevation as the adjoining roads. North, the site ends in a steep slope leading to a swamp located 3 meters lower. The demarcation line between the site and the swamp consist of a strip of piled-up tires in the open. The north-east part of the original ground is relatively flat and low until the Lake St-Louis surroundings, where it slightly goes up.

KAHNAWAKE - SITE MORRIS No 06-01-02 MORRIS SITE

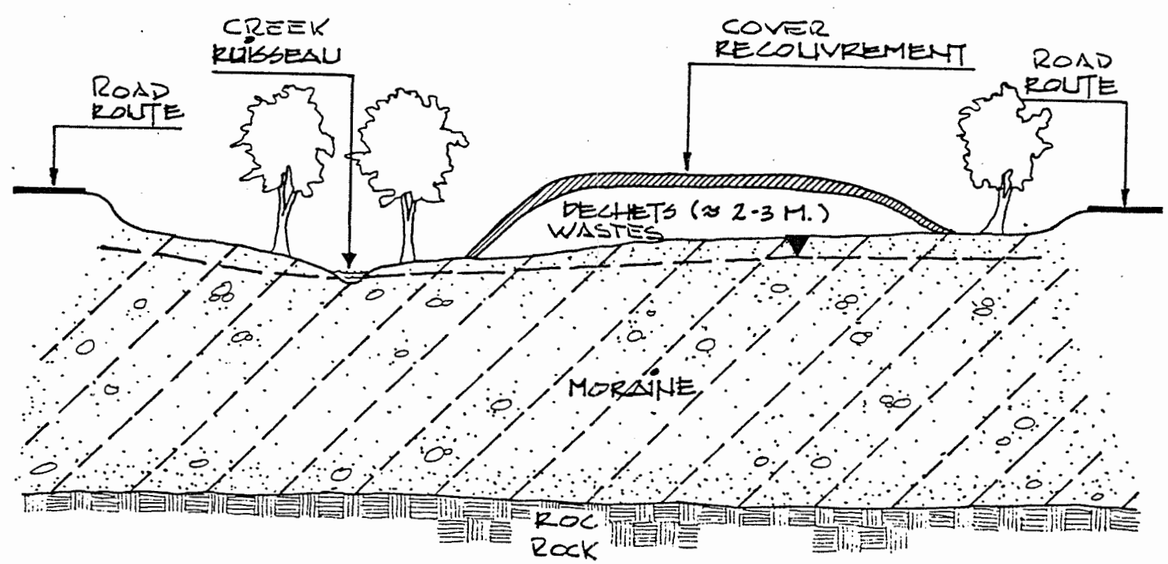


ÉCHELLE 1:6000
SCALE

LÉGENDE		LEGEND
LIMITE DU DÉPOTOIR		DUMP SITE
ROUTES		ROADS
LAC		LAKE
MARÉCAGE		SWAMP
RUISSEAU		CREEK
(ÉL. 200,00 m) B.M. ARBITRAIRE	+	ARBITRARY B.M (EL. 200,00 m)
FORAGE	●	BOREHOLE
ÉCHANTILLON D'EAU DE SURFACE	■	SURFACE WATER SAMPLE



COUPE A-A'
SECTION



COUPE B-B'
SECTION

5. Geological Characteristics

The depth of boreholes varied between 1.68 and 6.68 meters. Boreholes #1, #2A and #2 have reached refusal, probably on the bedrock, at respective depths of 6.68, 1.68 and 5.64 m.

The overburden of the site is composed of till containing local granular strata. The composition of the till varies from gravelly sand with some silt to silt with traces of sand and gravel.

Permeability tests conducted in the piezometers result in an average permeability, for the till, in the region of 1.3×10^{-4} cm/s. Hence, the till adjacent to the site can be considered as little permeable.

6. Hydrological Characteristics

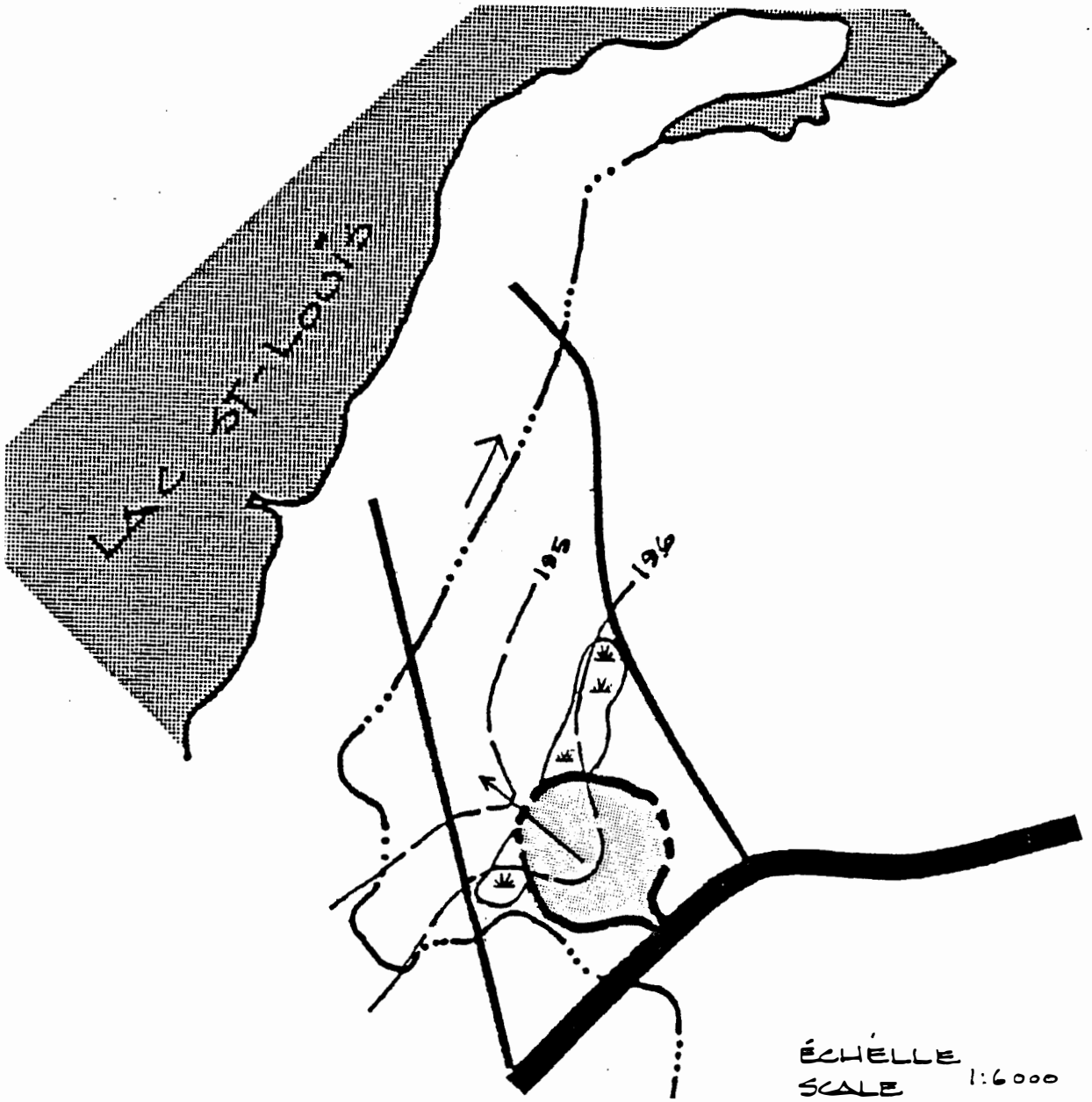
Surface water is drained by a creek running on the west side of the site, towards Lake St-Louis.

According to the equipotential lines drawn from the water level surveys, the ground water flows in a north-west direction, also towards Lake St-Louis (see sketch). An horizontal flow velocity in the region of 15 m/year was calculated.

The high water table was reached in boreholes #1, #2 and #3, with depths varying between 3.4 and 4.1 m. The northern part of the dump is resting on a swamp, which seems to be constituted of a perched water table according to water level surveys.

SCHÉMA DU SITE
SITE SKETCH

KAHNAWAKE - SITE MORRIS No 06-01-02 MORRIS SITE



LÉGENDE		LEGEND
LIMITE DU DÉPOTOIR		DUMP SITE
ROUTES		ROADS
LAC		LAKE
MARÉCAGE		SWAMP
RUISSEAU		CREEK
LIGNE ISOPIÈZE	195 m	EQUIPOTENTIAL LINE

7. Disposal Method and Nature of Waste

This site contains 2 to 3 m of construction waste, tires and hulks which have been deposited on the surface of the ground and partially in a swamp. About a dozen automobile hulks, on the surface or partially buried, and about 20 000 tires deposited for the greatest part in the open, have been counted.

It appears that filling was carried out with the construction waste, first along the St-Bernard road, then gradually towards the north, keeping the same site level. The last step would have consisted in depositing tires to form a 10 m-wide band directly in a northern swamp. The difficulty to circulate on the non-recovered tires and the ceasing of operatiions when the owner died have probably prevented the extension of the disposal area.

The closing procedure does not meet the recognized standards. The tires could be buried but experience has shown that they tend to reappear at the surface after some time. Other disposal techniques presently available (shredding, recycling, combustion in cement kilns, etc.) are very expensive and the demand for such a product very limited. Moreover, the Quebec Government presently advocates a temporary solution consisting of storing the tires in separate heaps in order to better control a possible fire. In this case, it is preferable to leave the tires on the site, taking the necessary measures against fire on the whole site, instead of moving the problem to another site.

Construction waste and automobile wrecks should be taken away or at least buried for the former, because of fire and security hazards.

8. Analysis Results

a. Water Quality

Chemical and toxicological water analysis results of ground and surface water samples are presented on the following page.

Chemical analysis results of ground water indicate for all stations, hard water with a high calcium concentration. Appreciables quantities of nitrogen were detected in the upstream borehole (high TKN). The TKN indicates which amount of ammonia and organic nitrogen, both contained in nitrogeneous organic waste, is present. In the two downstream boreholes, the high value obtained for the COD (added to the higher level of TOC at station #2) indicates the presence of organic and reducing matter in the water. Furthermore, the nitrate concentrations (NO_3) obtained for station #2 are appreciable, which suggests the disposal of organic matter on the site (the nature of it cannot be revealed by the present analyses). The calcium level obtained for borehole #3 is probably too highly estimated and due to an analysis or a sampling mistake.

Analyses show that surface water is also hard, specially in the creek. The northern swamp shows high contents for TKN, COD and COT, indicating the presence of organic matter. Conductivity values and high sulphate contents in the creek could come from the anaerobic decomposition of organic matter. There is no doubt that surface water is affected by the disposal site since the NH_s, SO_4 and COD levels exceed the quality standards for aquatic life of Environment Canada (appendix).

Name of site: KAHNAWAKE
Site number : 06-01-02

SURFACE AND GROUND WATER
ANALYSTS RESULTS

ANALYSES	SAMPLING STATIONS					
	● 1	● 2	● 2	● 3	■ 4	■ 5
SAMPLING DATE	28-10-83	28-10-83	22-11-83	28-10-83	28-10-83	28-10-83
pH	6,9	7,5	7,5	7,4	7,1	7,4
Alkalinity (mg/l)	400	290	-	300	180	400
Conductivity (µ mhos/cm)	1600	500	-	500	450	1490
Hardness (mg/l)	300	300	360	240	310	620
Chloride (mg/l)	5,20	3,30	-	0,50	0,30	0,90
SO_4 (mg/l)	80	130	-	90	200	7300
PO_4 (mg/l)	-	-	-	-	-	-
NO_2 (mg/l)	0,011	0,022	<0,005	0,015	<0,005	0,017
NO_3 (mg/l)	0,84	0,84	7,00	0,40	0,40	0,49
Redox potential (millivolts)	306	276	-	282	309	313
Dissolved solids(mg/l)	858	439	R	407	971	440
TKN (mg/l)	2,5	-	<0,14	3,3	15,3	2,1
NH_3 (mg/l)	0,35	-	<0,14	0,18	<0,14	<0,14
COD (mg/l)	68	142	77	271	352	27
TOC (mg/l)	15	33	13	75	80	10
Ca (mg/l)	107	163	103	900	79	155
Mg (mg/l)	-	-	25,0	-	-	-
BIOTEST						
Algae (toxic units)	8,9-17,9	1,1-2,2	-	4,4-8,9	1,1-2,2	1,1-2,2
Microtox (toxic units)	<2	<2	-	<2	<2	<2

● Borehole
■ Surface Water

R: Analysed but rejected by the laboratory
-: N.A.

Algae test results vary between 8.9 and 17.9 toxic units for boreholes water. There is no reason to think that this water represents a potential danger for the environment. There is no apparant toxicity in other stations but it is possibly concealed by the hardness of the water. Another ecotoxicological assessment of this water should therefore be undertaken.

To sum up, calcium and hardness values are high for all water on site, which indicates a probable disposal of organic matter. Hence, the possibility of implementing a more complete and diversified quality control analysis program should be considered in order to confirm or refute the high values obtained for TKN, COD and TOC (and for NO_3 at station #2).

b. Gas Analyses

Gas surveys, taken by means of a direct reading manual pump, showed a 400 ppm value for the CO_2 and a nil value for the CO. Explosimeter analyses (inflammable gases) indicated nothing.

The fact that a large part of the deposit is in the open prevents gas retention. Furthermore, the type of waste usually disposed on this site (construction materials, tires, etc.) is not a source of gas formation by decomposition.

c. Leachate Production

A very approximative estimate of the leachate production can be forwarded by assuming that its only source comes from rain which infiltrates through the deposit.

Considering a disposal area of 20 000 m^2, an average annual precipitation of 950 mm and a coefficient of infiltration of 0.6 which takes into account the flatness of the land and the non-covered waste, a leachate production in the region of 10 000 m^3/year can be estimated. This leachate flows towards the north-west in the high water table, the swamp and the creek.

9. Summary - Conclusions

The site 06-01-02 site is a small (about 2 hectares) and abandoned site owned by the Morris estate. For six years, it was used to fill a depression along the St-Bernard road, mainly with construction waste. Several automobile hulks can be found on the site and at one end, a noticeably large volume of tires (about 20 000) is disposed in an open-air swamp.

The underlying ground is constitued of little permeable till whose depth varies between 2 and 7 meters. The water flows towards Lake St-Louis. According to results obtained in the piezometers, an horizontal velocity of the ground water in the region of 15 m/year has been calculated.

The analysis of surface and ground water quality shows high contents for parameters indicating contamination resulting from the presence of organic matter. Furthermore, ecotoxicity tests show that ground water constitutes a potential danger for the environment. The site, therefore, is causing a noticeable impact on the environment and presents an environmental hazard.

The closing of the site is inadequate. The presence of construction waste and tires constitutes a possible fire hazard. Also, access to the site should be limited for security reasons and because of the quality of its surface water.

In conclusion, the intervention priority 1 established at the time of the 1982 inventory is fully justified and the site should be closely monitored because of its potential risk for health and environment. The third step of the federal control program should be undertaken for this site.

10. Recommendations

High contaminant contents, toxicity levels and variations between stations and/or parameters require a verification undertaken with Phase 3 of the federal control program. This Phase 3 should include the wells of summer cottages located near Lake St-Louis. If the new sampling confirms an existing contamination, there is good reason for additional boreholes and analyses to identify the extent (surface and deepness) of this contamination and the natural contents of the area. Of course, it would be important to regularly measure the water levels in all piezometers.

Concerning the closure procedure of the site, additional measures should be taken. First, construction waste should be recovered (or taken away) because they constitute a fire hazard; the presence of tires would make it difficult to control such an event. Vehicules hulks on the site and partially buried should be moved to another site or recycled, specially the oil truck that lies half buried in the swamp. The village's firemen should be informed of the nature of the buried waste and of possible accesses in case of fire; on this last point, the site entrance of the St - Bernard road should be closed by a fence or a cable and the fire men should have the key. Access being difficult to control for pedestrians by the lateral roads, "Danger - Polluted Water" signs should be posted near the creek and the swamp.

As for the tires, there is no short-term technical solution. For now, they should be left on the site and contact should be made with possible recycling companies.

4.5 Kahnawake Reserve - Site 06-01-03

1. History

This disposal site is owned by Mr. Lewis Beauvais and the Bordeaux family. According to the available information, it was operated by Lasalle Refuse Inc. from 1974 to 1975, then by Beauvais Refuse Inc. from 1975 and 1978. Mostly domestic waste was unloaded on this site without any beforehand control; furthermore, the waste was directly poured into ponds and creeks in order to eventually level the ground.

The site has not been used since 1978 following complaints from Châteauguay inhabitants, in addition to other existing problems (inadequate management, animals, odors, etc.). These complaints intensified after a fire occured on site 06-01-04, which had led to the theorical closing by the Band Council of all sites located on the reserve. The western part of the site was operated from 1974 to 1975 and the eastern part from 1974 to 1978.

At the time of the 1982 inventory of disposal sites on federal properties in Quebec, the site was given an intervention priority 1 mainly for the following reasons: presence of ponds and humid soils at its boundaries and proximity (500 m) of a private well. Since the inventory, a drainage ditch, which connects surface water with a creek crossing the site, has been dug along the Industrial boulevard. The ditch was dug without the authorization of the site owner and was later filled in the fall of 1983 because it prevented access to the site by cutting the entrance road 5 meters wide.

2. Location and Access

The site is located in the southern part of the Kahnawake Reserve, along the limits of the Châteauguay Municipality. It is accessible by the Industrial boulevard, from Châteauguay only and not from the reserve. The site is not fenced nor artificially delimited. A site location map is presented in the following page.

3. Work on Site

Five (5) boreholes were drilled with a mechanical auger. Borehole #4 was drilled in the center of the western part of the site; others were located around the site (see sketch). A piezometer was set up in each borehole.

As one of the piezometer got blocked up, water analyses were made on samples from four (4) stations.

Six (6) stations were used to collect surface water. They are located all around the site, except for one which was established at the center of the site, in the creek crossing it. Three (3) stations permit to see the evolution of the quality of water in the creek, one of which is located in the Châteauguay Municipality, upstream from site; its location was selected because surface water in that area is drained via a culvert in the creek.

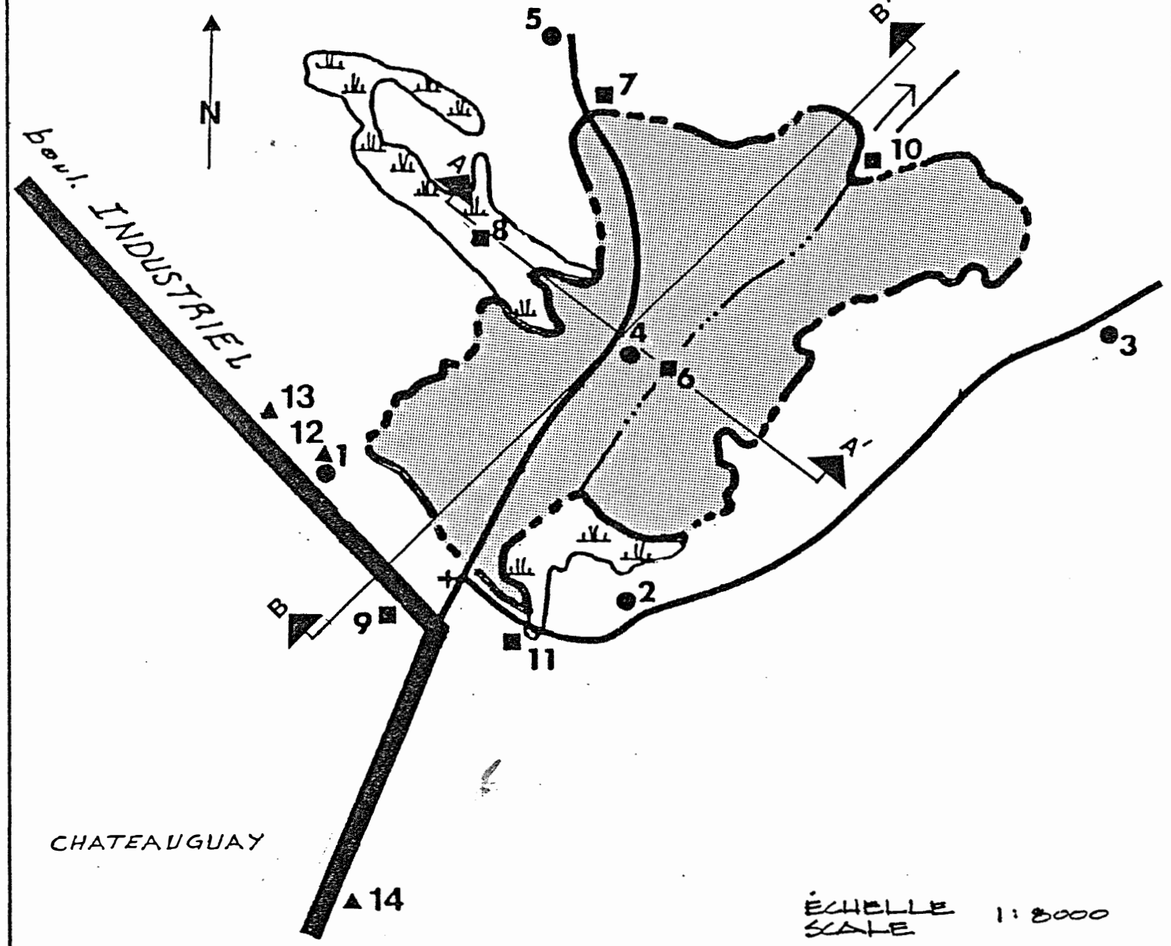
Furthermore, two (2) domestic wells have been sampled on the Industrial boulevard: the Centre de Lavage Automobile ("Car Wash") and A & A Démolition, both located on the north side of the boulevard. Also, it was possible to obtain analysis results conducted by Environnement Québec on the domestic well of Mrs. Brault, located at 268 Industrial Boulevard, south-west from the site.

