SITE MP WASTE SITE

1 73 TF 31 61 19 00 133 00 00
2 [illegible]
3 124.5 RR 40 [illegible]
4 CN RR. RR 42 — 61 59 00 132 27 00
5 Mi 174 Pump 9 RR-1 61 53 30 132 22
6 [illegible]
7 [illegible] RR 44
8 [illegible] RR-3
9 [illegible] RR 46
10 [illegible] RR 47

Gartner Lee

ENVIRONMENTAL SITE INVESTIGATIONS ALONG THE CANOL ROAD

1996 TR 251

RR-011 to 011

Prepared for:
ROSS RIVER DENA COUNCIL

Prepared by:
GARTNER LEE LIMITED

GLL 96-776

January 1997

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January 20, 1997

Ross River Dena Council
Ross River, Yukon
Y0B 1S0

Attention: George Smith, Councillor / Nora Ladue, Executive Director
Ross River Dena Council

Dear Mr. Smith and Ms. Ladue;

Re: Environmental Site Investigations along the Canol Road

Gartner Lee Limited and W.J. Klassen & Associates are pleased to provide the Ross River Dena with ten bound copies of our final report on the Environmental Site Investigations (ESIs) completed last summer at ten sites along the Canol Road. As well, we are enclosing one unbound reproducible copy and a diskette (Word Perfect 6.1).

The report outlines the work completed at the ten sites included in the project and provides comments on several other sites identified, if only based on anecdotal reports. The conclusions regarding site conditions and the recommendations made for each site are based on the field and laboratory data compiled. Environmental conditions at each site are discussed separately and in detail. An overview of our findings and recommendations is provided in the Executive Summary following this letter.

This report is very much the product of a group effort. Accordingly, the people who contributed to its success are listed at the end of the Project Summary. Most importantly, these people included students, Elders, Council members, and members of the Ross River Community. Their input, along with that of the federal and territorial employees and other consultants, helped direct the project, but also gave us an invaluable insight into the issues and priorities facing the Ross River Dena.

We trust this letter and the enclosed report meet your present needs. We have greatly enjoyed the opportunity to be involved in the project and look forward to working with you in the future. In the meantime, please do not hesitate to call me at our Whitehorse office at (403) 633-6474.

Yours very truly,
GARTNER LEE LIMITED

S.R. Morison

Stephen R. Morison, M.Sc.
Senior Geoscientist
Whitehorse Office Manager

(96769-1/20/97-rptltrtd)

EXECUTIVE SUMMARY

The Canol Road pipeline was built in the 1940s under the direction of the US military. It brought crude oil from Norman Wells in the North West Territories to Whitehorse in the Yukon. After less than 24 months of operation, it was abandoned leaving equipment and buildings, as well as debris, waste, and contamination behind.

The pipeline passes through the traditional lands of the Ross River Dena and the community of Ross River is located roughly half way along the Canol Road.

Over the years, items of value or use have been salvaged from many of the former camp sites and pump stations along the road. However, contamination and the potential for contamination from hydrocarbons and pesticides used at the sites, as well as from the debris and wastes left behind, has not been fully addressed. This project was initiated by the Ross River Dena to identify, and conduct environmental investigations at ten priority sites along the former pipeline and road.

In addition, the project incorporated an environmental management and technology transfer component. The Ross River Dena community selected First Nation students to participate in a two day training program, followed by a job-shadowing or mentoring program during which the students assisted in the field investigations under the direction of two of Gartner Lee's environmental professionals. The students' participation contributed directly and in a very real way to the success of the project.

The ten sites investigated had varying degrees of contamination, primarily from hydrocarbons. Areas of heavy surficial oil staining were found at the majority of sites. Concentrations of oil and grease at six of the ten sites would be classified as hazardous or Special Waste in British Columbia. Several waste landfills or dumps were also found, including two with drums or containers that were still full or partially full of liquid product.