KALINAWAKE - SITE BEAUVAIS No 06-01-03 BEAUVAIS SITE

ÉCHELLE
SCALE 1 : 40 000

SCHÉMA DU SITE
SITE SKETCH

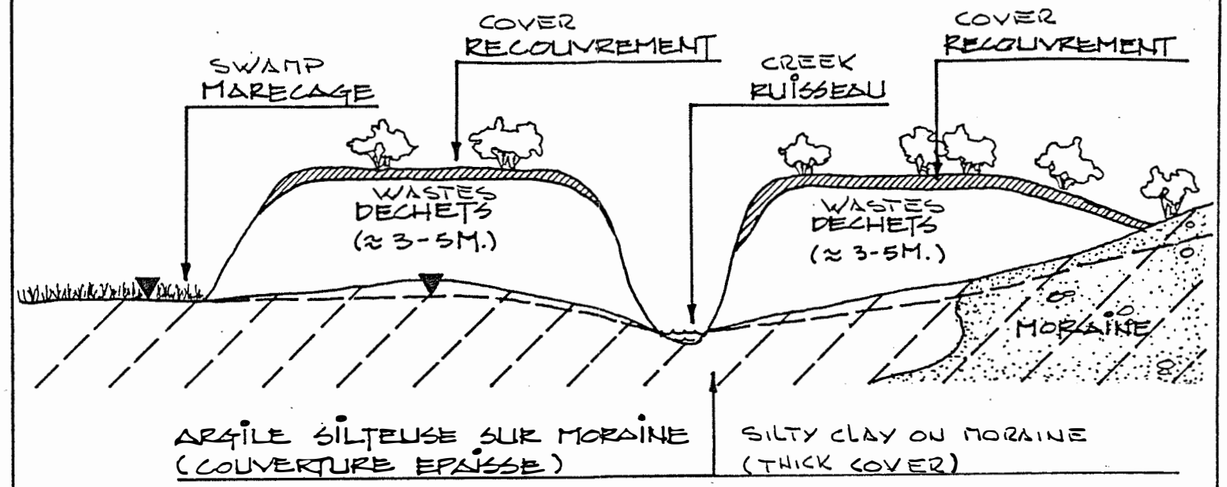
KALINAWAKE - SITE BEAUVAIS No 06-01-03 BEAUVAIS SITE



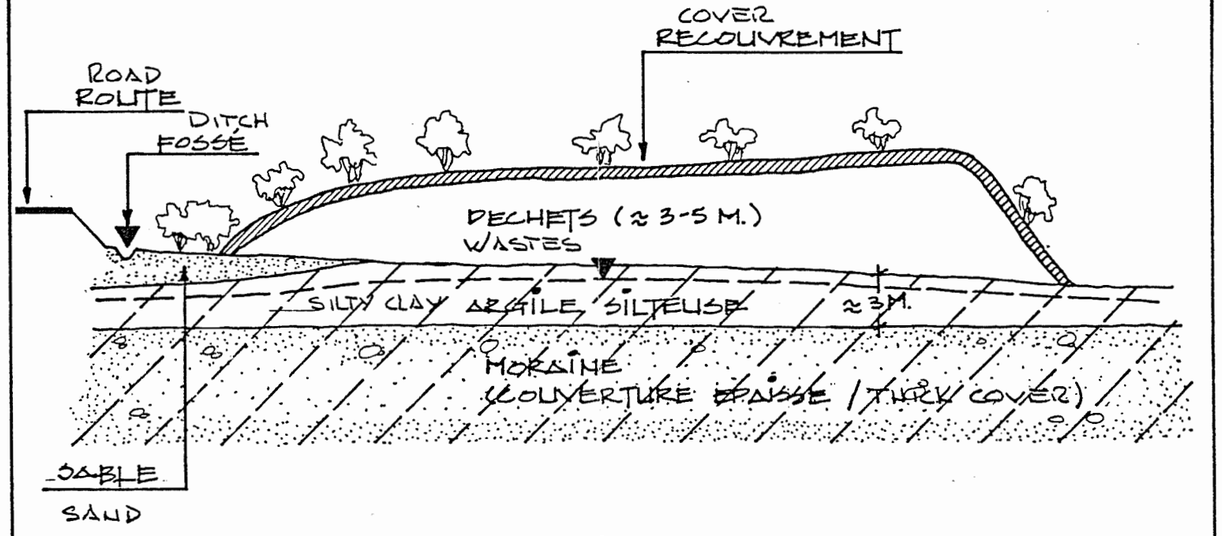
ÉCHELLE 1:8000
SCALE

LÉGENDE — LEGEND

LIMITE DU DÉPOTOIR		DUMP SITE
ROUTES		ROADS
MARÉCAGE		SWAMP
RUISSEAU		CREEK
(ÉL 400,00 m) B.M. ARBITRAIRE	+	ARBITRARY B.M. (EL. 400,00 m)
FORAGE	●	BORELIOLE
ÉCHANTILLON D'EAU DE SURFACE	■	SURFACE WATER SAMPLE
PUITS	▲	WELL



COUPE A-A'
SECTION



COUPE B-B'
SECTION

The arbitrary bench mark used for surveying was painted on the asphalt of the access road to the site.

4. Physical Characteristics

The site covers a surface of 20 hectares. It consists in fact of two sites separated by a drainage stream flowing north. Filling was done on a fleecy marshy area and today, the ground is relatively flat (except near the creek) and 3 to 4 meters higher than the original ground. The site is covered with a regenerating herbaceous and shrubby vegetation; there are also a few trees.

A dirt track crosses the site from south to north from the Industrial boulevard. Another road borders the eastern part of the site through the same access.

5. Geological Characteristics

Borehole depths vary between 4.80 and 8.53 m. Only drilling #2, located south-east from the site, has reached refusal on a block or on the bedrock, at a depth of 4.8 m.

The ground is successively constituted of layers of sand and clay recovering a till base composed of sandy silt with a little gravel.

Four (4) permeability tests were conducted in the piezometers. No permeability test could be done in borehole #2 because the piezometer got blocked up. The mean permeability of the till base or of the silty clay is 1.5×10^{-4} cm/s. These are therefore little permeable materials.

6. Hydrological Characteristics

The ground water of the site flows radially with a very low horizontal velocity, generally inferior to 20 m/year (see sketch on following page). A creek, flowing from south-west to north-east, crosses the disposal site in its center, disturbing at that place the equipotential lines. Part of the ground water of the site is drained into this creek with a higher hydraulic gradient than on the perimeter of the site. This creek also drains water from a land owned by the Châteauguay Municipality, located south-west from the site, through a culvert. The general water flow in the area goes towards the north-east, towards the Suzanne river and site 06-01-05 (Patton).

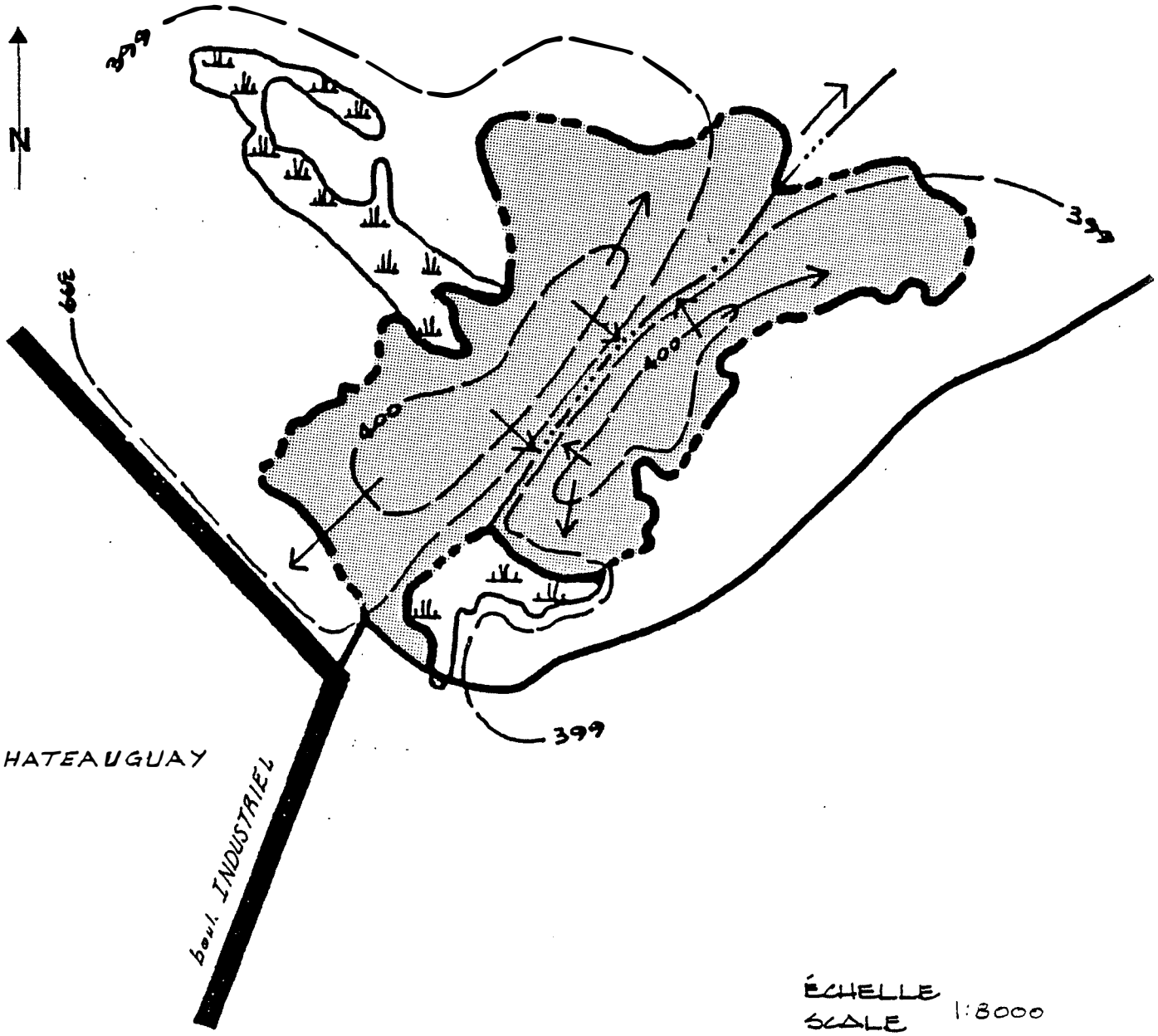
The water levels surveyed in the two swamp found on the perimeter of the site correspond to the water table levels. Therefore, there is a direct contact between the waste and the water table at this place as well as along the creek which crosses the site.

7. Disposal Method and Nature of Waste

The site contains 3 to 5 meters of domestic waste with 0.6-m layer of sand and construction materials on the surface (total estimated volume: 600 000 m^3). Nothing much is known about the waste located east from the creek because it is impossible to reach it by vehicle; but it can be reasonably supposed that the waste is also domestic. The greatest part of the site is recovered and little waste is visible except for a 10 m-wide strip on each side of the drainage creek where the slope is steep.

SCHÉMA DU SITE
SITE SKETCH

KAHNAWAKE - SITE BEAUVAIS No 06-01-03 BEAUVAIS SITE



ÉCHELLE
SCALE 1:8000

LÉGENDE LEGEND

LIMITE DU DÉPOTOIR	DUMP SITE
ROUTES	ROADS
MARÉCAGE	SWAMP
RUISSEAU	CREEK
LIGNE ISOPIÈZE 29 m	EQUIPOTENTIAL LINE

8. Analysis Results

a. Water Quality

Analysis results of the surface, ground and well water are presented in the following tables.

Chemical analysis results of surface water show that the water in the creek (station #6, located at the center of the site) presents high contents, specially in mineral elements and organic matter, which confirms the drainage pattern of the site: the creek acts like the water retention basin of the site, except during springtime when the flow must probably increase compared to its almost nil value the rest of the year.

The upstream part of the creek is not free of contamination however, which probably comes from the nearness of the disposal site and from the local radial flow. For the downstream part of the creek, contents are relatively much lower than the ones detected at the center of the creek. On the other hand, the usual direction of the flow leads us to believe that concentrations detected at this downstream station should normally be higher than the ones determined during the study.

Results from the borehole located at the center of the site (station #4) confirms the presence of domestic waste; indeed, the water collected there indicates the highest contents of all water sampled on the site, specially in minerals and organic matter. Analyses conducted on water from other boreholes show a lower contamination value around the site, even

Name of site: KAHNAWAKE
Site number : 06-01-03

SURFACE AND GROUND WATER
ANALYSIS RESULTS

	SAMPLING STATIONS						
ANALYSES	● 1	● 3	● 3	● 4	● 4	● 5	■ 6
SAMPLING DATE	28-10-83	28-10-83	22-11-83	28-10-83	22-11-83	28-10-83	13-10-83
pH	6,8	7,0	-	7,0	8,0	7,0	7,8
Alkalinity (mg/l)	320	260	-	>1000	1964	280	920
Conductivity (μ mhos/cm)	442	427	-	8000	4500	1070	2500
Hardness (mg/l)	200	260	-	790	1188	240	420
Chloride (mg/l)	0,30	0,10	-	>15	864	0,40	7,65
SO_4 (mg/l)	53	54	-	110	50	200	39
PO_4 (mg/l)	-	-	-	-	2,2	-	-
NO_2 (mg/l)	0,013	0,015	0,010	0,013	0,006	0,087	0,280
NO_3 (mg/l)	0,77	0,14	1,05	122	0,77	1,61	2,49
Redox potential (millivolts)	494	507	-	302	-	438	331
Dissolved solids(mg/l)	527	329	R	4970	R	446	1870
TKN (mg/l)	3,3	14,9	1,3	286	193	1,8	73
NH_3 (mg/l)	-	<0,14	0,56	157	111	0,50	70
COD (mg/l)	183	737	70	861	525	61	285
TOC (mg/l)	37	310	12	390	285	8	75
Ca (mg/l)	123	150	-	138	245	58	96
Mg (mg/l)	-	-	-	-	140	-	-
BIOTEST							
Algae (toxic units)	17,9	<1,1	-	8,9-17,9	<1,1	1,1-2,2	2,2-4,4
Microtox (toxic units)	<2	<2	-	2,4	<2	<2	<2

● Borehole
■ Surface Water

R: Analysed but rejected by the laboratory
-: N.A.

Name of site: KAHNAWAKE
Site number : 06-01-03

SURFACE AND GROUND WATER
ANALYSIS RESULTS

SAMPLING STATIONS

ANALYSES	■ 7	■ 8	■ 9	■ 10	■ 11		
SAMPLING DATE	13-10-83	13-10-83	22-11-83	22-11-83	22-11-83		
pH	7,6	7,7	7,7	6,7	7,4		
Alkalinity (mg/l)	190	225	450	126	59		
Conductivity (μ mhos/cm^{-1})	940	1180	1700	640	150		
Hardness (mg/l)	195	160	360	267	98		
Chloride (mg/l)	2,35	3,00	4,85	74	5,3		
SO_4 (mg/l)	25	28	160	90	17		
PO_4 (mg/l)	-	-	-	0,30	0,40		
NO_2 (mg/l)	0,013	0,020	0,320	0,026	<0,005		
NO_3 (mg/l)	<0,14	<0,14	0,29	5,60	9,10		
Redox potential (millivolts)	385	377	345	-	-		
Dissolved solids (mg/l)	512	597	1040	R	R		
TKN (mg/l)	3,8	5,9	17,9	9,9	0,44		
NH_3 (mg/l)	1,4	1,1	16,8	4,4	<0,14		
COD (mg/l)	92	192	92	45	19		
TOC (mg/l)	29	29	31	26	7,7		
Ca (mg/l)	42	32	50	81	32		
Mg (mg/l)	-	-	15,8	4,4	66		
BIOTEST							
Algae (toxic units)	<1,1	<1,1	1,1-2,2	<1,1	35,7-71,4		
Microtox (toxic units)	<2	<2	<2	<2	<2		

■ Surface Water

-: N.A.
R: Analysed but rejected by the laboratory

Name of site: KAHNAWAKE

Site number : 06-01-03

SURFACE AND GROUND WATER

DOMESTICS WELLS

ANALYSES	SAMPLING STATIONS ▲ 12	▲ 13	▲ 14*	▲ 14*		▲ 14*	▲ 14*
SAMPLING DATE	23-11-83	23-11-83	20-10-82	05-63		20-10-82	05-63
pH	7,9	8,0	7,5	7,8	Iron(mg/l)	3,08	1,4
Alkalinity (mg/l)	174	288	290	266	Mn (mg/l)	0,06	-
Conductivity (µ mhos/cm)	1950	730	725	-	K (mg/l)	2,3	-
Hardness (mg/l)	833	499	470	368	Na (mg/l)	7,3	-
Chloride (mg/l)	276	31	15	-	Co	26	-
SO_4 (mg/l)	448	90	950	-	Turbidity	28	12
PO_4 (mg/l)	<0,05	<0,05	<0,02	-	(U.T.N.)		
NO_2 (mg/l)	0,007	<0,005	<0,1	0,001			
NO_3 (mg/l)	70,0	8,0					
Redox potential (millivolts)	-	-	-	-			
Dissolved solids(mg/l)(105°C)	R	R	495	-			
TKN (mg/l)	<0,14	<0,14	-	-			
NH_3 (mg/l)	<0,14	<0,14	0,13	0,34			
COD (mg/l)	1	1	-	-			
TOC (mg/l)	7,0	3,5	-	-			
Ca (mg/l)	225	124	112	-			
Mg (mg/l)	66	46	47,8	-			
BIOTEST							
Algae (toxic units)	8,9-17,9	-	-	-			
Microtox (toxic units)	<2	-	-	-			

▲ Well

* Provincial Government - Environment Québec

-: N.A.

R: Analysed but rejected by the laboratory

in comparison with the water from the creek, at the center of the site. The creek is thus relatively important regarding this site because it is draining the water contaminated by the waste and it probably brings it more downstream towards the north-east.

The samples taken in the swamp located west from the site (station #8) allow to detect the influence of the site by showing noticeable concentrations of organic matter. Contents of the swamp located more north (station #7) are somewhat inferior. A more comprehensive sampling (more samples per station) could lead to an explanation of these variations.

The algae biotests indicated a high toxicity of ground water at station #1 and of surface water at station #11, both located south of the site, near the reserve and Châteauguay limits. Analysis of the ground water in station #4, located right at the center of the waste, indicates similar results.

As for the domestic wells, the well of Mrs. Brault, analyzed by Environnement Québec, contains drinkable water; only its iron content is too high. The water of well #13 (A & A Démolition) meets the standards for drinking water supplies as established by Environment Canada (1980); the hardness level however, is relatively high, so is the hardness level of well #12 (car wash), located near the site. In the later case, the water presents high chloride, sulphate, nitrate and calcium contents; the owner has mentioned, by the way, that when cars are washed with this water, white stains persists after air drying. These stains result from the high mineral contents mentioned above.

It can be noted that the water of station #1 (located 5 meters deep) and that of well #12 (103 meters deep), two stations located near one another, are both contaminated. It is therefore possible that both the high water table and the ground table are contaminated, in the latter case not necessarily by the site. These two stations (borehole #1 and well #12) present positive results for the algae biotest, and thus a potential danger.

b. Gas Analyses

Analyses conducted with the "Gastec" manual pump show a 400 ppm concentration of CO_2 and no CO. All readings on the explosimeter came to nothing. A sample was collected in a slit of the ground when warmer gas was visible on a cold fall day. Unfortunately, the bag provided by the laboratory was defective and the sample volume was not large enough when came the time to analyse it. No smell was noticeable at the slit which could not be found again afterwards.

c. Leachate Production

The estimated volume of leachate produced by the site is in the region of 75 000 m^3/year, considering a deposit aera of 200 000 m^2, an average annual production of 950 mm and a coefficient of infiltration of 0.4, which takes into account a total recovering of site with silty sand and a flat ground. The leachate is found in the ground as well as in surface water, specially in the creek draining part of the water table existing in the deposit.

9. Summary - Conclusions

The site 06-01-03 site is a private domestic waste disposal area which was in use for four years and closed in 1978. The volume of buried waste (600 000 m^3) and its surface area (20 hectares) are impressive. The site was covered with construction material and earth, and now forms a plateau which dominates in height the natural surrounding land, which contains several marshes.

The underlying ground is constituted of an appreciable cover of soil composed of generally little permeable materials (clay/till). The local flow of ground water is radial, with a relatively low horizontal velocity in the region of 10 m/year. Furthermore, a creek cuts the site in two, draining runoff and part of the ground water in contact with the site towards the northeast.

Sizeable concentrations of organic matter were found with the analysis of surface and ground water. It seems that the creek which crosses the site is acting as a retention basin for the site water; it is also highly contaminated, which is a characteristic of lixiviat.

The water analyses conducted on domestic wells show that the well used by the car wash, which is located near the site along the Industrial boulevard, is contaminated. According to the ecotoxicological analyses, the water of this well and the water of the sampled water table located right beside the well, present a potential danger. However, the well is not used as a source of drinking water. The car wash owner should be notified of the problem and the necesary action should be taken to make sure he is supplied with adequate water.

This site is no doubt a problem site because contents for the analysed parameters are considerable. On the other hand, it must be noted that appreciable variations in chemical parameter results, for the same sample, have been revealed by analysis. Nevertheless, the buried waste does have an important impact on the quality of the surrounding water.

Therefore, it is important to circumscribe water movement and specially to prevent an exterior surface water supply which could be contaminated while flowing through the site and contribute to pollute other areas.

In brief, the major reasons which had lead to an intervention priority 1 classification at the time of the 1982 inventory still prevail and are the presence of swamps and humid lands, and the proximity of a private well. This priority classification is still valid and the undertaking of Phase 3 of the monitoring program should be considered for this site.

10. Recommendations

Because of the relative importance of the creek crossing the site, draining ground water contaminated by the site, it is important to prevent runoff water to reach the creek and also to limit its movement. This recommendation applies particularly to the strip of land comprised between the reserve limit and the Industrial boulevard, and between the car wash and the access to the site.

The second recommendation concerns the car wash whose well, according to the analysis, is contaminated. The owner should be notified and drinking the water should be prohibited (other uses of the water should be tolerated in order not to close down the facility). Another sampling should be taken to confirm results

obtained. The possibility to sample the water of this well at different levels should be considered, in order to establish where the contamination comes from. A follow-up on this well is required.

The sampling program of ground and surface water should be undertaken again to confirm results. A surface survey, taken further downstream from the creek, specially in spring or summer, could allow to assess the contamination brought about by the creek water.

Finally, access to the site should be restricted by means of barriers on the access road and "Danger" signs should be posted near the swamps and the creek, because the site area is used, among other things, for hunting.

4.6 Kahnawake Reserve - Site 06-01-04

1. History

The site 06-01-04 is certainly the best known disposal site of the Kahnawake Reserve. Being located along Route 132-138, which connects the Châteauguay Municipality to the Mercier Bridge, it has been the object of many complaints regarding fires and smoke while it was still active.

The site, owned by Mr Irwin Goodleaf, occupies a 40 hectare surface. The part of the site located north of the Hydro-Québec lines is bare and visible from the road, while the southern part is covered with vegetation and is further from the road. The site has been officially closed since 1978.

At the time of the 1982 inventory, it had been classified as an intervention priority 2 site because of swamps at its center, emission of odors and a bad maintenance. Following a request by the Band Council, Environment Canada has decided to include it in Phase 2 of the 1983 study program even though it did not have an intervention priority 1 classification.

2. Location and Access

The site is located east of Route 132-138 under the Hydro-Québec high voltage lines, about 5 km south of the village of the Kahnawake Reserve. The following map presents the site location.

3. Work on Site

Five (5) boreholes were drilled on the site with a mechanical auger, one of which (#2) was located south-west outside the disposal area itself. Furthermore, refusals obtained in boreholes #2 and #5 were checked by two (2) adjoining testing boreholes. Only in borehole #1 was a piezometer set up.

KAHNAWAKE- SITE GOODLEAF No 06-01-04 GOODLEAF SITE

ÉCHELLE
SCALE 1:40000

For security reasons, no boreholes were drilled in the area immediately north of the electrical line. Even though the buried waste does not seem to exceed a 3 to 5 meter thickness, which would allow for the setting up of piezometers, there have been explosions and self-combustion in the past. This is why it was decided no drilling would take place in this area.

Only one (1) ground water sample was taken (station #1 located south) because the other boreholes have been refused or the rock was shallow.

Six (6) samples have been taken to characterize the surface water. Sample #6 has been collected in the ditch coming from the quarry and bordering the site. The other surveys come from small stagnant marshes located inside the site.

Work on site is located on the following site sketch.

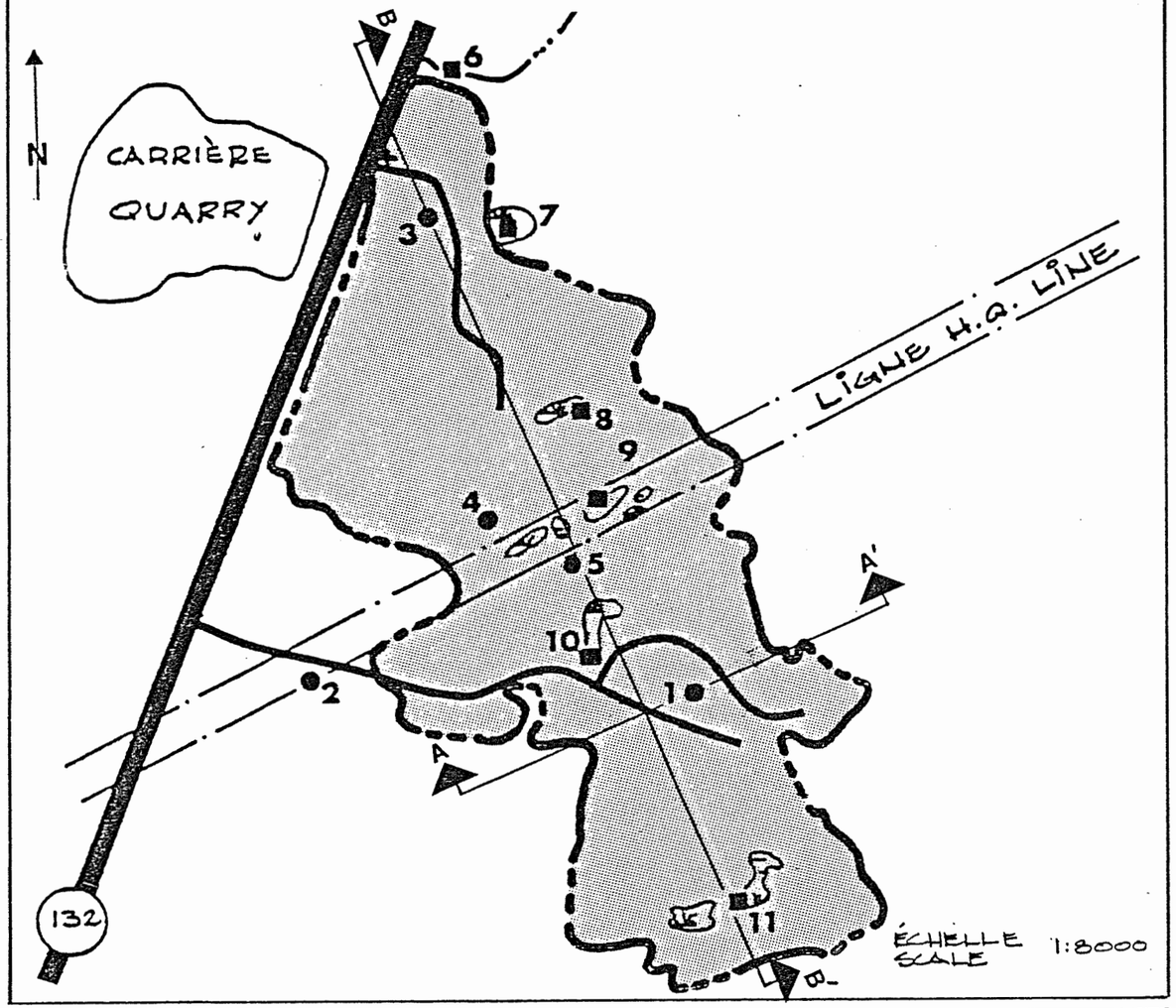
4. Physical Characteristics

The original ground is relatively flat and marshy north of the electrical line and the rock is outcropping at several places. Under the line, small swamps and ponds, which collect surface water, are found. The land is slightly sloping towards the south and south-west from its center.

There is vegetation north of the site but starting 200 m north from the electrical line to the south, it becomes luxuriant. It is constituted of herbaceous vegetation, shrubbs and young trees (adless, aspens, etc.).

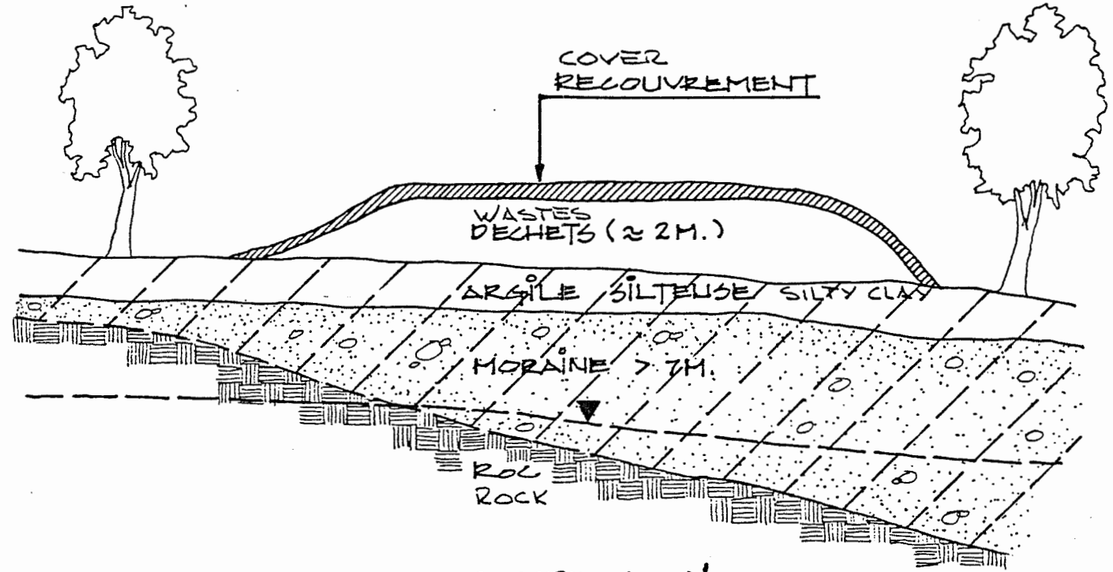
SCHÉMA DU SITE
SITE SKETCH

KAHNAWAKE- SITE GOODLEAF No 06-01-04 GOODLEAF SITE

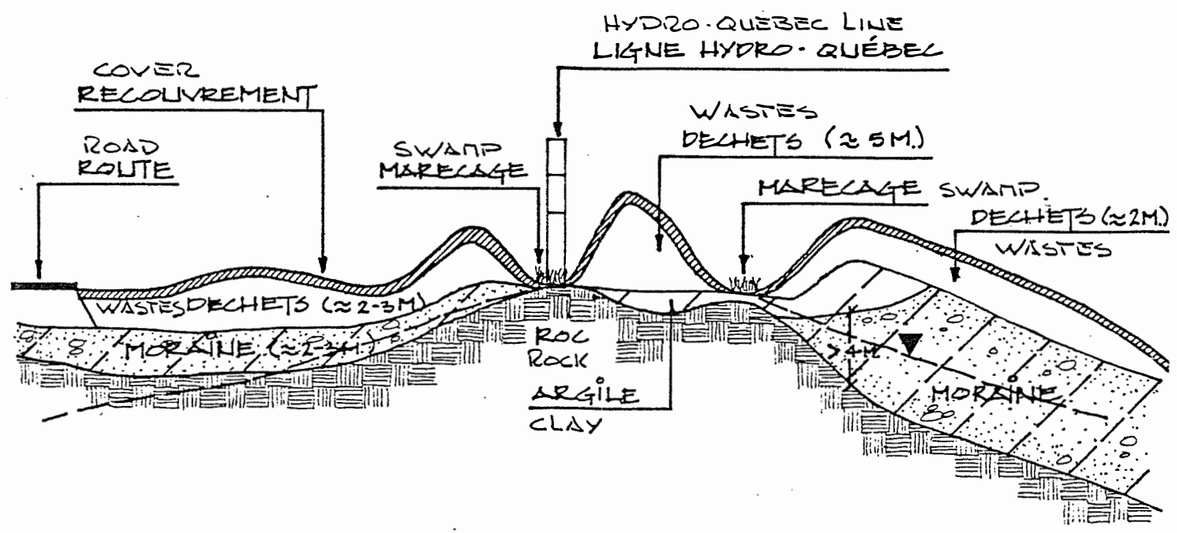


ÉCHELLE 1:8000
SCALE

LÉGENDE		LEGEND
LIMITE DU DÉPOTOIR	——·——	DUMP LIMIT
ROUTES	▬▬	ROADS
MARÉCAGE	⩛	SWAMP
(ÉL. 30,48 m) B.M. ARBITRAIRE	+	ARBITRARY B.M. (EL. 30,48 m)
FORAGE	●	BOREHOLE
ÉCHANTILLON D'EAU DE SURFACE	■	SURFACE WATER SAMPLE



COUPE A-A'
SECTION



COUPE B-B'
SECTION

An important active quarry is located a little north from the site, on the other side of Route 132-138. A ditch coming from the top of the quarry crosses underneath the road and borders it in a northern direction up to the end of the site.

5. Geological Characteristics

The site has a thin cover of overburden, of generally less than 3-m thick, covering the bedrock. The rock outcrops in a few places. It is constituted of limestone of the Chazy group, which is considered a good acquiferous for the development of ground water.

Only borehole #1, 10.29 m deep, located in the south-eastern part of the site, has not reached the bedrock. Refusals were reached for other boreholes at depths varying between 1.2 m and 6.4. m.

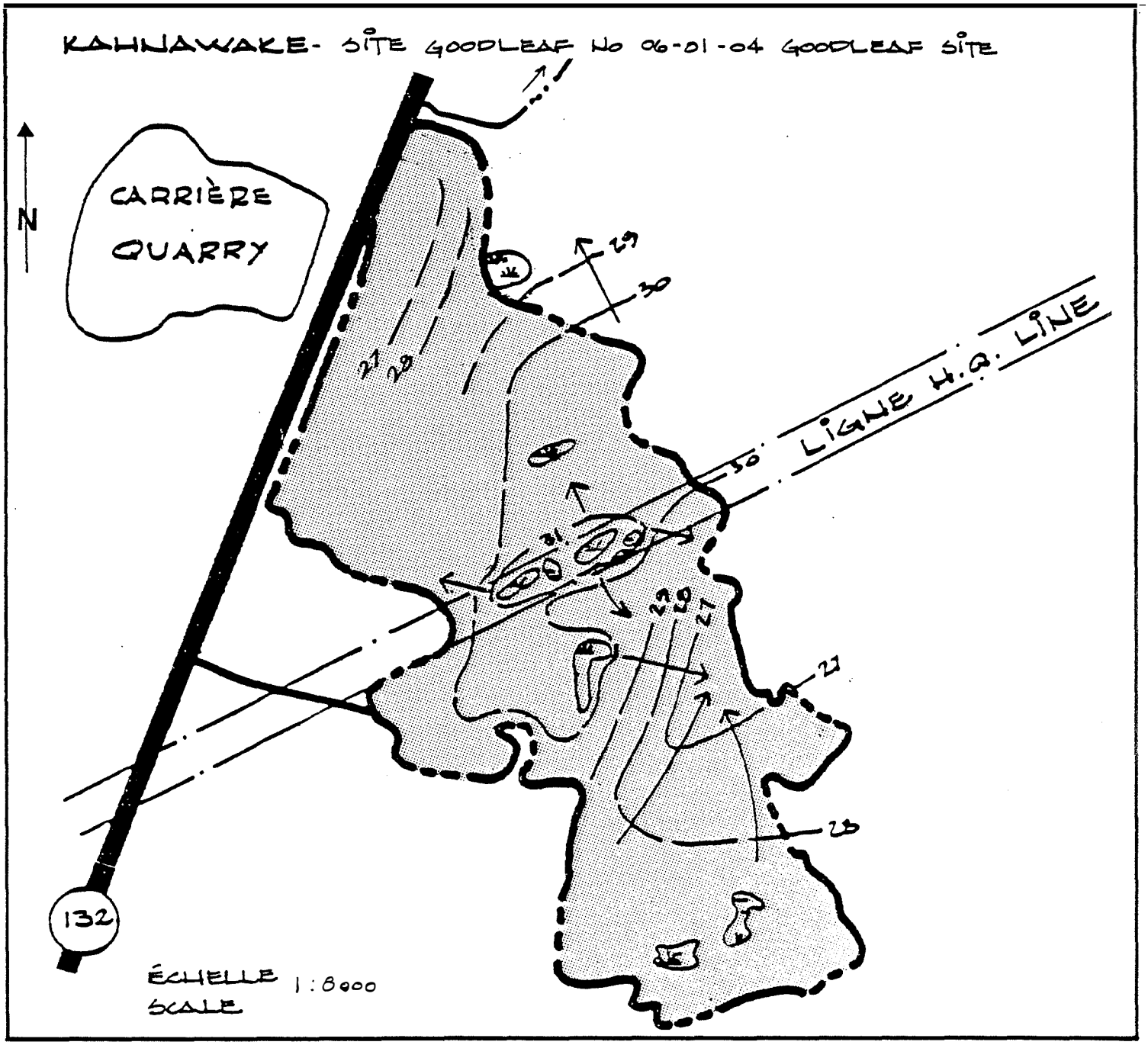
According to surveys, the overburden is mainly constituted of till whose composition varies from silty sand with some gravel to sandy silt with traces of gravel. In some places, clay, sand and gravel has been found.

The only permeability test that could be conducted shows that the till is little permeable, with a calculated value in the region of 1.2×10^{-4} cm/s.

6. Hydrological Characteristics

Surface runoff accumulates at certain places on the site, or flows at the periphery. A draining ditch runs along the border of the site, at its northern end.

SCHÉMA DU SITE
SITE SKETCH



LÉGENDE LEGEND

LIMITE DU DÉPOTOIR		DUMP LIMIT
ROUTES		ROADS
MARÉCAGE		SWAMP
LIGNE ISOPIÈZE	29	EQUIPOTENTIAL LINE

Only borehole #1 has found the water level, at a depth of about 7.5 m. Despite very little available information, and assuming that the marshes' levels correspond to the water levels, which is not necessarily true, the equipotential lines defining the probable levels of the high water table have been calculated all the same. The equipotential lines and the corresponding flow lines, which are presented on the site sketch, are a possible interpretation of the water table conditions. We have not, however, tried to calculate the flow velocity because of the great variability of the hydraulic gradients and the flow directions.

According to our observations, it is not impossible that waste is in direct contact with the high water table at the swamps.

7. Disposal Method and Nature of Waste

This site can be considered as three (3) distinct adjoining sites. The southern part, the oldest one, is mostly composed of a 2-km layer of domestic waste disposed on the original ground. The central part, which is about 300 meters wide and whose center would correspond to the hydro-electrical line, is composed of domestic waste and construction materials (barrels and industrial waste); it is 1-m thick in its southern portion and 5-m thick in its northern portion. This part, owned by Irwin Goodleaf and Clifford Rice until 1975 and by Mr Goodleaf since then, has been the object of many fires and explosions. Finally, the closest to and the most visible part from Route 132-138 consists of domestic waste recovered with construction materials and waste (the total approximative thickness of it is 2 or 3 m). This portion, owned by Irwin Goodleaf, was operated together with the central part by Mr. Boyer from Châteauguay, and later on by one of his employee. The site has a total surface of 40 hectares.

Until 1975, waste was disposed in the open; after that date, it seems that it was buried and recovered. Following numerous complaints from Châteauguay citizens about fires, odors and smoke, a closing order was issued in June 1977 for bad management, by the Deputy Minister of the Indian and Northern Affairs of Canada. The Band Council had all activities ceased by 1978. Despite the closure, there was still some disposal from time to time, but the nature of waste or materials is unknown.

According to available information, the site was gradually acquired by Irwin Goodleaf, who now owns all of it since 1983.

The closing of the site has not been carried out adequatly, specially in its central part. The presence of a lot of waste and many barrels on the surface is an important contamination source which influences the concentrations noted in water accumulation points. The site has not been recovered, or very little, in this section, and fire, emanations and security hazards are high. The regeneration vegetation is misleading; the impact of the site on the environment is obvious.

8. Analysis Results

1. Water Quality

Water analysis results are presented on the following pages.