Environmental impacts on the physical environment and / or wildlife, as well as migration of contaminants beyond site boundaries were documented at five of the sites. Remedial actions should be completed at these five sites, as well as four other sites where contamination or debris is less serious but still considered an issue. A table summarizing site conditions as well as the conclusions and recommendations at all ten sites is provided at the end of the report in Section 6.0.

Metals were not found to be a significant contaminant at eight of the ten sites investigated. While elevated concentrations of arsenic, barium, cadmium, molybdenum, nickel, and zinc were found at several sites, these were attributed to the regional geochemistry. Elevated concentrations of arsenic at a waste landfill at one site and lead concentrations at another were, however, attributed to contamination from pipeline activities.

Pesticides were also tested, but found not to be an issue. Testing included field immunoassay kits and confirmation at an accredited environmental laboratory. Field testing with the immunoassay kits tended to return false positive results, not confirmed by more reliable laboratory analysis. The kits were, however, a useful, cost effective screening tool.

Remedial activities and follow-up investigations are recommended. These focus on a more extensive test pitting program conducted in conjunction with the excavation and removal of known areas of petroleum contamination and landfilled materials. Three options for the treatment or containment of impacted soils have been provided.

ACKNOWLEDGEMENTS

GARTNER LEE LIMITED would like to acknowledge the contributions of the following people: Bruce Thomson, George Smith, Nora Ladue, Brett Hartshorne, Ian Thomson and the Ross River forestry crew, Michael King and Norm Winters.

In addition, the following students should be commended for their efforts in the classroom and the field: Bob Shorty, Rose Shorty and Michael Dick.

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Appendix C Regional Geochemistry of Selected Elements

1.0 INTRODUCTION

In July 1996, Gartner Lee Limited (GLL) was retained by the Ross River Dena Council to conduct a series of environmental site investigations at ten former waste sites located in the Ross River Dena people's traditional territory. This project was funded by and undertaken as part of, the Department of Indian Affairs and Northern Development's (DIAND) Arctic Environmental Strategy (AES) Action on Waste Program for the delineation of waste sites in the Yukon. Technical support was provided to the Ross River Dena and GLL by Mr. Brett Hartshorne, Manager of the AES Action on Waste program.

1.1 OBJECTIVES

The goal of this project as prepared by the Ross River Dena Council Request is as follows; "*to gain preliminary environmental information on waste sites in the Ross River Dena people's traditional territory and establish a technical understanding of environmental issues for the Ross River Dena people.*" This goal has been used to guide Gartner Lee Limited (GLL) in the design and implementation of this project. The following are the project objectives which were developed by the Ross River Council and AES to ensure that the above goal was achieved:

- To provide the Ross River Dena First Nation with a thorough scientific understanding of selected abandoned waste disposal sites in their traditional territory.
- To ensure that an effective transfer of knowledge occurs in all stages and aspects of the project for the benefit of the Ross River Dena people.
- To review all published and other pertinent information as required to select study sites and to assist with design of the field activities to assess these sites.
- To prepare and implement a training program for Ross River Dena students as an introduction to environmental sciences (e.g. environmental geochemistry, surficial geology, terrain analysis, stream hydrology, ground water and others) and include the linkages with programs which support self government initiatives.
- To prepare and complete a report on the sites assessed which includes the methods used, the field and analytical results and recommendations for remediation where appropriate for each of the project sites.

2.0 BACKGROUND

2.1 CANOL ROAD HISTORY

When the United States became involved in World War II, especially on the Pacific front, fears arose that their oil supplies in Alaska may be threatened. In response to this, the Canol Road project was initiated to construct an oil pipeline and road that would carry oil and supplies from Norman Wells, N.W.T., to Whitehorse, Y.T (Figure 1). In Whitehorse, the oil was to be refined and transported to Alaska.