Name of site: KANHAWAKE

Site number : 06-01-04

SURFACE AND GROUND WATER

ANALYSIS RESULTS

ANALYSES	SAMPLING STATIONS 1	6	7	8	9	10	11
SAMPLING DATE	23-11-83	23-11-83	23-11-83	23-11-83	23-11-83	23-11-83	23-11-83
pH	7,6	8,0	7,4	7,5	7,8	8,0	7,5
Alkalinity (mg/l)	314	322	148	94	104	156	94
Conductivity (µ mhos/cm)	1350	1220	900	710	675	1220	520
Hardness (mg/l)	4820	682	430	458	3440	425	269
Chloride (mg/l)	218	93	73	7,5	10	93	28
SO_4 (mg/l)	137	264	216	224	264	400	139
PO_4 (mg/l)	0,01	2,1	0,10	1,2	0,05	0,50	0,10
NO_2 (mg/l)	0,018	0,007	0,075	0,036	<0,005	0,007	<0,005
NO_3 (mg/l)	10,5	8,4	21,0	6,30	9,80	8,40	8,4
Redox potential (millivolts)	-	-	-	-	-	-	-
Dissolved solids (mg/l)	R	R	R	R	R	R	R
TKN (mg/l)	1,7	0,30	0,80	<0,14	<0,14	<0,14	<0,14
NH_3 (mg/l)	0,25	0,99	1,80	<0,14	<0,14	<0,14	<0,14
COD (mg/l)	415	<3	51	36	51	44	29
TOC (mg/l)	68	58	19	13	6,5	13	6,5
Ca (mg/l)	1675	207	140	152	1350	86	78
Mg (mg/l)	155	40	19,5	19,0	16,8	51,2	18,1
BIOTEST							
Algae (toxic units)	2,2-4,5	4,4-8,9	2,2-4,5	<1,1	<1,1	<1,1	1,1-2,2
Microtox (toxic units)	4	<2	<2	<2	<2	<2	<2

● Borehole
■ Surface Water

-: N.A.
R: Analysed but rejected by the laboratory

Analyses of ground water were conducted on only one sample taken from the only borehole that could be drilled. Of course, because the borehole was located in the waste, all concentrations of studied parameters were very high. The water is very hard and greatly charged with organic matter. The Microtox biotest also indicates that this water constitutes a potential danger on the environment (4 toxic units).

For surface water, only a summary interpretation can be made as the samples were taken from swamps and stagnant areas, independant one from another and distributed throughout the site. It is impossible to establish any gradient of the measured concentrations.

Nevertheless, all results show that surface points sampled present a noticeable organic contamination and that surface water is, as a matter of fact, hard. Station #9, located in the central part, reveals excessive calcium concentrations and a very important hardness. It can therefore be said that contamination problems of the water does exist, and are potential environmental hazards.

b. Gas Analyses

Gas surveys taken with the "Gastec" manual pump have shown no presence of CO and 400 ppm of CO_2. All readings on the explosimeter have not revealed the presence of any inflammable gas.

c. Leachate Production

Because available information on ground water levels on the site are very uncertain, one borehole in all having found the high water table, only a very approximative estimate of the leachate produced by the site can be calculated.

Mainly because of the large surface of the deposit (about 400 000 m^2), it can be estimated at 190 000 m^3/year. An average annual precipitation of 950 mm was considered and a coefficient of infiltration of 0.5 was assumed because the land is flat and the recovering of the deposit is varied.

9. Summary - Conclusions

Ths site 06-01-04 is a large site (40 hectares) located east from Route 132-138 connecting Châteauguay to the Mercier Bridge, on the Kahnawake Reserve. The site, owned by Irwin Goodleaf, has attracted numerous complaints regarding fires and smoke resulting from its operation. It has been officially closed since 1978.

The site can be divided into three parts. The central part, located underneath the Hydro-Québec transmission line, is covered with domestic and industrial waste 1 to 5 meters deep. There are many swamps in this sector. The southern part, which is older, is mostly covered with domestic waste 2-meters deep. Because a luxuriant regenerating vegetation has grown on these parts, the waste is partially hidden. The northern section is bare and visible from the road; 2 to 3 meters of domestic waste recovered with construction materials were deposited there, and the rock is outcropping at some places.

The ground subjacent to the site consists generally of a thin till layer of little permeability, less than 3 m thick and covering the bedrock. Waste may lie directly on the bedrock at some places.

It is possible that the waste is in contact with the high water table in the swamps. The local flow of the ground water is hard to define on this site. The northern portion seems to have a flow going in a north-west direction while the southern portion seems to have a flow going in a north-east direction.

Water analyses show an important organic contamination. It is not posible however to establish any concentration gradients to assess the extent and the dispersion of the contamination as the sampled surface water tables are independant one from another and only one piezometer was set up because of the shallowness of the rock. Nevertheless, according to the analysis results, it can be said this site presents a possible environmental hazard.

The closing of the site was not carried out properly, specially for the central part where a lot of waste and barrels are lying on its surface; such a situation represents a fire hazard, gas emmanations are likely to be produced, and the site is not safe.

To sum up, the classification of this site at the time of the 1982 inventory did not reflect the potential health and environmental hazards of the site. A separate analysis of the central part of the site would certainly have resulted in classifying this section as an intervention priority 1, requiring an immediate assessment. Phase 3 of the federal control program should be carried out for this disposal site.

10. Recommendations

Considering the concentrations found in the surface water, access to the site should be restricted. A fence should be set up, specially under the Hydro-Québec line, and its maintenance employees should be notified of the existing risks.

An analysis program should be undertaken involving a higher number of sampling stations and additional parameters, such as mercury, PCB and HBC, oils, greases, etc. If the contamination is confirmed and everything leads to believe it, piezometers should be set up at various levels in the rock in order to verify the behavior and the quality of the high water table. Water levels should be monitored in the piezometers and in the quarry located on the other side of the road.

Also, it should be insured that all disposal activities definitely cease on the site because of security hazards. Finally, "Danger" signs should be posted on the site, specially because the area is used for hunting.

4.7 Kahnawake Reserve - Site 06-01-05

1. History

Site 06-01-05 used to be a sanitary landfill site for the "Sanitary Refuse Collector" company of Montréal, which operated it until 1972, by renting it from various owners. The site has not been used since 1978, when its activities were stopped by the Band Council. The actual owner of the site is Mr. Angus Patton, who also owns the Caughnawaga Golf Club, located besides the site. It appears that Mr. Patton bought it in order to avoid harming the image of his club and to prevent the possible passage of vehicles, as the access road crosses through part of the golf.

The volume of disposed waste is considerable: a surface of 44 hectares and a depth varying between 4 and 9 meters. For this reason and at the request of the Kahnawake Band Council, Environment Canada has decided to include it in its 1983 study program, even though it has been classified in the intervention priority 2 category at the time of the 1982 inventory.

The major items recorded at the time of the previous inventory were the presence of bad odors, swamps, humid lands and a river bordering the site, and finally, the proximity of domestic wells.

2. Location and Access

This site is located about 500 meters west from the St-Isidore road (Route 207), approximately 10 km south from the village of the Kahnawake Reserve. This road is the only access to the site. The following map presents the site location.

KAHNAWAKE - SITE PATTON NO 06-01-05 PATTON SITE

ÉCHELLE
SCALE 1:40000

3. Work on Site

Four (4) boreholes were drilled on the site with the mechanical auger (see sketch). Three (3) boreholes (#1, #3 and #4) were drilled in the waste area, the fourth one was located immediately outside the northern limit of the area. No boreholes could be drilled west of the site since it was not accessible to the equipement because of swamps or dense vegetation. The depths of the boreholes varied between 7.26 and 14.78 meters. A piezometer was set up in each borehole.

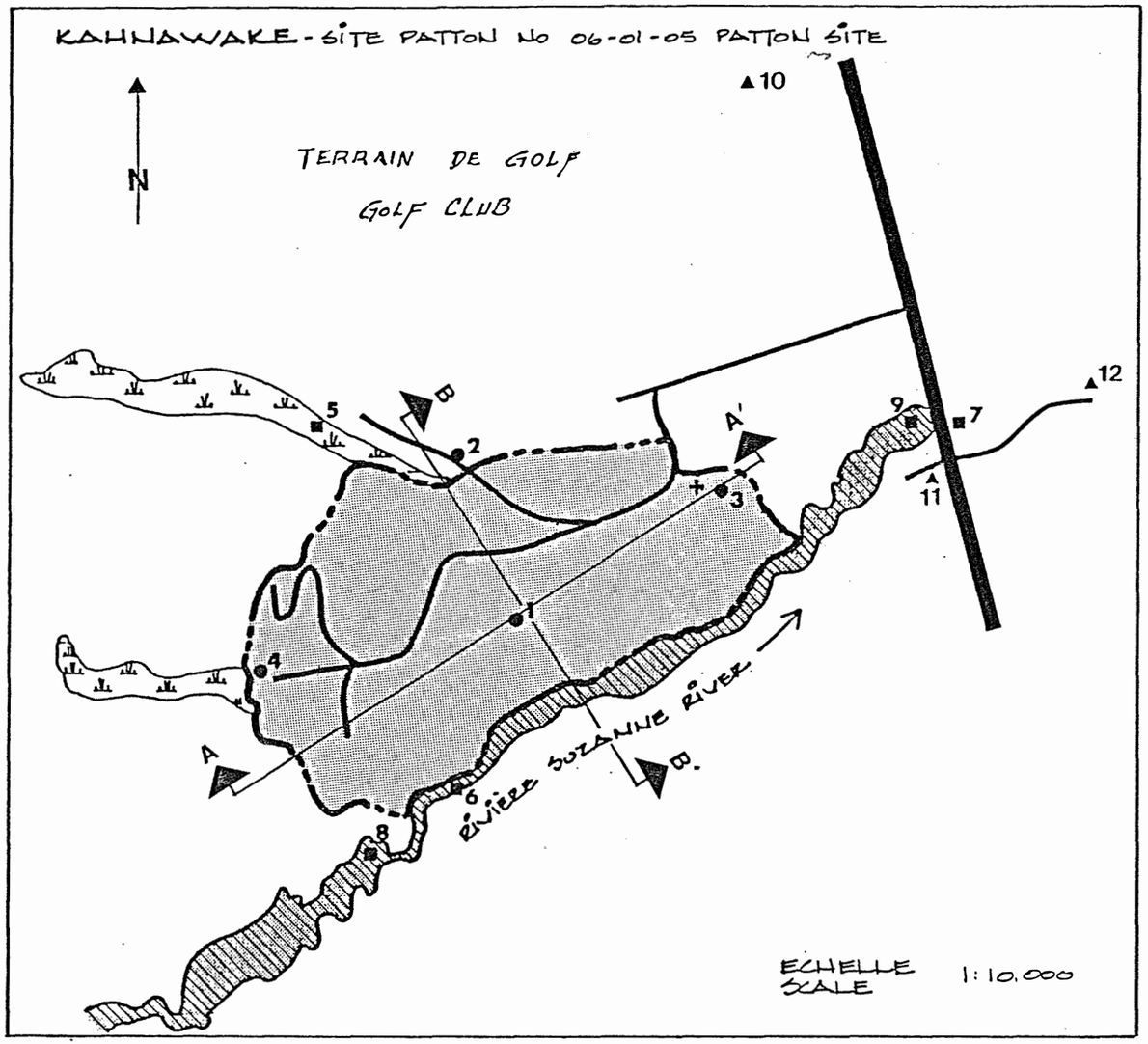
Ground water sampling was done on three (3) boreholes, the first one located at the center of the site and the others on the outside limit of the waste. The piezometer set up in station #4 did not provide enough water for a sample and therefore, no analysis could be conducted.

Five (5) samples were taken to characterize the surface water. Station #5 correponds to the swamp north-west from the site. Station #6 and #8 respectively correspond to river water taken upstream from the site and in its center, while stations #7 and #9 characterize the water downstream from the site. Samples #6 and #7 were taken in October, and samples #8 and #9 in December 1983.

No domestic wells were sampled since the Canadian Health and Welfare has already analysed the water of several wells located near the site in the spring of 1983.

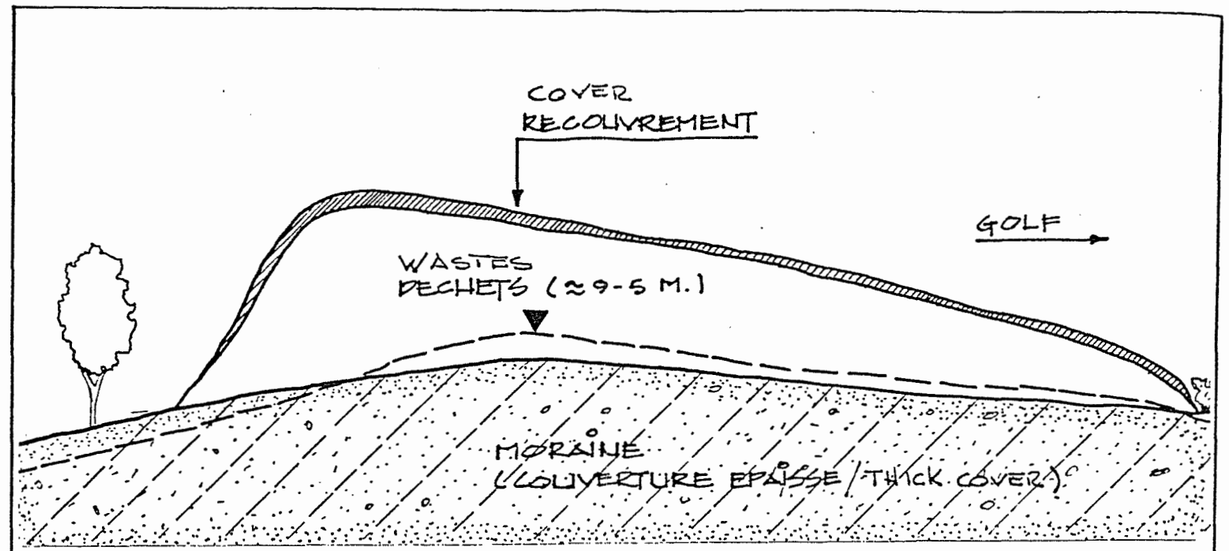
The arbitrary bench mark used for surveying corresponds to the top of a concrete block located in the refuse near borehole #3. The location of work is presented on the following page.

SCHÉMA DU SITE
SITE SKETCH

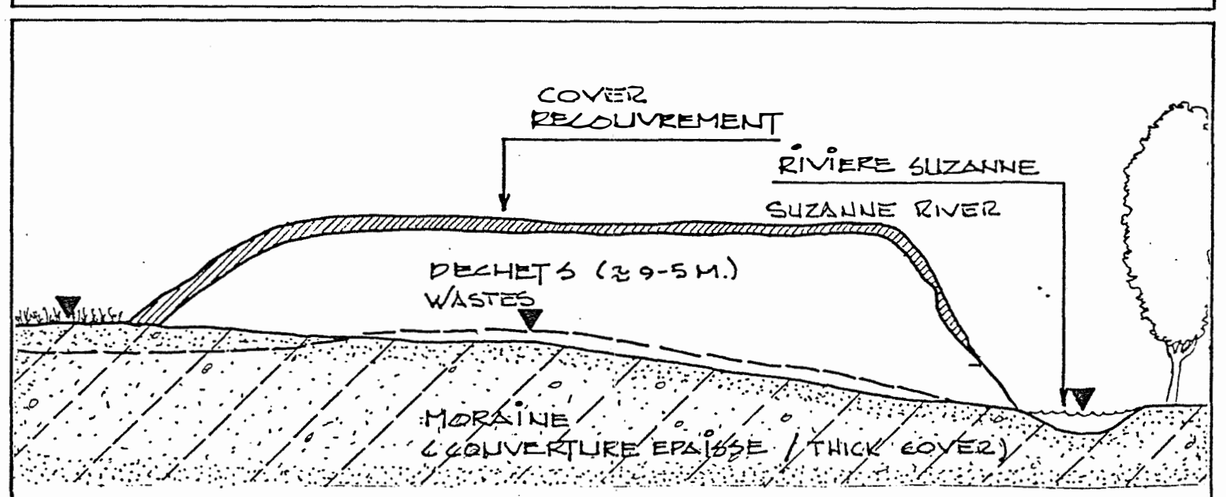


LÉGENDE LEGEND

LIMITE DU DÉPOTOIR		DUMP SITE
ROUTES		ROADS
MARÉCAGE		SWAMP
RIVIÈRE		RIVER
(ÉL. 100,00 m) B.M. ARBITRAIRE	+	ARBITRARY B.M. (EL 100.00m)
FORAGE	●	BOREHOLE
ÉCHANTILLON D'EAU DE SURFACE	■	SURFACE WATER SAMPLE
PUITS	▲	WELL



COUPE A-A'
SECTION



COUPE B-B'
SECTION

4. Physical Characteristics

The land located west from the St-Isidore road is at the same level as the latter on a distance of about 400 m. The original ground then gradually slopes downward until a flat and marshy land which is crossed by the Suzanne River.

The waste filling forms a plateau on top of the original ground, thus reaching the level of the golf course. Slopes are steep at the western and southern demarcation lines of the site, along the Suzanne River; the difference in level varies between 4 and 10 meters between the top of the site and the original ground.

The swamps located north-west from the site probably used to be connected with the Suzanne River, but they are now partially filled with waste. The river, which had a very low flow at the time of the study (fall 1983), springs from the low lands located south-west downstream of site 06-01-03 (Beauvais); along the site, it is more a marsh than a river.

5. Geological Characteristics

No borehole has found the bedrock. Essentially, the site was laid out on a till base composed of sandy silt with a little sand and traces of gravel.

The mean permeability of the till, according to tests conducted in the piezometers, is in the region of 1.1×10^{-4} cm/s. This material can therefore be classified as little permeable.

6. Hydrological Characteristics

The Suzanne River, adjoining the site on its south-eastern site, directly drains the waste deposit in a north-eastern direction. Furthermore, the disposal site interrupts the natural drainage of the swamps located north-west from the site. The general direction of the ground water flow in the area goes towards the Suzanne River.

All boreholes have found the water level at depth varying between 4 and 12 m. At boreholes #1 and #3, it was noted that the waste is in direct contact with the local water table. By tranfering the piezometric survey results on the site sketch, it can be noticed that the ground water flow inside the site is radial, with a very high hydraulic gradient near the Suzanne River. In this latter location, an horizontal flow velocity of 85 m/year was calculated, which is much higher than the 20 m/year found elsewhere. The swamp located north from the site appears to be a perched water table.

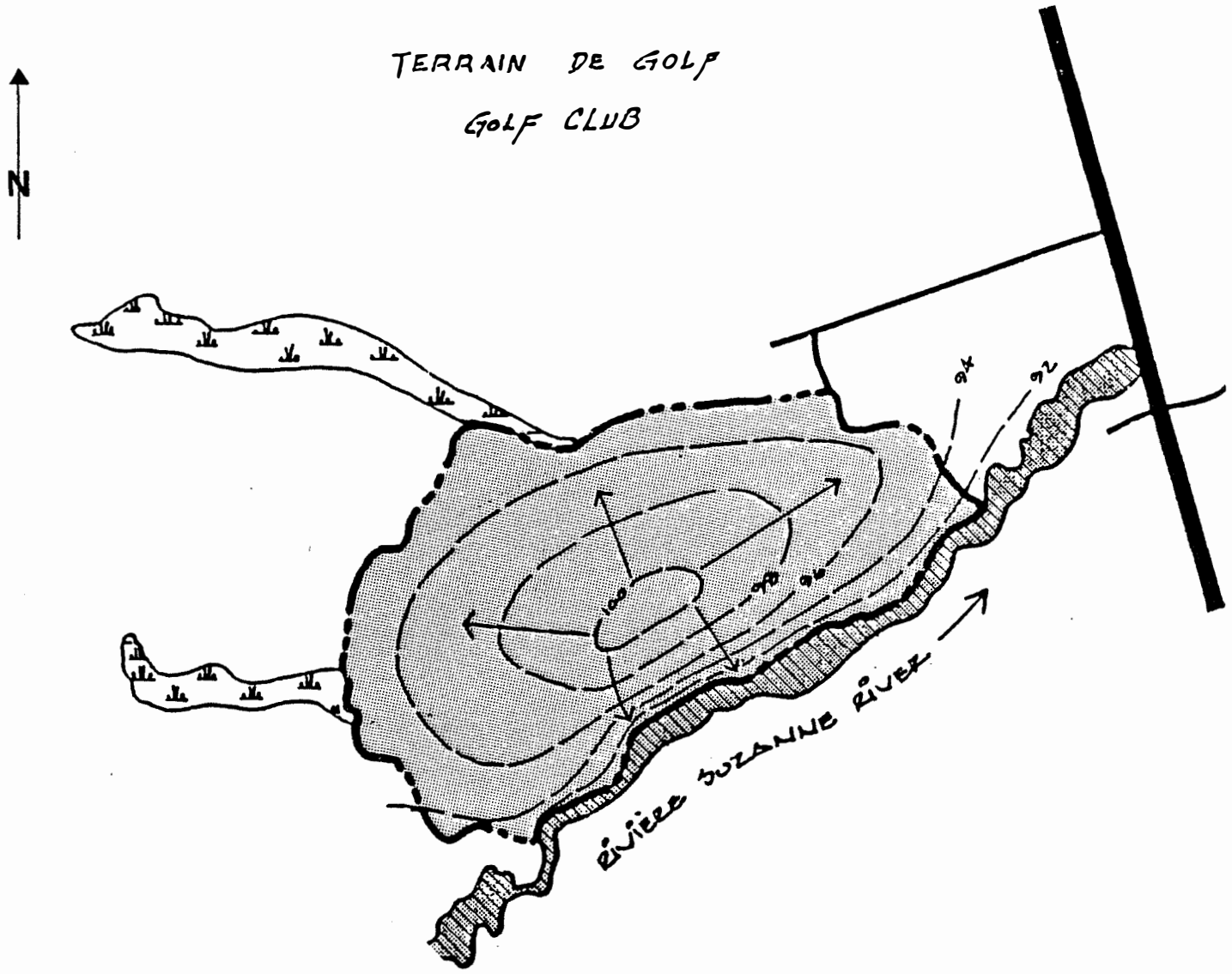
7. Disposal Method and Nature of Waste

The materials disposed on the site are composed of domestic and commercial waste coming from the customers of Sanitary Refuse Collector, mostly from the Montreal island. The estimated volume is in the region of 3 000 000 m^3, which is considerable.

It appears that a flat and marshy area, located about 7 meters lower than the original ground, now occupied by the golf club, was gradually filled. The disposal was done from east to west, directly on the humid lands; its southern limit consisted in the bank of the Suzanne River, where the waste forms a steep slope. According to the available information, waste was recovered daily. The final layer of the site is mostly composed of construction materials, 0.5-to 1-m thick. Some industrial waste has also been buried; at the south-west end of the site, there is a heap of reddish matter which appears to be smelter residues.

SCHÉMA DU SITE
SITE SKETCH

KAHNAWAKE - SITE PATTON NO 06-01-05 PATTON SITE



ÉCHELLE
SCALE 1:10000

LÉGENDE LEGEND

LIMITE DU DÉPOTOIR		DUMP SITE
ROUTES		ROADS
MARÉCAGE		SWAMP
RIVIÈRE		RIVER
LIGNE ISOPIÈZE	99	EQUIPOTENTIAL LINE

The site was closed in 1972. In 1976-77, it was used by a quarry owner in St-Isidore, Mr. Victor Beauvais, to dispose materials that his trucks transported when returning from stone delivering. About 1.5 m deep of materials were thus deposited in the western part of the site. This activity was stopped in 1977 or 1978 by the Band Council when it was noted that the disposal matter was not only consisting of soil but was also composed of construction and possibly industrial waste. It also appears fires occured near station #4, west from the site.

No water or gas control or retention system exists on this site. It is not fenced but the only way to gain access to the site is by the golf course where a steel cable blocks the road. Hence, the owner of the golf course, who also owns the site, has some control.

8. Analysis Results

a. Water Quality

Ground surface and well water analysis results are presented on the following tables.

Ground water analysis results indicate that water located in the waste (boreholes #1 and #3) is very contaminated (high alkalinity, conductivity, hardness, TKN, COD, TOC and Ca contents), proving the direct influence of the site.

The surrounding surface water, which is relatively stagnant, also undergoes the influence of the site. Results obtained in station #5 (the swamp located near the site limit) show a highly contaminated water, probably due to surface runoff which directly flows through the waste.

Name of site: KAHNAWAKE
Site number : 06-01-05

SURFACE AND GROUND WATER
ANALYSIS RESULTS

ANALYSES	SAMPLING STATIONS						
	● 1	● 1	● 2	● 3	■ 5	■ 6	■ 7
SAMPLING DATE	28-10-83	22-11-83	28-10-83	22-11-83	13-10-83	13-10-83	13-10-83
pH	6,4	7,7	6,9	7,7	8,0	7,5	7,6
Alkalinity (mg/l)	1190	1172	336	580	880	1400	370
Conductivity (μ mhos/cm)	2800	2000	210	2030	2090	2900	100
Hardness (mg/l)	-	1113	150	6133	320	480	320
Chloride (mg/l)	3,7	221	0,30	104	6,25	9,20	2,00
SO_4 (mg/l)	130	1,0	33	20	28	63	71
PO_4 (mg/l)	-	0,05	-	1,20	-	-	-
NO_2 (mg/l)	0,011	0,005	0,061	0,014	0,050	0,039	0,028
NO_3 (mg/l)	2,67	0,49	0,40	4,90	0,40	1,40	<0,14
Redox potential (millivolts)	136	-	386	-	324	291	357
Dissolved solids (mg/l)	2850	R	332	R	1492	2068	644
TKN (mg/l)	58	27,5	2,3	7,5	106	199	15,6
NH_3 (mg/l)	22	9,9	-	4,4	104	193	15
COD (mg/l)	833	1421	75	365	300	416	46
TOC (mg/l)	250	660	15	63	85	135	13
Ca (mg/l)	305	248	42	1533	36	68	60
Mg (mg/l)	-	120	-	560	-	-	-
BIOTEST							
Algae (toxic units)	17,9		1,1-2,2	2,2-4,4	<1,1	<1,1	
Microtox (toxic units)	1,5		<2	5,3	<2	<2	

● Borehole
■ Surface Water

-: N.A.
R: Analysed but rejected by the laboratory

Name of site: KAHNAWAKE
Site number : 06-01-05

SURFACE AND GROUND WATER
ANALYSIS RESULTS

ANALYSES	SAMPLING STATIONS ■ 8	■ 9	▲ 10*	▲ 11*	▲ 12*
SAMPLING DATE	22-11-83	22-11-83	04-83	04-83	04-83
pH	7,7	7,6	7,2	7,2	6,7
Alkalinity (mg/l)	1224	-	720	322	134
Conductivity (µ mhos/cm)	1800	-	469	505	422
Hardness (mg/l)	343	186	245	282	180
Chloride (mg/l)	388	-	4,4	11	32
SO_4 (mg/l)	36	-	47	41	32
PO_4 (mg/l)	3,2	-	<0,02	0,03	<0,02
NO_2 (mg/l)	0,675	0,010	<0,002	<0,002	<0,008
NO_3 (mg/l)	91,0	10,5	12,19	15,35	9,68
Redox potential (millivolts)	-	-	-	-	-
Dissolved solids (mg/l)	R	R	316	332	211
TKN (mg/l)	121	5,0	0,73	1,01	1,16
NH_3 (mg/l)	79	2,2	0,35	0,53	0,34
COD (mg/l)	243	70	-	-	-
TOC (mg/l)	64	12	1,0	1,8	2,3
Ca (mg/l)	87	56	-	-	-
Mg (mg/l)	30,6	11,2	-	-	-
BIOTEST					
Algae (toxic units)	-	-	-	-	-
Microtox (toxic units)	-	-	-	-	-

■ Surface Water
Health and Welfare Canada - Medical Services - Quebec Region

▲ Well
-: N.A.
R: Analysed but rejected by the laboratory

It must be noticed that the water sample taken upstream from the site on the Suzanne River at station #8 could not be surveyed in order to correctly characterize the water upstream from the site, because the access to the bank is somewhat limited. The river is very marshy where it widens and its banks are difficult to reach (vegetation, decaying and very soft soil).

Therefore, the sample #8 was taken at the site limit and the ground water flow direction leads to think that the contents observed represent both the local influence of the site and of the river water more upstream.

As a matter of fact, the contents observed reveal an important presence of minerals and organic matter. The presence of NO_3 (91.0 mg/l) is alarming and the site should be more thoroughly assessed. The nitrates may have come from organic fertilisers or vegetal or animal remains.

Samples #7 and #9 were both taken in the downstream part of the Suzanne River, on each side of the road. The water found there is hard and charged with organic water. On the other hand, the river, with its low flow, seems to be responsible for a slight purification since concentrations noted here are lower than the ones observed upstream. This buffer effect is worth studying more closely; it would also be relevant to sample this water.

The site as such appears to disturb the water quality in the area. Biotests indicate that the water sampled does not present any apparent danger for the environment, because of its toxicity, but a very hard water, as is the case here, can contribute to conceal or interfer with the test results.

Regarding domestic wells, the study conducted in 1983 by the Canadian Health and Welfare Department and entitled "Assessment of a possible contamination of the water table by toxic chemical products", reveals a bacterial contamination of the wells located on each side of the disposal site. The contents observed for the other parameters respect the quality standards of drinking water used in this study, and it is obvious that well #12 shows lower contents than well #11, located nearer to the site.

b. Gas Analyses

Gas levels measured with the manual pump gave a 400 ppm concentration for the CO_2 and nothing for the CO. Zero values were recorded with the explosimeter.

c. Leachate Production

The levels of the local ground water table are better defined on this site than on previous sites. However, its condition on a long-term basis are unknown. Consequently, only a very crude estimate of the leachate production rate on the site can be stated by calculating the water supply of the water table through the infiltration of rain.

The deposit surface is 400 000 m^2, the average annual precipitation in the area is 950 mm and the coefficient of infiltration for the site is 0.4, considering the flat land and the silty sand cover on almost the whole site. Therefore, an annual leachate production in the order of 170 000 m^3 can be estimated. This leachate is found gradually in the ground water and in the Suzanne River which drains the water table located under the deposit.

9. Summary - Conclusions

The site 06-01-05 is the most important waste disposal site of the Kahnawake Reserve as much because of its size (44 hectares) as for the volume of buried waste (3 000 000 m^3). "Sanitary Refuse Collector", which operated it until 1972, was its main user. The site has not been used since 1978.

The site forms a plateau comprised between the St-Isidore road (Route 207), the Suzanne River and the Caughnawaga Golf Club; the owner of the golf club bought the site because, among others, the access road to the site crosses part of the golf course. A thick layer of little permeable till underlines the site. The high water table is in direct contact with the waste in several places. The contaminated ground water has a radial flow on the site, with a high hydraulic gradient towards the Suzanne River. The natural drainage of the swamp located north-west from the site is disturbed by the presence of the deposit.

Under the site as such, the ground water is, as expected, highly contaminated and typical of leachate. The analysis of the water located around the site shows that the site has a noticeable impact on its surroundings and affects the quality of water in the area.

A study conducted by Health and Welfare Canada reveals a contamination of the wells near the site. The contamination is of a microbial nature and according to the present study, it is not possible to directly relate it to the site. However, the wells respect the raw water quality levels for drinking water supplies for the chemical parameters.

It can be stated that the closing of the site was properly carried out with the exception of its ends, where the recoveing is insufficient and the slope steeper.

To sum up, Environment Canada was right to consider this site as an intervention priority 1 for the Phase 2 of the program, even though it was part of priority 2 category at the time of the 1982 inventory. Indeed, results obtained show a contamination of the environment and present potential health and environmental hazards. Phase 3 of the federal control program should be undertaken for this disposal site.

10. Recommendations

The important contamination level of surface and ground water recorded during this study should be confirmed by another sample taking. Station #8, located at the south-west end of the site, requests special attention in order to evaluate the source of nitrates present in noticeable quantity. The river should be sampled much more upstream in order to establish its natural contents, and downstream to confirm the buffer effect of the river at the site level.

Domestic wells which have shown a bacterial contamination should be monitored and it should be determined if the contamination is related to the presence of the landfill.

The drilling program could not determine the extent (surface and depth) of the contamination caused by the site. We recommend to undertake during Phase 3, the drilling of additional boreholes, on the site, at various depths, a borehole on the opposite side of the Suzanne River and another one west from the site. In this

last case, it could be necessary to use an all-roads drill or to work during the winter, since the land is marshy and difficult of access. Water levels should be regularly surveyed in all existing or future piezometers.

Finally, "Danger" signs should be posted at the crossing of the river and the road, as well as at the golf limit, in order to notify passers-by, golfers and hunters.

5.0 Conclusion and recommendations

5.0 CONCLUSIONS AND RECOMMENDATIONS

The study program undertaken in this second phase allowed to confirm or invalidate the site classification results of Phase 1. Briefly, it can be said that the management methods of the Mistassini sites need to be optimized but the sites do not present any major environmental problems. On the other hand, the analysis of the Kahnawake Reserve sites reveal a high environmental contamination whose extent must be defined by additional studies. The specific conclusions and recommendations for each site were presented in the previous chapter.

The following paragraphs will deal mainly with comments on Phase 2, which has been carried out, and on Phase 3, to be undertaken for some of the site.

A few remarks should be made about the study. First, it should be noted that the study was carried out at a time when the water level is high (fall) and therefore, samples were probably diluted. Some samples were even taken when snow was already covering the ground. This delay was caused by the difficulty of obtaining, for some sites, the necessary authorizations. Of course, the selection of stations and/or the quality of the samples cannot be optimal in such conditions. A study of this kind should be spread over a longer period of time in order to survey the ground water levels at different times throughout the year, which would allow to better describe the behavior of the water table. However, the preliminary assessment of impacts that was undertaken here is still valid and provides information on the next steps of the program to be carried out, when necessary.

A few recommendations are to be made about these next steps. The setting up of piezometers at various levels and in the rock should be considered in order to see the vertical contamination caused by the site and to determine the water table behavior. Also, a larger number of boreholes should be drilled and these boreholes spread out in a larger radius than the one specified in the mandate of Phase 2 (< 300 m) in order to evaluate the extent of the contamination (in surface) and to define the regional drainage pattern. This would also allow a better assessment of the leachate production generated by the passing of the water table through the waste. It several cases however, it will be necessary to provide for different drilling equipment and methods in order to avoid the same problems faced during Phase 2. For example, it should be considered using vehicles on caterpillars or drilling in wintertime, hence facilitating access to the area outside certain sites, or drilling boreholes in the rock in order to reach the water table.

The following measures should be included in the next water analysis program:

1. Each station should be sampled more than once. To establish the significance of concentration variations between point x and point y, at least two analysis results should be obtained. In addition, these duplicates should allow, up to a certain point, to validate the results or to explain important variations in the results of a same station.

2. The sampling stations of one disposal site should all be visited on the same day. Also, the piezometers should be set up at least 2 or 3 meters into the water table in order to provide enough water for sampling and to avoir going back to the piezometer to complete the sampling.

3. Phase 3 will call for a more complex analysis of water quality parameters in order to define the type of contamination (organic, inorganic, toxic or non-toxic).

If all these conditions are respected, it would then be possible to establish a more realistic picture of the contamination caused by the site and its extent outside the site.

Whatever the results revealed by this study, it is important to ensure an environmental follow-up of the sites, both on a basis of social awareness and according to scientific experts(1). Water levels should be surveyed on a regular basis and the sampling and analysis of permanent set up stations should be conducted for several years, until the contamination has completely disappeared. Such a program could become considerable, but the available resources on the reserves could be combined with the Department of Indian and Northern Affairs inspectors and Environment Canada technicians, who inspect those territories.

Solid waste disposal is a complicated issue and solving the problems it creates is not easy. However, with concerted efforts from all interveners and well-defined monitoring programs, it is possible to insure a healthy management of our environment.

(1) Recommended Procedures for Landfill Monitoring Programme Design and Implementation Proceedings of an International Seminar, Fisheries and Environment Canada, Environmental Protection Service, May 1977.

Appendices

1. Examples of Data Sheet

ETUDE PHASE II
PHASE II STUDY

SITES D'ELIMINATION DES DECHETS
SUR LES TERRES FEDERALES AU QUEBEC

LANDFILL SITES ON FEDERAL LANDS IN QUEBEC

FICHE DE DONNEES
DATA SHEET

CODE D'IDENTIFICATION DU SITE: _____
SITE IDENTIFICATION CODE : _____

NOM DU SITE: _____
SITE NAME : _____

1. INFORMATIONS GENERALES/GENERAL INFORMATION:

1.1 Localisation du site/Site location:

Comté/ Conty : _____

Cadastre officiel/ Official Cadastre : _____

Municipalité/ Municipality : _____

Paroisse/ Parish : _____

No. de lots/ Lot no. : _____

Chemin/ Road : _____

Coordonnées U.T.M./
U.T.M. Coordinates : N ---------- E ----------

Elévation approximative/
Approximative elevation : ---------- m géodésiques/--------
Geodetic

Cartes topographiques/
Topographics maps : ---------- échelle/ ----------
scale

---------- " ----------

---------- " ----------

---------- " ----------

Photographies aériennes/
Areal photographs : ----------

1.2 Historique du site/Site history:

1.2.1 Propriétaire actuel/Actual owner

Organisme/
Organization : ----------

Personne ressource/
Contact : ----------

1.2.2 Propriétaire durant vie active/Owner during active life

Organisme/
Organization : ----------

Personne ressource/
Contact : ----------

1.2.3 Exploitant (si différent de 1.2.1)/User if different from 1.2.1)

Organisme/
Organization : ----------

Personne ressource/
Contact : ----------

Contrat et obligations/
Contract & obligations ----------

Durée du contrat/
Contract duration : ---------- Echéance/
Termination : ----------

1.3 Date de mise en opération/
Start-up date of operation : ----------

1.4 Fermeture ou abandon du site/Closure or site abandon

Date/Date : ----------
Motifs/Motives: ----------

1.5 Sources de renseignements/Information source

(Nom, adresse, téléphone, responsabilité, organisme)
(Name, address, phone, responsability, organization)

----

2. CARACTERISTIQUES PHYSIQUES/PHYSICAL CARACTERISTICS

2.1 Utilisation du terrain/Land use

Utilisation des terres contigües et proximité des lotissements/:
Use of adjacent lands and proximity of developments.

. Spécifications: (1) domiciliaire ou projet domiciliaire/
developments, housing

(2) écoles, terrains de jeux, places publiques/
schools, playgrounds, public place

(3) commercial ou industriel/
commercial or industrial

(4) agricole/
agriculture

	Rayon / Radius < 300 m	300 m < Rayon / Radius < 1600 km	1,6 km < Rayon / Radius < 8 km
N/N			
S/S			
E/E			
O/W			

Travaux de construction sur ou dans le site (égouts, routes, bâtiments, etc.)/
Construction work on site (sewers, roads, etc.)

Préciser/Specify: ----------

Autre (détailler)/
Other (specify) : ----------

Source d'alimentation en eau (puits, lac, etc...)/
Water supply (well, lake, etc...)

Proximité/
Proximity : ---------- m ou km

Localisation/
Location : ----------

Utilisation/
Use : ----------

Population raccordée
à la source/ : ----------
Population served
by well

Proximité d'un environnement fragile ou d'un habitat vital (plaine d'inondations, refuges fauniques, parcs, réserves écologiques, etc...)/ :
Proximity of a fragile environment or a vital habitat (flood-plaines, faunic refuge parks, ecologic reserves, etc...)

Proximité/
Proximity : ----------

Localisation/
Location : ----------

Nature/Type : ----------

Autre (préciser)/
Other (specify) : ----------

Proximité du site aux: chemins publics/ ----------
Site proximity to: public roads

boisés/woods ----------

Topographie/
Topography : ----------

Végétation (préciser présence et nature du couvert végétal)/:
Vegetation (specify presence and nature of vegetation cover)

2.2 Géologie générale/General geology

Forages existants/Existing borings

Commentaires/Comments

2.3 Caractéristiques hydrologiques/Hydrological caracteristics

2.3.1 Climatologie/Climatology

A) Pluviosité/Rainfall :--------

Précipitation max. 24H/Max. Precipitation in 24hrs:--------

Précipitation moyenne annuelle/
Max. annual precipitation :--------

Station de référence/Reference station :--------

B) Vents (préciser configuration et exposition au vent):
Wind (specify paterns and exposition)

2.3.2 Eaux de surface/Surface water

A) Inondations/: crue annuelle/annual flooding :-------
Flood

crue décennale/ten years flooding :-------

crue centennale/hundred years flooding:-------

aucune crue/no flooding :-------

zone affectée par la crue/
zone affected by flooding :-------

B) Drainage/Drainage:

2.4 Hydrogéologie/Hydrogeology

2.4.1 Puits existants/Existing wells

(Type, profondeur, âge, etc...)/ (Type depth, age, etc...)

2.4.2 Nappe d'eau: profondeur moyenne/:
Water table: average depth

2.4.3 Perméabilité moyenne du site/:
Mean permeability of site

2.4.4 Sources d'infiltration & points de resurgence/:
Inflow and outflow sources

---

3. ELIMINATION DES DECHETS/WASTE DISPOSAL

3.1 Aire de disposition/ Site area : Long./ Lenght ------ M Larg./ Width ------ M Superficie/ Area ------

3.2 Protection du site/Site protection

Accès contrôlé/ Controled access : ----------

Accès libre/ Uncontroled access : ----------

Surveillance (spécifier)/ Surveillance (specify) : ----------

Clôture permanente/ Permanent fence : ----------

Clôture mobile/ Mobile fence : ----------

Jours d'opération/ Days operational : ----------

Protection incendie/ Fire protection : ----------

Autre/Other: ----------

3.3 Equipements de contrôle (balances, guérite, etc...)/: Control equipement (scale, cabin, etc...) -------

---

3.4 Procédé de fermeture du site (pour sites fermés)/: Procedure for site closure (for closed sites) ----------

---

3.5 Type de déchets

Spécifier ici la nature (domestiques, construction, carcasses, autos, terre, pneus, mortier, déchets radioactifs, déchets pathogènes, déchets dangereux, etc...), le volume et si possible la source (provenance) des déchets.

Type of Waste

Here, specify the nature (domestic, industrial, chemical, construction, carcases, cars, earth, tires, mortor, radioactive waste, pathological waste, hazardous waste, etc...), the volume and if possible the source (origin) of these wastes.

Provenance/Origin	Nature	Volume (Kg, m^3 ou barils) (Kg, m^3 or barils)
		TOTAL:

3.6 Mode d'élimination/Disposal method

3.6.1 Type d'installation/Type of installation:

Enfouissement/Controled discharge : _____
A ciel ouvert/Open dump : _____
Incinération/Incineration : _____
Dépôt matériaux secs/Inert material depot: _____
Poste transfert/Transfert station : _____
Autre (spécifier)/Other (specify) : _____

3.6.2 Couverture déchets/Waste cover:

% déchets couverts/% waste covered : _____%
Profondeur ou hauteur des déchets/ Depth or hight of waste : _____m

3.6.3 Enfouissement/Landfill

Sanitaire (déchets recouverts chaque jour)/ Sanitary (dayly cover) : _____

Sanitaire modifié (déchets recouverts non quotidiennement/ Modified sanitary (not covered daily) : _____

Enfouissement/Landfill:

surface/surface : _____
tranchée/trench : _____
pente/slope : _____

Mode d'opération (spécifier nature et fréquence des opérations d'élimination après la décharge)/:
Type of operation (specify the nature and the frequency of the disposal operation after reception)

* Combustion/Combustion : _____
* Compaction/Compaction : _____
* Recouvrement/covering : _____
  . Nature matériaux/ Type of materials : _____

. Origine/Origin: sur le site/on site : _____
ailleurs (spécifier)/ : _____
off site (specify)

. Fréquence/Frequency : _____

* Matériel de manutention et compactage (type, nature et description)/:
Handling and compacting equipment (type, nature and description.