The road and pipeline, which included work camps and oil pumping stations, were completed in 1944 and subsequently abandoned in 1945. When the Americans pulled out, the pipeline was left intact, vehicles and heavy equipment were winterized and left behind, and buildings were boarded up (K. Bisset and Associates, 1995). Also remaining behind were the numerous garbage dumps associated with the camps and pumping stations, oil drums, and contamination from oil spills.

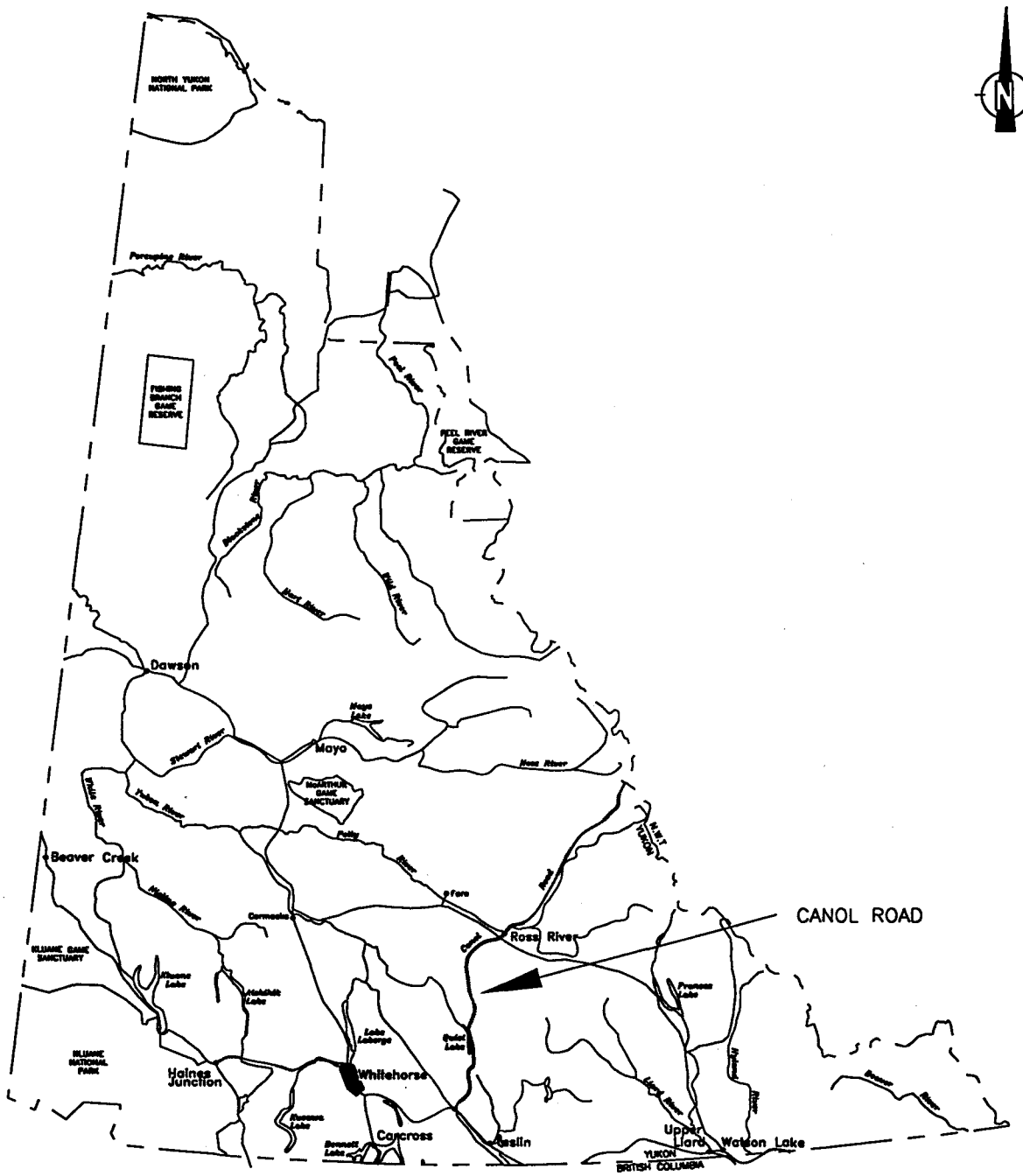
The Canadian Government was given the first option to purchase the salvage rights of the project; however, the government declined and the rights were sold to a private salvage company (Synergy West Ltd., 1975).