_____

_____

_____

* Autre/Other: _____

_____

_____

3.6.4 Dépôt à ciel ouvert/Open dump:

Spécifier nature et fréquence des opérations d'élimination après la décharge/:
Specify nature and frequency of the disposal operation after reception.

Combustion/Combustion : _____
Compaction/Compaction : _____
Disposition résidus/ : _____
Waste disposal
Autre/Other : _____

3.6.5 Incinération/Incineration:

Capacité/Capacity : _____
Type de four/Kiln type : _____
Mode d'alimentation/ : _____
Feeding mode
Combustible d'appoint/: nature/nature: _____
Supplementary fuel volume/volume _____
Température d'opération/
Operating temp. : _____

Dispositif anti-pollution (description)/ Pollution control equipment (describe) : ----------

---

Résidus de l'incinération/ Incineration waste : ----------

3.6.6 Poste de transfert/Transfert station:

(Spécifier nature et fréquence du traitement des déchets)/: (Specify nature and frequency of waste treatment)

Récupération/Recovery : ----------

Déchiquetage/Shredding : ----------

Compactage/Compacting : ----------

Destruction finale/ Final destruction : ----------

Autre/Other : ----------

3.6.7 Recyclage (sur le site d'élimination)/: Recycling (on site)

Eléments récupérés/ Waste recovery :

papier/paper : ----------

métal/metal : ----------

verre/glass : ----------

energie/energy: ----------

Description (volume, utilisateur, etc...)/ Description (volume, user, etc...) : ----------

---

3.6.8 Méthodes déployées pour contenir les déchets à risques élevés/:
Methods used for containment of high risk waste

3.7 Eaux de lixiviation/Leachate:

Système artificiel de drainage/
Artificial drainage system : ----------

Rétention lixiviat/
Leachate retention : ----------

Traitement des eaux/
Water treatment : ----------

Autre/Other : ----------

3.8 Mode de gestion du site (pour sites en opération)/:
Site management (for site in operation)

3.9 Gaz (Commentaires)/Gas (Comments):

2.5 Schéma du site/Site sketch

2.6 Profil du site/Site profil

4. RESULTATS D'ANALYSES/ANALYSIS RESULTS:

4.1 Eau (surface souterraine)/Water (surface underground)

Percolation apparente/Apparent percolation:

4.2 Gaz/Gas:

---

5. IMPACT POTENTIEL SUR L'ENVIRONNEMENT
(Eau de lixiviation, Eau de surface, Esthétique, Gaz, Topographie, Vegetation)

POTENTIAL IMPACT ON THE ENVIRONMENT
(Leachate water, Surface water, Aesthetic, Gas, Topography, Vegetation)

6. RECOMMANDATION/RECOMMENDATION

2. Borehole Reports

BOREHOLE REPORTS

EXPLANATION OF THE FORM OF THE BOREHOLE REPORT

This form summarizes field information obtained from each boring and gives the result of the permeability test made in the piezometer. An explanation of the various columns of the report follows.

ELEVATION AND DEPTH

These columns give the elevation and depth of inferred geologic contacts. This elevation is referred to the datum shown in the general heading.

DESCRIPTION

A description of the soil, using standard geotechnical terminology, is contained in this column.

Classification of soil strata is based on the following particle size distribution:

Clay	less than 0,002 mm	(lesser than 0,002 mm)
Silt	from 0,002 to 0,075 mm	(0,002 mm to #200 sieve)
Sand	from 0,075 to 4,75 mm	(#200 sieve to #4 sieve)
Gravel	from 4,75 to 75 mm	(#4 sieve to 3 in)
Cobbles	from 75 to 200 mm	(3 in à 8 in)
Blocks	larger than 200 mm	(over 8 in)

Unified soil classification system ASTM D2487-75.

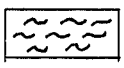
DESCRIPTION (following)

Terminology used for describing soil strata is based on the proportion of individual particle sizes present:

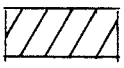
Trace or occasional	Less than 10%
Some	10 to 20%
Adjective (e.g. silty or sandy)	20 to 35%
And (e.g. sand and gravel)	35 to 50%

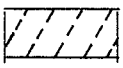
STRATIGRAPHIC PLOT

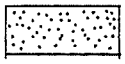
The stratigraphic plot for the description of soil strata is given with the following symbols:

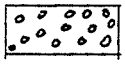

Organic soil

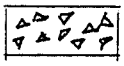

Wastes

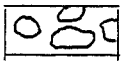

Clay


Silt


Sand


Gravel


Cobbles


Blocks

WATER CONDITIONS

In this column, the water level taken from the piezometer is indicated to scale for the date shown.

SAMPLES AND TESTS - TEST RESULTS

This part of the form presents field test results at the level where they were performed. The localisation of the test is given in a graphic form. The type of the test is defined by and abbreviation for which an explanation is given in the lower part of the form. The number of the test is shown. The recovery of the sample is the ratio of the soil length taken in the split spoon on it's driving length.

SAMPLES AND TESTS - TEST RESULTS (following)

The permeability test result made in the piezometer is presented in cm/s. For the standard penetration test, the number of strokes needed to drive in the split spoon for each 15 cm (6 in) is indicated. The standard penetration index (N) corresponding to the number of strokes needed for the last 30 cm (12 in) drive in is also indicated.

PIEZOMETER SETTING

A sketch shows to correct elevations and depths the piezometer made from cleft plastic tube containing mineral fibre, the calibrated sand, the bentonite plugs and the upper protection steel pipe. The space between the bentonite plugs is filled with the soil recovered from the borehole.

MISTASSINI

SITE 02-01-01 - OLD DUMP

BOREHOLE REPORT

Borehole No. 1

Project no: 829,NBA.1C — Date of drilling: Oct.19,83

Project: Landfill sites, Indian reserves - Phase 2 — Date of report: Nov.15,83

Site: Mistassini, site 02-01-01 (old dump) — Hammer: mass ..... kg

Elevation reference: Arbitrary BM, el.100,00 — Type of borehole: 13 cm auger — Height of drop ..... cm

SOIL SECTION					Samples and tests			Test Results	Piezometer Setting		
ELEV. m	DEPTH m	DEPTH ft	DESCRIPTION	Strat.	W.L.	Loc.	Type & No.	Rec. (%)	SKETCH	ELEV. m	DEPTH m / ft
102,75	0	0								103,16	0 / 0
102,14	1	5	Brown sandry silt; some cobble and blocks.		▼	19-10-83				102,45	1 / 5
101,23	2		Brown silty sand; some cobbles and blocks.								2
99,86	3	10	Till: silty sand, traces of gravel to gravelly, brown-grey to grey								3 / 10
	4	15									4 / 15
	5										5
	6	20									6 / 20
	7										7
95,44		25			▼	20-10-83					25
	8									94,62	8
93,99	9									94,34	9
		30	End of drilling at 8,76 m								30
	10										10
		35									35
	11										11
	12	40									12 / 40
	13										13
		45									45
	14										14
	15	50									15 / 50

TEST RESULTS

N : STD PENETRATION INDEX (STROKES/0,3 m)

k : PERMÉABILITY (cm/s)

NOTES: Surface water level observed during drilling at 0,6 m depth.

BOREHOLE REPORT

Borehole No. 2
Project no: 829.NBA.1C
Date of drilling: Oct. 19, 83
Project: Landfill sites, Indian reserves - Phase 2
Date of report: Nov. 15, 83
Site: Mistassini, site 02-01-01 (old dump)
Hammer: mass ..... kg
Elevation reference: Arbitrary BM, el. 100,00 Type of borehole: 13 cm auger
Height of drop ..... cm

SOIL SECTION						Samples and tests			Test Results	Piezometer Setting		
ELEV. m	DEPTH m	DEPTH ft	DESCRIPTION	Strat.	W.L.	Loc.	Type & No.	Rec. (%)		SKETCH	ELEV. m	DEPTH m / ft
103,39	0	0									103,52	0 / 0
			Brown sandy silt.								103,09	
102,32	1				▼						102,60	1
102,17		5	Till: silty sand to sand and silt, traces of gravel, brown-grey; some cobbles.			20-10-83						5
	2											2
	3	10									100,80	3 / 10
											100,39	
											100,01	
	4						k-1		k: invalid test		99,73	4
99,00		15	End of drilling at 4,39 m								99,17	15
	5											5
	6	20										6 / 20
	7											7
	8	25										8 / 25
	9											9
	10	30										10 / 30
	11											11
	12	35										12 / 35
	13											13
	14	40										14 / 40
	15											15
		45										45
		50										50

TEST RESULTS

N : STD PENETRATION INDEX (STROKES/0,3 m)
k : PERMÉABILITY (cm/s)

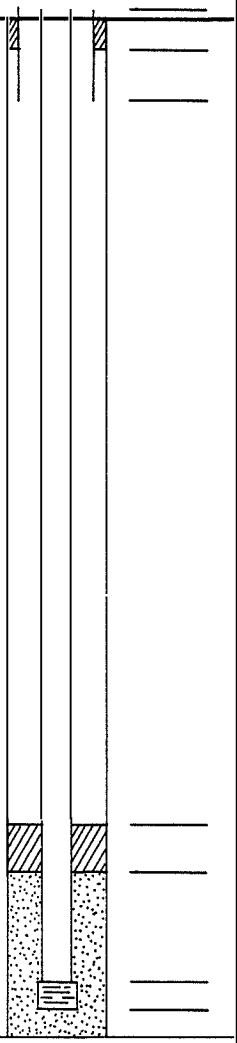
NOTES:
Partial cave in of hole when drill rods were being pulled up; hole filled itself below 4,22 m depth.

BOREHOLE REPORT

Borehole No. 3
Project no: 829.NBA.1C
Date of drilling: Oct.19,83
Project: Landfill sites, Indian reserves - Phase 2
Date of report: Nov.15,83
Site: Mistassini, site 02-01-01 (old dump)
Hammer: mass ..... kg
Elevation reference: Arbitrary EMel.100,00 Type of borehole: 13 cm auger Height of drop ..... cm

ELEV. m	DEPTH m	DEPTH ft	DESCRIPTION	Strat.	W.L.	Samples and tests: Loc.	Type & No.	Rec. (%)	Test Results
101,56	0	0							
	1	5	Domestic wastes.						
99,74	2								
	3	10	Grey silt.						
97,91	4								
	5	15	Till: silty sand, a bit of gravel, grey; some cobbles and blocks.						
	6	20							
94,55	7				▼	21-10-83			
	8	25							
	9	30							
	10						k-1		k: invalid test
91,35	11	35	End of drilling at 10,21 m						
	12	40							
	13								
	14	45							
	15	50							

Piezometer Setting — SKETCH



ELEV. m	DEPTH m	DEPTH ft
101,67	0	0
101,26	1	5
100,75	2	
	3	10
	4	
	5	15
	6	20
	7	
93,49	8	25
93,03	9	30
91,94	10	
91,66	11	35
	12	40
	13	
	14	45
	15	50

TEST RESULTS

N : STD PENETRATION INDEX (STROKES/0,3 m)
k : PERMÉABILITY (cm/s)

NOTES:

BOREHOLE REPORT

Borehole No. 4
Project no: 829.NBA.1C
Date of drilling: Oct. 20, 83
Project: Landfill sites, Indian reserves - Phase 2
Date of report: Nov. 15, 83
Site: Mistassini, site 02-01-01 (old dump)
Hammer: mass ..... kg
Elevation reference: Arbitrary BM el. 100,00 Type of borehole 13 cm auger Height of drop ..... cm

SOIL SECTION						Samples and tests			Test Results	Piezometer Setting			
ELEV. m	DEPTH m	DEPTH ft.	DESCRIPTION	Strat.	W.L.	Loc.	Type & No.	Rec. (%)		SKETCH	ELEV. m	DEPTH m	DEPTH ft
99,80	0	0									99,97	0	0
			Domestic wastes.								99,49		
											99,06	1	5
98,09	2					21-10-83							
97,66			Brown silty sand.								97,10		
	3	10									96,77	3	10
96,75			Till: silty sand, a bit of gravel, grey, cobbles and blocks.				k-1		k: 7,8 X 10^{-5} cm/s				
	4										96,14		
95,53											95,86	4	
		15	End of drilling at 4,27 m										15
	5											5	
	6	20										6	20
	7											7	
		25											25
	8											8	
	9	30										9	30
	10											10	
		35											35
	11											11	
	12	40										12	40
	13											13	
		45											45
	14											14	
	15	50										15	50

TEST RESULTS

N : STD PENETRATION INDEX (STROKES/0,3 m)
k : PERMÉABILITY (cm/s)

NOTES:

MISTASSINI

SITE 02-01-02 - EXISTING DUMP

BOREHOLE REPORT

Borehole No. 1
Project no: 829.NBA.1C
Date of drilling Oct.20,83
Project Landfill sites, Indian reserves - Phase 2
Date of report Nov.15,83
Site Mistassini, site 02-01-02 (existing dump)
Hammer: mass ..... kg
Elevation reference Arbitrary BM, el.200,00 Type of borehole 13 cm auger Height of drop ..... cm

SOIL SECTION					Samples and tests			Test Results	Piezometer Setting		
ELEV. m	DEPTH m	DEPTH ft	DESCRIPTION	Strat.	W.L.	Loc.	Type & No.	Rec. (%)		SKETCH	ELEV. m	DEPTH m	DEPTH ft
199,43	0	0									199,55	0	0
	1	5	Domestic wastes.								199,13	1	5
	2										198,63	2	
197,30	3	10	Gravel.									3	10
	4	15										4	15
194,56	5		Sand, gravels and cobbles.									5	
	6	20									193,69	6	20
193,21					▼						193,34		
	7	25				21-10-83	k-1		k: 7,3 X 10^{-5} cm/s		192,55	7	25
	8										192,27	8	
190,90											191,97		
	9	30	End of drilling at 8,53 m									9	30
	10	35										10	35
	11											11	
	12	40										12	40
	13											13	
	14	45										14	45
	15											15	
		50											50

TEST RESULTS

N : STD PENETRATION INDEX (STROKES/0,3 m)
k : PERMÉABILITY (cm/s)

NOTES: Partial cave in of hole when drill rods were being pulled up; hole filled itself below 7,47 m.

BOREHOLE REPORT

Borehole No. 2
Project no: 829.NBA.1C
Date of drilling: Oct. 20, 83
Project: Landfill sites, Indian reserves - Phase 2
Date of report: Nov. 16, 83
Site: Mistassini, site 02-01-02 (existing dump)
Hammer: mass ..... kg
Elevation reference: Arbitrary BM el. 200,00 Type of borehole: 13 cm auger
Height of drop ..... cm

SOIL SECTION						Samples and tests			Test Results	Piezometer Setting				
ELEV. m	DEPTH m	DEPTH ft.	DESCRIPTION	Strat.	W.L.	Loc.	Type & No.	Rec. (%)		SKETCH	ELEV. m	DEPTH m	DEPTH ft.
199,84	0	0									199,89	0	0
199,54			Moss.								199,54		
			Sand and gravel.								198,99	1	5
	2											2	
	3	10										3	10
	4											4	
	5	15										5	15
194,02	6	20			▼		21-10-83				194,25	6	20
											193,90		
							k-1		k: 5,0 X 10^{-5} cm/s		193,26		
192,68	7										192,98	7	
			End of drilling at 7,16m										
	8	25										8	25
	9	30										9	30
	10											10	
	11	35										11	35
	12	40										12	40
	13											13	
	14	45										14	45
	15	50										15	50

TEST RESULTS

N : STD PENETRATION INDEX (STROKES/0,3m)
k : PERMÉABILITY (cm/s)

NOTES:

KAHNAWAKE

SITE 06-01-01 - MUNICIPAL

BOREHOLE REPORT

Borehole No. 1
Project no: 829.NBA.1B
Date of drilling: Oct.3,83
Project: Landfill sites, Indian reserves - Phase 2
Date of report: Feb.9,84
Site: Kahnawake, site 06-01-01 (Municipal)
Hammer: mass ..... kg
Elevation reference: Arbitrary BM, el. 300,00 Type of borehole 13 cm auger
Height of drop ..... cm

SOIL SECTION					Samples and tests			Test	Piezometer Setting		
ELEV. m	DEPTH m	DEPTH ft	DESCRIPTION	Strat.	W.L.	Loc.	Type & No.	Rec. (%)	Results	SKETCH	ELEV. m	DEPTH m	DEPTH ft
296,14	0	0										0	0
			Domestic wastes										
295,23	1		End of drilling at 0,91 m - Refusal on rock									1	
		5											5
	2											2	
	3	10										3	10
	4											4	
		15											15
	5											5	
	6	20										6	20
	7											7	
		25											25
	8											8	
	9	30										9	30
	10											10	
		35											35
	11											11	
	12	40										12	40
	13											13	
		45											45
	14											14	
	15	50										15	50

TEST RESULTS

N : STD PENETRATION INDEX (STROKES/0,3 m)
k : PERMEABILITY (cm/s)

NOTES: Water level not reached, no piezometer installed. Two other drillings, in the same zone, reached refusal at 0,61 m.

BOREHOLE REPORT

Borehole No. 2
Project no: 829.NBA.1B
Date of drilling Oct.3,83
Project Landfill sites, Indian reserves - Phase 2
Date of report Feb.9,84
Site Kahnawake, site 06-01-01 (Municipal)
Hammer: mass ..... kg
Elevation reference Arbitrary FM, el.300,00 Type of borehole 13 cm auger
Height of drop ..... cm

SOIL SECTION						Samples and tests			Test Results	Piezometer Setting		
ELEV. m	DEPTH m	DEPTH ft.	DESCRIPTION	Strat.	W.L	Loc.	Type & No.	Rec. (%)		SKETCH	ELEV. m	DEPTH m / ft
296,31	0	0										0 / 0
			Domestic wastes									
294,94	1,37	5	End of drilling at	1,37	m -	Refusal	on rock					

TEST RESULTS

N : STD PENETRATION INDEX (STROKES/0,3 m)
k : PERMEABILITY (cm/s)

NOTES: Water level not reached, no piezometer installed.

KAHNAWAKE

SITE 06-01-02 - MORRIS

BOREHOLE REPORT

Borehole No. 1
Project no: 829.NBA.1B
Date of drilling: Sept. 28, 83
Project: Landfill sites - Indian reserves - Phase 2
Date of report: Nov. 9, 83
Site: Kahnawake, site 06-01-02 (Morris)
Hammer: mass ..... kg
Elevation reference: Arbitrary BM, el. 200,00 Type of borehole: 15 cm hollow type and 13 cm augers
Height of drop ..... cm

SOIL SECTION						Samples and tests			Test Results	Piezometer Setting		
ELEV. m	DEPTH m	DEPTH ft	DESCRIPTION	Strat.	W.L.	Loc.	Type & No.	Rec. (%)		SKETCH	ELEV. m	DEPTH m / ft
200,64	0	0									200,79	0 / 0
			Fill: dark brown sand and pieces of concrete and bricks.								200,34	
199,58	1										199,88	1
		5	Gravelly sand, a bit of silt, yellow-brown. Some cobbles and blocks.									5
197,60	2											2
	3	10										3 / 10
			Sand, a bit of silt to silty, a bit of gravel, dark brown. Some cobbles.									
196,61	4					31-10-83						4
196,23		15										15
	5		Till: Sandy silt, traces of gravel, dark grey.				k-1		k: 2,3 X 10^{-4} cm/s		195,77	5
											195,56	
194,55	6	20									194,60	6 / 20
194,24			Cobbles and blocks.								194,27	
193,96			Probably rock.	ROCK							194,24	
	7	25	End of drilling at 6,68 m.									7 / 25
	8											8
	9	30										9 / 30
	10											10
	11	35										11 / 35
	12											12
		40										40
	13											13
	14	45										14 / 45
	15											15
		50										50

TEST RESULTS

N : STD PENETRATION INDEX (STROKES/0,3 m)
k : PERMÉABILITY (cm/s)

NOTES: The water was very muddy during the installation of the piezometer.

BOREHOLE REPORT

Project no: 829.NBA.1B

Borehole No. 2A
Date of drilling Oct. 3, 83
Date of report Nov. 9, 83
Hammer: mass ..... kg
Height of drop ..... cm

Project: Landfill sites, Indian reserves - Phase 2
Site: Kahnawake, site 06-01-02 (Morris)
Elevation reference: Arbitrary BM, el. 200,00 Type of borehole: 13 cm auger

SOIL SECTION					Samples and tests			Test Results	Piezometer Setting		
ELEV. m	DEPTH m	DEPTH ft.	DESCRIPTION	Strat.	W.L.	Loc.	Type & No.	Rec. (%)		SKETCH	ELEV. m	DEPTH m	DEPTH ft
199,25	0	0										0	0
	1	5	Brown silty sand. Some cobbles and blocks.									1	5
197,57	2		End of drilling at	1,68	m –	Refusal	on rock	or block.				2	
	3	10										3	10
	4	15										4	15
	5											5	
	6	20										6	20
	7											7	
	8	25										8	25
	9											9	
	10	30										10	30
	11											11	
	12	35										12	35
	13	40										13	40
	14											14	
	15	45										15	45
		50											50

TEST RESULTS

N : STD PENETRATION INDEX (STROKES/0,3 m)
k : PERMEABILITY (cm/s)

NOTES: Water level not reached, no piezometer installed.

BOREHOLE REPORT

Borehole No. 2
Project no: 829.NBA.1B
Date of drilling Oct.3,83
Project Landfill sites - Indian reserves - Phase 2
Date of report Nov.9,83
Site Kahnawake, site 06-01-02 (Morris)
Hammer: mass ..... kg
Elevation reference: Arbitrary BM, el.200,00 Type of borehole 13 cm auger
Height of drop ..... cm

SOIL SECTION						Samples and tests			Test Results	Piezometer Setting		
ELEV. m	DEPTH m	DEPTH ft	DESCRIPTION	Strat.	W.L.	Loc.	Type & No.	Rec. (%)		SKETCH	ELEV. m	DEPTH m / ft
198,63	0	0									198,76	0 / 0
			Silty sand, a bit of gravel, brown. Some cobbles and blocks.								198,32	
											197,63	1 / 5
	2											2
195,73	3	10	Gravel.									3 / 10
195,43			Silty sand, a bit of gravel, brown.									
194,67	4											4
194,51		15	Gravels and cobbles, a bit of sand to silty and gravelly sand, grey - brown.		▼	26-10-83	k-1		k.: 2,6 X 10^{-5} cm/s		194,51	
											194,21	5 / 15
193,52	5		Silt, traces of sand and gravel, grey.								193,47	
192,99											193,14	
	6	20	End of drilling at 5,64 m - Refusal on rock.									6 / 20
	7	25										7 / 25
	8											8
	9	30										9 / 30
	10	35										10 / 35
	11											11
	12	40										12 / 40
	13	45										13 / 45
	14											14
	15	50										15 / 50

TEST RESULTS

N : STD PENETRATION INDEX (STROKES/0,3 m)
k : PERMÉABILITY (cm/s)

NOTES: A second drilling was necessary due to high lateral deviation caused by the presence of blocks at 2,5 m depth.

BOREHOLE REPORT

Borehole No. 3
Project no: 829.NBA.1B
Date of drilling Oct.3,83
Project Landfill sites, Indian reserves - Phase 2
Date of report Nov.9,83
Site Kahnawake, site 06-01-02 (Morris)
Hammer: mass ..... kg
Elevation reference Arbitrary BM, el. 200,00 Type of borehole 13 cm auger
Height of drop ..... cm

SOIL SECTION					Samples and tests			Test Results	Piezometer Setting		
ELEV. m	DEPTH m	DEPTH ft	DESCRIPTION	Strat.	W.L	Loc.	Type & No.	Rec. (%)		SKETCH	ELEV. m	DEPTH m	DEPTH ft
200,00	0	0									200,11	0	0
			Silty sand, a bit of gravel to gravelly, light brown. Some cobbles and blocks.								199,70		
	1										199,20	1	
198,18		5											5
	2		Silty sand, a bit of gravel to gravelly, dark grey. Some layers containning more gravels.									2	
196,65		10			▼	26-	10-83						10
	4											4	
		15									195,81		15
	5						k-1		k: invalid	test	195,51	5	
											195,00		
194,37											194,67		
	6	20	End of drilling at 5,64 m.									6	20
	7											7	
		25											25
	8											8	
	9	30										9	30
	10											10	
		35											35
	11											11	
	12	40										12	40
	13											13	
		45											45
	14											14	
	15	50										15	50

TEST RESULTS

N : STD PENETRATION INDEX (STROKES/0,3 m)
k : PERMÉABILITY (cm/s)

NOTES:

KAHNAWAKE

SITE 06-01-03 - BEAUVAIS

BOREHOLE REPORT

Borehole No. 1
Project no: 829.NBA.1B — Date of drilling: Sept. 29, 83
Project: Landfill sites, Indian reserves - Phase 2 — Date of report: Nov. 8, 83
Site: Kahnawake, sites 06-01-03 (Beauvais) — Hammer: mass ..... kg
Elevation reference: Arbitrary BM, el. 400,00 — Type of borehole: 13 cm auger — Height of drop ..... cm

SOIL SECTION					Samples and tests			Test Results	Piezometer Setting		
ELEV. m	DEPTH m	DEPTH ft	DESCRIPTION	Strat.	W.L.	Loc.	Type & No.	Rec. (%)		SKETCH	ELEV. m	DEPTH m	DEPTH ft
404,23	0	0									404,34	0	0
			Brown sand.								403,93		
											403,42	1	
403,01		5	Brown sand and clay.										5
	2											2	
401,18	3	10	Silty clay.									3	10
	4											4	
		15			▼	14-	10-83						15
399,56	5											5	
398,19	6	20										6	20
			Till: sandy silt, a bit of gravel. Some cobbles, grey.								397,04		
	7										396,72	7	
		25					k-1		k: $6,2 \times 10^{-5}$ cm/s		396,33		25
	8										396,00	8	
395,70													
	9	30	End of drilling at 8,53 m.									9	30
	10											10	
		35											35
	11											11	
	12	40										12	40
	13											13	
		45											45
	14											14	
	15	50										15	50

TEST RESULTS

N : STD PENETRATION INDEX (STROKES/0,3 m)
k : PERMÉABILITY (cm/s)

NOTES:

BOREHOLE REPORT

Project no: 829.NBA.1B

Borehole No. 2
Date of drilling Sept. 29, 83
Date of report Nov. 8, 83
Hammer: mass ..... kg
Height of drop ..... cm

Project: Landfill sites, Indian reserves - Phase 2
Site: Kahnawake, site 06-01-03 (Beauvais)
Elevation reference: Arbitrary BM, el. 400,00 Type of borehole: 13 cm auger

SOIL SECTION					Samples and tests			Test Results	Piezometer Setting	
ELEV. m	DEPTH m	DEPTH ft	DESCRIPTION	Strat.	W.L.	Loc.	Type & No.	Rec. (%)	SKETCH	ELEV. m / DEPTH m, ft
400,86	0	0								401,01 / 0, 0
	1		Brown sand.							400,55 / 400,10
399,64					▼		12-10-83			
399,59		5	Till: sandy silt, a bit of gravel Some cobbles, grey.							
	2									
	3	10								397,66
	4									397,30
		15								396,77
396,06										396,44
	5		End of drilling at 4,80 m - Refusal or block or rock.							
	6	20								
	7									
		25								
	8									
	9	30								
	10									
		35								
	11									
	12	40								
	13									
		45								
	14									
	15	50								

TEST RESULTS

N : STD PENETRATION INDEX (STROKES/0,3 m)
k : PERMÉABILITY (cm/s)

NOTES: No permeability test made because the piezometer was obstructed.

BOREHOLE REPORT

Borehole No. 3
Project no: 829.NBA.1B
Date of drilling Sept. 29, 83
Project Landfill sites, Indian reserves - Phase 2
Date of report Nov. 8, 83
Site Kahnawake, site 06-01-03 (Beauvais)
Hammer: mass ..... kg
Elevation reference Arbitrary BM, el. 400,00 Type of borehole 13 cm auger
Height of drop ..... cm

SOIL SECTION					Samples and tests			Test Results	Piezometer Setting		
ELEV. m	DEPTH m	DEPTH ft	DESCRIPTION	Strat.	W.L	Loc.	Type & No.	Rec. (%)		SKETCH	ELEV. m	DEPTH m	DEPTH ft
400,90	0	0									401,05	0	0
			Brown sand.								400,59		
399,98	1										400,13	1	
			Till: sandy silt, traces of clay and gravel, dark grey.		▼								
399,30		5				12-10-83							5
	2											2	
397,85	3	10										3	10
			Grey silt.								397,70		
											397,39		
	4						k-1		k: invalid test		397,14	4	
		15									396,81		15
	5										396,50	5	
395,18	6	20	End of drilling at 5,71 m.									6	20
	7											7	
		25											25
	8											8	
	9	30										9	30
	10											10	
		35											35
	11											11	
	12	40										12	40
	13											13	
	14	45										14	45
	15											15	
		50											50

TEST RESULTS

N : STD PENETRATION INDEX (STROKES/0,3 m)
k : PERMÉABILITY (cm/s)

NOTES: Partial cave in of hole when drill rods were being pulled up; hole filled itself below 4,39 m depth.

BOREHOLE REPORT

Borehole No. 4
Project no: 829.NBA.1B
Date of drilling: Sept. 30, 83
Project: Landfill sites, Indian reserves - Phase 2
Date of report: Nov. 9, 83
Site: Kahnawake, site 06-01-03 (Beauvais)
Hammer: mass ..... kg
Elevation reference: Arbitrary BM, el. 400,00 Type of borehole: 15 cm hollow type auger
Height of drop ..... cm

SOIL SECTION					Samples and tests			Test Results	Piezometer Setting		
ELEV. m	DEPTH m	DEPTH ft	DESCRIPTION	Strat.	W.L.	Loc.	Type & No.	Rec. (%)		SKETCH	ELEV. m	DEPTH m	DEPTH ft
406,12	0	0									406,35	0	0
			Fill: sand and construction materials.								405,81		
405,51			Domestic wastes.								405,43		
	1	5										1	5
	2											2	
	3	10										3	10
	4											4	
		15											15
401,24	5		Silty clay, dark grey.									5	
400,43					▼	26-10-83					400,63		
	6	20									400,33	6	20
							k-1	k: 3,2 X 10^{-4} cm/s			399,46		
	7										399,13	7	
398,83		25	End of drilling at 7,29 m.										25
	8											8	
	9	30										9	30
	10											10	
		35											35
	11											11	
	12	40										12	40
	13											13	
		45											45
	14											14	
	15	50										15	50

TEST RESULTS

N : STD PENETRATION INDEX (STROKES/0,3 m)
k : PERMEABILITY (cm/s)

NOTES: Hole first drilled with 13 cm auger but filled itself following a collapse when drill rods were being pulled up.

BOREHOLE REPORT

Borehole No. 5

Project no: 829.NBA.1B — Date of drilling: Sept. 30, 83

Project: Landfill sites, Indian reserves - Phase 2 — Date of report: Nov. 9, 83

Site: Kahnawake, site 06-01-03 (Beauvais) — Hammer: mass ..... kg

Elevation reference: Arbitrary BM, el. 400,00 — Type of borehole: 13 cm auger — Height of drop ..... cm

SOIL SECTION					Samples and tests			Test Results	Piezometer Setting	
ELEV. m	DEPTH m	DEPTH ft	DESCRIPTION	Strat.	W.L.	Loc.	Type & No.	Rec. (%)		SKETCH
402,01	0	0								402,14
			Brown sand.				-			401,71
	1									401,22
400,79		5	Brown sandy clay.							
	2									
399,27	3	10	Soft grey clay.							
398,71					▼ 12-10-83					
	4	15								
397,13	5		Gravels and cobbles							396,37
	6	20								396,07
395,92			Till: sandy silt, a bit of gravel, dark grey.				k-1		k: $6,9 \times 10^{-5}$ cm/s	395,61
	7									395,28
394,85		25	End of drilling at 7,16 m.							
	8									
	9	30								
	10									
		35								
	11									
	12	40								
	13									
		45								
	14									
	15	50								

TEST RESULTS

N : STD PENETRATION INDEX (STROKES/0,3 m)

k : PERMÉABILITY (cm/s)

NOTES:

KAHNAWAKE

SITE 06-01-04 - GOODLEAF

BOREHOLE REPORT

Borehole No. 1
Project no: 829.NBA.1B
Date of drilling Oct.5,83
Project Landfill sites, Indian reserves - Phase 2
Date of report Nov.9,83
Site Kahnawake, site 06-01-04 (Goodleaf)
Hammer: mass ..... kg
Elevation reference: Arbitrary BM, el.30,48 Type of borehole 13 cm auger Height of drop ..... cm

SOIL SECTION					Samples and tests			Test Results	Piezometer Setting		
ELEV. m	DEPTH m	DEPTH ft	DESCRIPTION	Strat.	W.L.	Loc.	Type & No.	Rec. (%)		SKETCH	ELEV. m / DEPTH m / DEPTH ft
34,57	0	0									34,75 / 0 / 0
			Grey sand.								34,27
33,81	1	5	Domestic wastes.								33,83 / 1 / 5
31,83	3	10	Brown sandy clay.								3 / 10
	5	15									5 / 15
29,08	6	20	Till: silty sand, a bit of gravel, grey.								6 / 20
26,95	8	25			▼	05-10-83					26,34 / 8 / 25
	9	30									26,04 / 9 / 30
							k-1		k: 1,2 X 10^{-4} cm/s		
	10										24,92 / 10
24,28		35	End of drilling at 10,29 m.								24,59 / 35
	11										11
	12	40									12 / 40
	13										13
	14	45									14 / 45
	15	50									15 / 50

TEST RESULTS

N : STD PENETRATION INDEX (STROKES/0,3 m)
k : PERMÉABILITY (cm/s)

NOTES:

BOREHOLE REPORT

Borehole No. 2
Project no: 829.NBA.1B
Date of drilling Oct. 4,83
Date of report Nov.15,83
Project Landfill sites, Indian reserves - Phase 2
Site Kahnawake, site 06-01-04 (Goodleaf)
Hammer: mass ..... kg
Elevation reference: Arbitrary BM, el. 30,48 Type of borehole 13 cm auger Height of drop ..... cm

SOIL SECTION					Samples and tests			Test Results	Piezometer Setting		
ELEV. m	DEPTH m	DEPTH ft.	DESCRIPTION	Strat.	W.L.	Loc.	Type & No.	Rec. (%)	SKETCH	ELEV. m	DEPTH m / ft
31,75	0	0									0 / 0
			Fine brown sand.								
31,14	1	5	Brown sand and gravel.								1 / 5
	2										2
29,31	3	10	End of drilling at	2,44	m - Refusal on rock.						3 / 10
	4	15									4 / 15
	5										5
	6	20									6 / 20
	7	25									7 / 25
	8										8
	9	30									9 / 30
	10	35									10 / 35
	11										11
	12	40									12 / 40
	13	45									13 / 45
	14										14
	15	50									15 / 50

TEST RESULTS

N : STD PENETRATION INDEX (STROKES/0,3 m)
k : PERMÉABILITY (cm/s)

NOTES: Water level not reached, no piezometer installed. Two other drillings, in the same zone, reached refusal respectively at 1,22 and 1,98 m depth.

BOREHOLE REPORT

Borehole No. 3
Project no: 829.NBA.1B
Date of drilling Nov. 22, 83
Project Landfill sites, Indian reserves - Phase 2
Date of report Feb. 9, 84
Site Kahnawake, site 06-01-04 (Goodleaf)
Hammer: mass ..... kg
Elevation reference Arbitrary BM, el. 30,48 Type of borehole 13 cm auger and 15 cm hollow type auger
Height of drop ..... cm

SOIL SECTION						Samples and tests			Test Results	Piezometer Setting		
ELEV. m	DEPTH m	DEPTH ft.	DESCRIPTION	Strat.	W.L	Loc.	Type & No.	Rec. (%)		SKETCH	ELEV. m	DEPTH m / ft
31,32	0	0										0 / 0
	1	5	Dry materials: soil and construction materials.									1 / 5
29,80	2		Domestic wastes.									2
28,42	3	10	Sandy silt, traces of gravel, dark grey.									3 / 10
	4	15										4 / 15
26,44	5		End of drilling at 4,88 m		-	Refusal on rock probably.						5
	6	20										6 / 20
	7	25										7 / 25
	8											8
	9	30										9 / 30
	10	35										10 / 35
	11											11
	12	40										12 / 40
	13	45										13 / 45
	14											14
	15	50										15 / 50

TEST RESULTS

N : STD PENETRATION INDEX (STROKES/0,3 m)
k : PERMÉABILITY (cm/s)

NOTES: Water level not reached, no piezometer installed.

BOREHOLE REPORT

Borehole No. 4
Project no: 829.NBA.1B
Date of drilling Nov. 22, 83
Project Landfill sites, Indian reserves - Phase 2
Date of report Feb. 9, 84
Site Kahnawake, site 06-01-04 (Goodleaf)
Hammer: mass ..... kg
Elevation reference Arbitrary BM, el. 30,48 Type of borehole 15 cm hollow type auger
Height of drop ..... cm

SOIL SECTION					Samples and tests			Test Results	Piezometer Setting		
ELEV. m	DEPTH m	DEPTH ft.	DESCRIPTION	Strat.	W.L.	Loc.	Type & No.	Rec. (%)		SKETCH	ELEV. m	DEPTH m	DEPTH ft.
34,72	0	0										0	0
	1		Fill: soil and dry materials.									1	
33,81		5	Waste: wire, wood, soil...etc.										5
	2											2	
32,28	3	10	Till: sandy silt, traces of gravel.									3	10
	4											4	
		15											15
	5											5	
29,39	6	20	End of drilling at 5,33 m - Refusal on rock probably.									6	20
	7											7	
		25											25
	8											8	
	9	30										9	30
	10											10	
		35											35
	11											11	
	12	40										12	40
	13											13	
		45											45
	14											14	
	15	50										15	50

TEST RESULTS

N : STD PENETRATION INDEX (STROKES/0,3 m)
k : PERMÉABILITY (cm/s)

NOTES: Water level not reached, no piezometer installed.

BOREHOLE REPORT

Borehole No. 5
Project no: 829.NBA.1B
Date of drilling Nov. 22,83
Project Landfill sites, Indian reserves - Phase 2
Date of report Feb. 9,84
Site Kahnawake, site 06-01-04 (Goodleaf)
Hammer: mass ..... kg
Elevation reference: Arbitrary BM, el. 30,48 Type of borehole 13 cm auger and 15 cm hollow type auger
Height of drop ..... cm

SOIL SECTION					Samples and tests			Test	Piezometer Setting		
ELEV. m	DEPTH m	DEPTH ft.	DESCRIPTION	Strat.	W.L	Loc.	Type & No.	Rec. (%)	Results	SKETCH	ELEV. m	DEPTH m	DEPTH ft
35,61	0	0										0	0
35,00			Vegetal soil cover.										
	1	5	Wastes: construction material.									1	5
	2											2	
	3	10										3	10
	4											4	
		15											15
	5											5	
29,82	6	20	Humid clayey soil.									6	20
29,21			End of drilling at 6,40 m - Refusal on rock.										
	7	25										7	25
	8											8	
	9	30										9	30
	10											10	
		35											35
	11											11	
	12	40										12	40
	13											13	
	14	45										14	45
	15											15	
		50											50

TEST RESULTS

N : STD PENETRATION INDEX (STROKES/0,3 m)
k : PERMÉABILITY (cm/s)

NOTES: Water level not reached, no piezometer installed. Two other drillings, in the same zone, reached refusal respectively at 2,13 and 2,74 m.

KAHNAWAKE

SITE 06-01-05 - PATTON

BOREHOLE REPORT

Borehole No. 1

Project no: 829.NBA.1B — Date of drilling: Sept. 26, 83

Project: Landfill sites, Indian reserves - Phase 2 — Date of report: Nov. 1, 83

Site: Kahnawake, site 06-01-05 (Patton) — Hammer: mass 6,35 kg

Elevation reference: Arbitrary FM, el. 100,00 — Type of borehole: 15 cm hollow type auger — Height of drop: 76 cm

SOIL SECTION					Samples and tests			Test Results	Piezometer Setting		
ELEV. m	DEPTH m	DEPTH ft	DESCRIPTION	Strat.	W.L.	Loc.	Type & No.	Rec. (%)		SKETCH	ELEV. m	DEPTH m	DEPTH ft
106,07	0	0									106,18	0	0
			Fill: domestic wastes and construction materials.								105,76		
											105,16		
101,01	5	20			▼ 26-10-83								
99,36	7	25	Silt, a bit of clay, traces of sand and gravel, dark grey.										
							N-1	100	6,11,13 N=24		97,38		
											97,28		
							k-1		k: $1,8 \times 10^{-4}$ cm/s		96,44		
											96,09		
95,76	10,31	35	End of drilling at 10,31 m.										
	15	50											

TEST RESULTS

N : STD PENETRATION INDEX (STROKES/0,3 m)

k : PERMÉABILITY (cm/s)

NOTES: The installation of the lower bentonite plug was difficult; imperviousness is uncertain.