With the abandonment of the Canol Road project, the roads and bridges fell into disrepair and soon became impassable. In the early 1950s, the first salvage crews began rebuilding the roads and bridges in order to reach the abandoned equipment. Since that time, salvage by both authorized and unauthorized parties has removed most of the materials left behind.

In the early 1970s mining exploration in the MacMillan Pass area required that the road and bridges be maintained. Since that time, upkeep of the road has been supervised by the Yukon Territorial Government (YTG).

2.2 PREVIOUS REPORTS

Three reports have been written describing conditions along the Canol Road. Two of these, the "*Number One Construction Engineering Unit*" (Canadian Armed Forces, 1970), and "*Canol Road Clean-Up Assessment Study*" (Synergy West Ltd., 1975), concentrated on compiling an inventory, and clean-up plan including costs, for removal of abandoned materials remaining from military activities. The third report, "*Research of Former Military Sites and Activities in Yukon*" (K. Bisset and Associates, 1995), reviewed activities at sites throughout the Yukon and identified potential contaminants of concern including petroleum hydrocarbons, metals and pesticides from past military operations.



LEGEND

SCALE 1:6,250,000

0 50 100 200 KM

CANOL ROAD SITE LOCATION

Canol Road
Site Assessments

Drawn By: B. Belzoc	Project No. 96769
Site Name: Canol Road	File Name: D:\96769\769-1

Gartner Lee

Figure No. 1

The latter two reports were reviewed by Gartner Lee Limited to obtain general knowledge of issues expected at the sites and to aid in formulating a work plan for the investigative phase of the project.

3.0 SCOPE OF WORK AND TECHNICAL APPROACH

The scope of the work completed by Gartner Lee Limited is summarized below:

- performed background research of potential sites and identified issues;
- identified 10 priority sites in conjunction with the Ross River Dena Council with local community input;
- performed a terrain analysis of each site to identify potential receptors;
- conducted a two day training session with Ross River students to introduce desktop and field investigative techniques;
- investigated priority sites by locating and mapping sites and, sampling soils, surface water and vegetation which appeared to be contaminated or thought to be at risk;
- conducted field testing of soils for potential sources of contaminants;
- submitted selected samples to an accredited analytical laboratory for testing;
- interpreted analytical data and compared data to relevant criteria;
- produced a report documenting site conditions and providing recommendations for preliminary remedial measures.

The field portion of the program commenced on August 10, 1996, with the initial site reconnaissance carried out by Terry Duffy, B.Sc., a Gartner Lee Limited (GLL) hydrogeologist, Bruce Thompson, the project coordinator appointed by the Band, and Michael King, an engineering technologist. The training session was conducted by Rob Dickin, P. Geo., GLL's senior hydrogeologist, and Bill Klassen of Klassen and Associates Limited, on August 12 and 13.

The actual site investigations were conducted from August 14 through September 1, 1996, under the supervision of Terry Duffy and David Green, a GLL biologist.

3.1 ROSS RIVER DENA COUNCIL AND STUDENT TRAINING PROGRAM

As the client, the Ross River Dena Council has been responsible for the management and administration of the contract Gartner Lee Limited provided to carry out this work. The Ross River Dena Council hired a Project Coordinator from Ross River, Mr. Bruce. Thomson to oversee the field component and logistics of this work. Gartner Lee's field team coordinator, Mr. Terry Duffy, and Mr. Bill. Klassen maintained regular contact with the Project

Coordinator and the Ross River Dena Council as required. The Ross River Dena students who participated in the training and job shadowing component were selected through a competitive process at the community level.