BOREHOLE REPORT

Borehole No. 2

Project no: 829.NBA.1B — Date of drilling: Sept. 27, 83

Project: Landfill sites, Indian reserves - Phase 2 — Date of report: Nov. 8, 83

Site: Kahnawake, site 06-01-05 (Patton) — Hammer: mass ..... kg

Elevation reference: Arbitrary BM, el. 100,00 — Type of borehole: 13 cm auger — Height of drop ..... cm

SOIL SECTION						Samples and tests			Test Results	Piezometer Setting		
ELEV. m	DEPTH m	DEPTH ft	DESCRIPTION	Strat.	W.L.	Loc.	Type & No.	Rec. (%)		SKETCH	ELEV. m	DEPTH m / ft
100,98	0	0									101,13	0 / 0
											100,68	
100,07	1		Silty sand, traces of clay, yellow-brown								100,22	
	2	5	Sandy silt, traces to a bit of clay, dark grey. Gravels and cobbles between 1,5 and 1,8 m depth.									
	3	10										
	4	15										
	5											
	6	20										
94,53					▼	26-10-83						
93,97	7		Sandy silt, traces of clay and gravel, dark grey.									
	8	25										
	9	30										
	10											
	11	35										
	12	40	Cobble at 12,2 m.									
	13										87,87	
	14	45					k-1		k: 4,0 X 10^{-5} cm/s		87,59	
86,20	15	50	End of drilling at 14,78 m.								86,83	
											86,50	

TEST RESULTS

N : STD PENETRATION INDEX (STROKES/0,3 m)

k : PERMEABILITY (cm/s)

NOTES:

BOREHOLE REPORT

Borehole No. 3
Project no: 829.NBA.1B
Date of drilling: Sept. 27, 83
Project: Landfill sites, Indian reserves - Phase 2
Date of report: Nov. 8, 83
Site: Kahnawake, site 06-01-05 (Patton)
Hammer: mass ..... kg
Elevation reference: Arbitrary BM, el. 100,00 Type of borehole: 13 cm auger
Height of drop ..... cm

SOIL SECTION					Samples and tests			Test Results	Piezometer Setting		
ELEV. m	DEPTH m	DEPTH ft	DESCRIPTION	Strat.	W.L.	Loc.	Type & No.	Rec. (%)		SKETCH	ELEV. m	DEPTH m	DEPTH ft
99,84	0	0									99,95	0	0
			Fill: organic soil and construction materiels.								99,54		
											99,04	1	
98,68		5	Domestic wastes.										5
	2											2	
	3	10										3	10
95,75	4				▼	26-10-83						4	
		15											15
94,97	5											5	
			Sandy silt, traces to a bit of clay and traces of gravel, dark grey.								93,77		
	6	20									93,70	6	20
							K-1		k: $1,2 \times 10^{-4}$ cm/s		93,16		
	7										92,83	7	
92,58		25	End of drilling at 7,26 m.										25
	8											8	
	9	30										9	30
	10											10	
		35											35
	11											11	
	12	40										12	40
	13											13	
		45											45
	14											14	
	15	50										15	50

TEST RESULTS

N : STD PENETRATION INDEX (STROKES/0,3 m)
k : PERMÉABILITY (cm/s)

NOTES: The lower bentonite plug is only 7 cm thick; difficulties in placing the bentonite plug, hole partially blocked at 2,5 m depth.

BOREHOLE REPORT

Borehole No. 4
Project no: 829.NBA.1B
Date of drilling: Oct. 4, 83
Project: Landfill sites, Indian reserves - Phase 2
Date of report: Nov. 9, 83
Site: Kahnawake, site 06-01-05 (Patton)
Hammer: mass ..... kg
Elevation reference: Arbitrary BM, el. 100,00 Type of borehole 13 cm auger Height of drop ..... cm

SOIL SECTION						Samples and tests			Test Results	Piezometer Setting		
ELEV. m	DEPTH m	DEPTH ft	DESCRIPTION	Strat.	W.L.	Loc.	Type & No.	Rec. (%)		SKETCH	ELEV. m	DEPTH m / ft
106,65	0	0									106,79	0 / 0
106,35			Fill: bricks.								106,35	
			Domestic wastes.								105,88	
	1	5										1 / 5
	2											2
	3	10										3 / 10
	4											4
		15										15
	5											5
	6	20										6 / 20
	7											7
		25										25
	8											8
97,81	9	30	Till: silt, a bit of sand, traces of clay and gravel, dark grey.									9 / 30
	10											10
		35										35
	11						k-1		k: invalid test		96,59	11
95,27					▼		26-10-83				96,29	
											95,73	
94,82	12	40	End of drilling at 11,84 m.								95,40	12 / 40
	13											13
	14	45										14 / 45
	15											15
		50										50

TEST RESULTS

N : STD PENETRATION INDEX (STROKES/0,3 m)
k : PERMEABILITY (cm/s)

NOTES:

3. Water Level Surveys

WATER LEVEL SURVEYS (m)

MISTASSINI RESERVE SITES

SITE	PIEZO. Nb.	SURFACE WATER STATION Nb.	DATE OF WATER LEVEL SURVEYS 83-10-20 A.M.	83-10-20 P.M.	83-10-21
Old dump site 02-01-01	1		95,28	95,44	
	2		102,22	102,32	102,25
	3		92,87	93,51	94,55
	4		97,74		98,09
		5		96,24	
		6		99,29	
		7		99,20	
		8		96,79	
Existing dump site 02-01-02	1		192,39		193,21
	2		193,77		194,02
		3			188,64
		4			187,02
		5			194,37
		6			

- Water levels are given in m. relative to the arbitrary bench mark of each site.
  Water levels were observed in the piezometers and most of surface water sampling stations.

WATER LEVEL SURVEYS (m)

KAHNAWAKE RESERVE SITES

SITE	PIEZO. Nb.	SURFACE WATER STATION Nb.	DATE OF WATER LEVELS SURVEYS									
				83-09-29	83-10-07	83-10-12	83-10-14	83-10-26	83-10-27	83-10-28	83-10-31	83-11-21	83-12-20
Municipal-	1		nil	no piezometer installed									
site 06-01-01	2		nil										
		3			278,54								
Morris-	1		196,07		196,50			196,58	196,14	196,55	196,61	198,20	
site 06-01-02	2A		nil										
	2		193,52		193,52			194,51	193,47	193,40	194,06	195,45	
	3		196,14		196,65			196,65	195,78	196,27	196,49	198,48	
		4						198,00					
		5						196,57					
Beauvais-	1		397,75				399,56		399,45		399,43		
site 06-01-03	2		398,73			399,59	399,39	399,56					
	3		398,00			399,30		399,25	399,15		399,15		
	4		400,40			400,40		400,43	400,43		400,35		
	5		396,83			398,71		398,66	398,48		398,58		
		6				398,80							
		7				400,50							
		8				399,58							
		9				398,73							
		10				-							
		11				-							
Goodleaf-	1		26,95									27,20	
site 06-01-04	2		nil	no piezometer installed									
	3		nil	no piezometer installed									
	4		nil	no piezometer installed									
	5		nil	no piezometer installed									
		6											27,64
		7											28,99
		8											30,93
		9											31,14
		10											30,58
		11											28,51

WATER LEVEL SURVEYS (m)

KAHNAWAKE RESERVE SITES

SITE	PIEZO. Nb.	SURFACE WATER STATION Nb.	DATE OF WATER LEVELS SURVEYS										
				83-09-29	83-10-07	83-10-12	83-10-14	83-10-26	83-10-27	83-10-28	83-10-31	83-11-21	83-12-20
Patton-site 06-01-05	1		102,79	100,71				100,01	97,23		98,45	100,89	
	2		90,32	89,60				94,53	91,94		90,62	94,60	
	3		94,96	94,30				95,75	92,88		93,08	93,90	
	4		-	-				95,27	-		-	95,22	
		5								98,53			
		6								-			
		7								-			
		8								92,05			
		9								91,54			

- Water levels are given in m. relative to the arbitrary bench mark of each site.
  Water levels were observed in the piezometers and most of surface water sampling stations.

- Bore holes #2 the piezometer of clogged up.

4. Environment Canada Guidelines

Environment Canada
Environnement Canada

WATER QUALITY SOURCEBOOK

A Guide to Water Quality Parameters

R.N. McNeely, V.P. Neimanis and L. Dwyer

INLAND WATERS DIRECTORATE,
WATER QUALITY BRANCH,
OTTAWA, CANADA, 1979.

(Résumé en français)

TABLE 1
MAXIMUM PERMISSIBLE WATER QUALITY LEVELS FOR DRINKING WATER SUPPLIES

PARAMETER	LEVEL			REFERENCE
ARSENIC, as As	LE	0.050	mg/L	INTERNATIONAL JOINT COMMISSION, 1977
BACTERIA, FECAL COLIFORM	LT	1000	No./dL	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
BACTERIA, FECAL STREPTOCOCCI	LT	50	No./dL	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
BACTERIA, TOTAL COLIFORM	LT	5000	No./dL	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
BARIUM, as Ba	LE	1.0	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
BORON, as B	LE	5.0	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
CADMIUM, as Cd	LE	0.01	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
CHROMIUM, as Cr(VI)	LE	0.050	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY. 440/9-76-023
CYANIDE, as CN	LE	0.20	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
FLUORIDE, as F	LE	1.5	mg/L	DEPT. OF THE ENVIRONMENT, 1972, TECH. BULL. 67
HARDNESS, TOTAL, as $CaCO_3$	LE	500	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
LEAD, as Pb	LE	0.05	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
NITRATE + NITRITE, as N	LE	10.0	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
NITRITE, as N	LE	1.0	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
SELENIUM, as Se	LE	0.01	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
SILVER, as Ag	LE	0.05	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969

TABLE 3
ACCEPTABLE RAW WATER QUALITY LEVELS FOR DRINKING WATER SUPPLIES

PARAMETER	LEVEL			REFERENCE
ALKALINITY, TOTAL, as $CaCO_3$	GE	30	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
	LE	500	mg/L	
AMMONIA, as N	LE	0.5	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
ARSENIC, as As	LE	0.01	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
BACTERIA, FECAL COLIFORM	LT	100	No./dL	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
BACTERIA, TOTAL COLIFORM	LT	1000	No./dL	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
BARIUM, as Ba	LT	1.0	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
BORON, as B	LT	5.0	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
CADMIUM, as Cd	LT	0.01	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
CALCIUM, as Ca	LE	200	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
CHLORIDE, as Cl	LE	250	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
CHROMIUM, as Cr(VI)	LT	0.05	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
COLOUR	LE	15	TCU	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
COPPER, as Cu	LE	1.0	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
CYANIDE, as CN	LE	0.01	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
FLUORIDE, as F	LE	1.4	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
HARDNESS, TOTAL, as $CaCO_3$	LE	120	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
IRON, DISSOLVED, as Fe	LE	0.3	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
LEAD, as Pb	LT	0.05	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
MAGNESIUM, as Mg	LE	150	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
MANGANESE, as Mn	LE	0.05	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
MERCURY, as Hg	LE	2	µg/L	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76-023
NITRATE + NITRITE, as N	LT	10.0	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
NITRITE, as N	LE	1.0	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
ODOUR	LE	4	TON	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
OIL AND GREASE		ND	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
pH	GE	6.5		DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
	LE	8.3		
PHENOLIC SUBSTANCES, as PHENOL	LE	0.001	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76-023
PHOSPHATE, TOT.INORG., as P	LE	0.065	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
PHOSPHATE, TOTAL, as P	LT	100	µg/L	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76-023
PHOSPHORUS, as P	LE	0.2	mg/L	HART, 1974, AUSTRAL. WAT. RES. COUNCIL. TECH. PAPER 7
α– RADIATION, TOTAL	LE	0.5	pCi/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
β– RADIATION, TOTAL	LE	5	pCi/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
SELENIUM, as Se	LT	0.01	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
SODIUM, as Na	LE	270	mg/L	HART, 1974, AUSTRAL. WAT. RES. COUNCIL, TECH. PAPER 7
SULPHATE, as SO_4	LE	500	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
SULPHIDE, as H_2S	LE	0.3	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
SURFACTANTS, as MBAS	LE	0.5	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
TEMPERATURE, ^{o}C	LE	15	^{o}C	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
TOTAL DISSOLVED SOLIDS	LE	1000	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
TURBIDITY	LE	5	JTU	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
URANYL ION, as UO_2	LE	5000	µg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
ZINC, as Zn	LE	5.0	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969

TABLE 5
OBJECTIVE LEVELS FOR RAW WATER USED AS A DRINKING WATER SOURCE

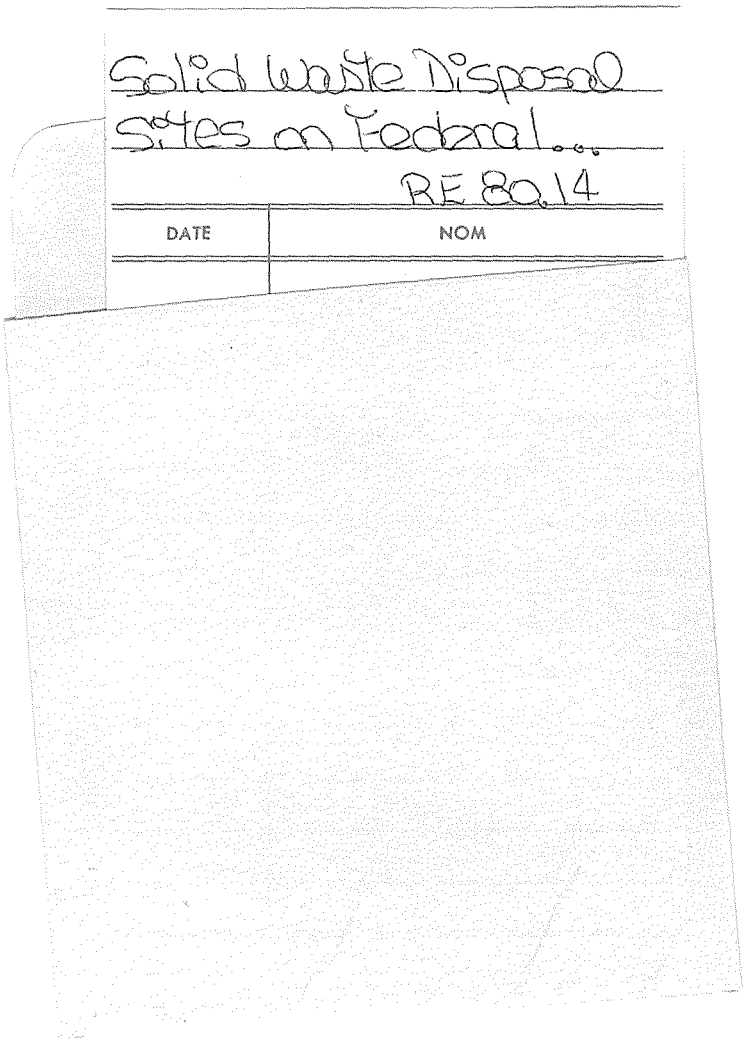
PARAMETER	LEVEL			REFERENCE
AMMONIA, as N	LE	0.01	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
ARSENIC, as As		ND	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
BACTERIA, FECAL COLIFORM	LT	10	No./dL	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
BACTERIA, FECAL STREPTOCOCCI	LT	1	No./dL	ONTARIO WATER RESOURCES COMMISSION, 1970
BACTERIA, TOTAL COLIFORM	LT	100	No./dL	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
BARIUM, as Ba		ND	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
CADMIUM, as Cd		ND	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
CALCIUM, as Ca	LT	75	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
CHLORIDE, as Cl	LT	250	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
CHROMIUM, as Cr(VI)		ND	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
COLOUR	LT	5	TCU	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
COPPER, as Cu	LT	0.01	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
CYANIDE, as CN		ND	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
FLUORIDE, as F	LT	1.2	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
HARDNESS, TOTAL, as $CaCO_3$	LT	120	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
IRON, DISSOLVED, as Fe	LT	0.05	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
LEAD, as Pb		ND	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
MAGNESIUM, as Mg	LT	50	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
MANGANESE, as Mn	LT	0.01	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
NITRATE + NITRITE, as N	LT	10.0	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
ODOUR		ND	TON	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
PHENOLIC SUBSTANCES, as PHENOL		ND	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
PHOSPHATE, TOT.INORG., as P	LT	0.065	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
RADIATION, TOTAL	LT	10	pCi/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
SELENIUM, as Se		ND	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
SULPHATE, as SO_4	LT	250	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
SULPHIDE, as H_2S		ND	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
SURFACTANTS, as MBAS	LT	0.2	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
TEMPERATURE	LT	10	^{o}C	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
TOTAL DISSOLVED SOLIDS	LT	500	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
TURBIDITY	LT	1	JTU	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
URANYL ION, as UO_2	LT	1000	μg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969
ZINC, as Zn	LT	1.0	mg/L	DEPT. OF NATIONAL HEALTH & WELFARE, CANADA, 1969

TABLE 6
GUIDELINES FOR LIVESTOCK AND WILDLIFE WATERING

PARAMETER	LEVEL			REFERENCE
ALUMINUM, as Al	LE	5	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
ARSENIC, as As	LE	0.2	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
BORON, as B	LE	5.0	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
CADMIUM, as Cd	LE	0.050	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
CALCIUM, as Ca	LE	1000	mg/L	HART, 1974, AUSTRAL. WAT. RES. COUNCIL, TECH. PAPER 7
CHROMIUM, as Cr	LE	1.0	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
COBALT, as Co	LE	1.0	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
COPPER, as Cu	LE	0.5	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
FLUORIDE, as F	LE	2.0	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
LEAD, as Pb	LE	0.1	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
MERCURY, as Hg	LE	10	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
MOLYBDENUM, as Mo	LE	0.01	mg/L	HART, 1974, AUSTRAL. WAT. RES. COUNCIL, TECH. PAPER 7
NITRATE + NITRITE, as N	LE	100	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
NITRITE, as N	LE	10	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
α– RADIATION, TOTAL	LE	0.5	pCi/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
β– RADIATION, TOTAL	LE	5	pCi/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
SELENIUM, as Se	LE	0.05	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
SULPHATE, as SO_4	LE	1000	mg/L	HART, 1974, AUSTRAL. WAT. RES. COUNCIL, TECH. PAPER 7
TOTAL DISSOLVED SOLIDS	LE	3000	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
VANADIUM, as V	LE	0.1	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
ZINC, as Zn	LE	25	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033

TABLE 18
GUIDELINES FOR THE PROTECTION OF FRESHWATER AQUATIC LIFE

PARAMETER	LEVEL			REFERENCE
ALDRIN	LE	0.001	μg/L	INTERNATIONAL JOINT COMMISSION, 1977
ALKALINITY, as $CaCO_3$	GT	20	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76-023
ALUMINUM, as Al	LE	0.100	mg/L	GREAT LAKES WATER QUALITY BOARD, 1976
AMMONIA, UN-IONIZED, as NH_3	LE	0.02	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76-023
BERYLLIUM, as Be	LE	0.011	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76-023
γ– BHC, (LINDANE)	LE	0.01	μg/L	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76-023
CADMIUM, as Cd	LE	0.003	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76-023
CHLORDANE	LE	0.01	μg/L	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76-023
CHROMIUM, as Cr	LE	0.100	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76-023
COPPER, as Cu	LE	0.005	mg/L	GREAT LAKES WATER QUALITY BOARD, 1976
CYANIDE, as CN^-	LE	0.005	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76-023
p,p′– DDT	LE	0.001	μg/L	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76-023
DIAZINON	LE	0.08	μg/L	GREAT LAKES WATER QUALITY BOARD, 1976
DIELDRIN	LE	0.001	μg/L	INTERNATIONAL JOINT COMMISSION, 1977
α– ENDOSULFAN	LE	0.003	μg/L	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76-023
β– ENDOSULFAN	LE	0.003	μg/L	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76-023
ENDRIN	LE	0.002	μg/L	INTERNATIONAL JOINT COMMISSION, 1977
GUTHION	LE	0.005	μg/L	GREAT LAKES WATER QUALITY BOARD, 1976
HEPTACHLOR	LE	0.001	μg/L	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76-023
IRON, as Fe	LE	0.300	mg/L	GREAT LAKES WATER QUALITY BOARD, 1976
LEAD, as Pb	LE	0.03	mg/L	ENVIRONMENTAL STUDIES BOARD, 1973, EPA.R3.73.033
MALATHION	LE	0.1	μg/L	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76-023
MERCURY, as Hg	LE	0.2	μg/L	GREAT LAKES WATER QUALITY BOARD, 1976
p,p′– METHOXYCHLOR	LE	0.03	μg/L	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76-023
MIREX	LE	0.001	μg/L	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76-023
NICKEL, as Ni	LE	0.025	mg/L	GREAT LAKES WATER QUALITY BOARD, 1976
OXYGEN, DISSOLVED, as O_2	GE	4.0	mg/L	DEPT. OF THE ENVIRONMENT, 1972, TECH. BULL. 67
PARATHION	LE	0.008	μg/L	GREAT LAKES WATER QUALITY BOARD, 1976
pH	GE	6.5		US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76-023
	LE	9.0		
PHENOLIC SUBSTANCES, as PHENOL	LE	0.001	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76-023
PHOSPHATE, TOTAL, as P	LT	0.050	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76-023
PHOSPHATE, TOTAL, as P	LT	0.100	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76-023
PHOSPHATE, TOTAL, as P	LT	0.025	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76-023
POLYCHLORINATED BIPHENYLS	LE	0.001	μg/L	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76-023
SUSPENDED SOLIDS	LE	25	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76-023
SULPHIDE, as H_2S	LE	0.002	mg/L	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76-023
SURFACTANTS, as MBAS	LE	0.5	mg/L	LITTLE, 1977
TOXAPHENE	LE	0.005	μg/L	US. ENVIRONMENTAL PROTECTION AGENCY, 440/9-76-023
ZINC, as Zn	LE	0.030	mg/L	GREAT LAKES WATER QUALITY BOARD, 1976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