The training session and job shadowing program provided an introduction to environmental sciences, the importance of understanding environmental issues and environmental assessment in terms of resource management and the responsibilities for First Nations in terms of self government initiatives and the relationship with the "Umbrella Final Agreement". Included in the training session was an overview of the project, the objectives, methods and rationale for conducting this work. The following was included:

- Training Session: Day 1 - classroom session introductions, environmental assessment, Umbrella Final Agreement, practical exercises used for a desktop review prior to initiating any type of field program.
- Training Session: Day 2 - introduction to field techniques at one of the priority sites to be investigated, demonstrations of soil, surface water and benthic community sampling methods, introduction to mapping with hip-chain and compass.

At the completion of the student training program, the field assessments of the sites began. GLL professional staff mentored students in the field during the job-shadowing aspect of the program not only on techniques employed to conduct the site assessments, but also on the actual reasoning behind choices for sample collection points.

3.2 SITE SELECTION

Sites were selected for investigation after the following process:

- Background research utilizing previous reports (i.e., Synergy, 1975; Bisset, 1995) which focused on former military camps and pump stations associated with the Canol Road Pipeline corridor to assess the issues and potential contaminants.
- A field reconnaissance trip with the Bruce Thomson, Michael King and Terry Duffy to assess the potential sites in a field setting.
- Follow-up with George Smith and other members of the Ross River Dena Council on the proposed sites for comments and alternate sites.

As a result of this process, the 10 sites listed in Table 1 were selected for field investigation.

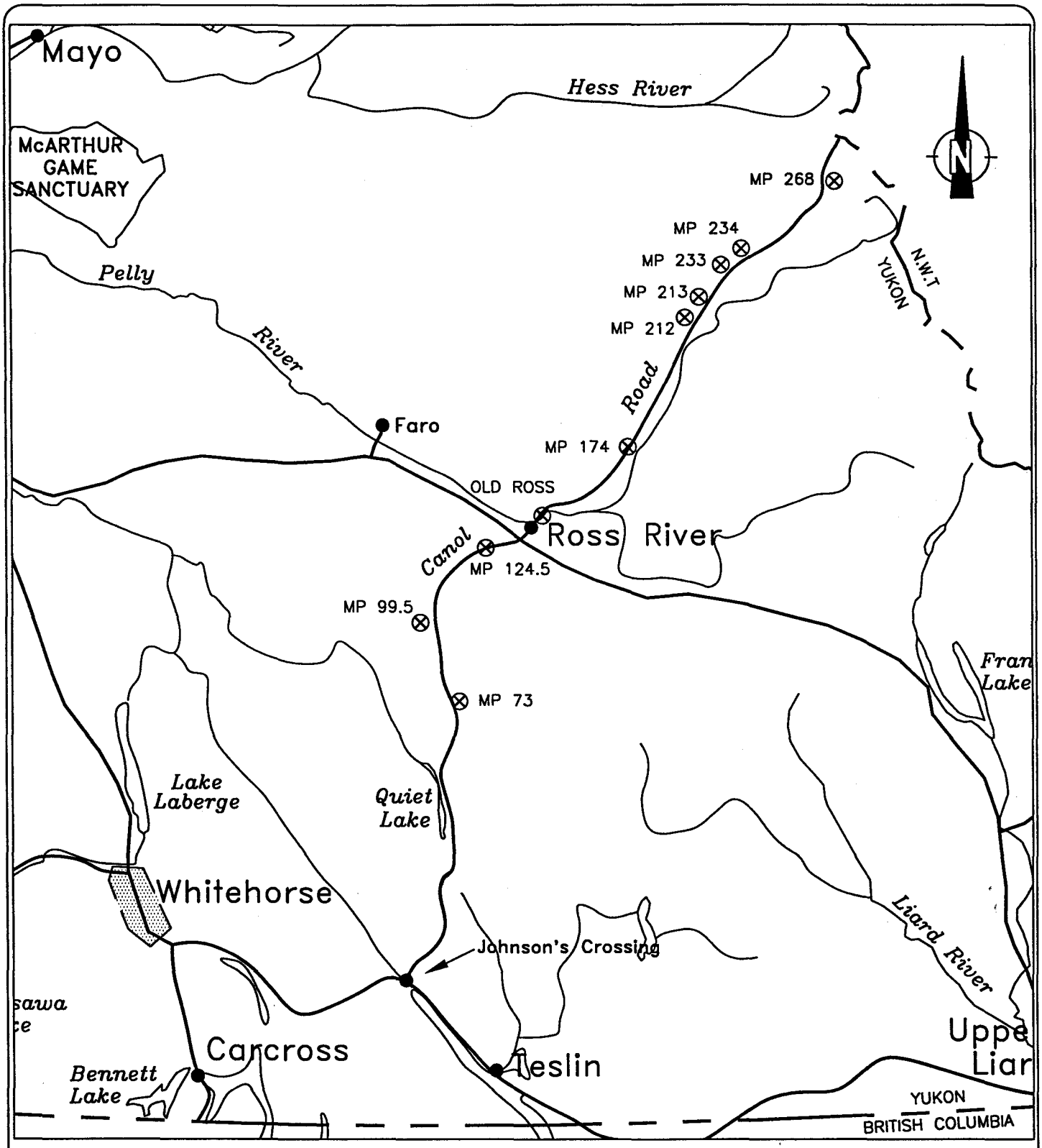
During the course of the site investigations one of the original ten sites was dropped from the list in favour of a site discovered to be more of a priority, in the opinion of the field crew. After a reconnaissance visit to the site identified as MP 247 revealed that the issues at this site were very minor, the site identified as MP 234 was added to the project as the initial site

reconnaissance revealed heavy surficial staining. In addition to the ten selected sites, two other sites (including MP 247) were visited in the field for a preliminary assessment. Finally, additional sites which have never been investigated were discovered after discussions with the local community in Ross River and with members of the Ross River Dena Council.
The following table provides a summary of the ten sites investigated and brief summary of past activities at each site.

Table 1 Site Selection Summary

SITE LOCATION	REASONS FOR ASSESSMENT
MP 73	A pumping station and associated camp on the South Canol Road had areas of surface staining and spills were identified. The proximity to Gravel Creek made this site a priority site to be assessed.
MP 99 LAPIE LAKES	A military camp consisting of several small buildings and a storage area for drums had been located near the east side of one of the Lapie Lakes.
MP 124.5 LAPIE RIVER	A pumping station and military camp had been located on this site where the pipeline crossed the Lapie River. Areas of debris and refuse as well as surface staining had been identified.
OLD ROSS TOWNSITE	Local residents identified this site, located across the Pelly River from the current Ross River townsite, as a concern due to a garbage dump and remnants of some old buildings.
MP 174 FLAT CREEK	A pumping station and associated camp had been located on both sides of the road at this location. Surface staining and piles of metal debris had been previously identified.
MP 212 SHELDON LAKE	This site had been used as a garbage dump for a camp located at MP 213. Large amounts of metal debris and other refuse associated with the camp had been previously identified.
MP 213 SHELDON LAKE	A large military camp had been located on the west side of the road near Sheldon Lake. Areas of surface staining and storage areas of oil drums had
MP 233	This site was formerly occupied by a pumping station. Concrete foundations associated with the past operations were still present on the site as were areas of surface staining and numerous vehicle hulks.
MP 234	This site was not listed initially as one of the sites to be assessed. A decision was made in the field to include this site as anecdotal information provided by a local resident suggested that drums full of oil and grease had been buried here.
MP 268 MacMILLAN RIVER#2	Numerous vehicle hulks and an oil drum storage area had been identified as being located on this site.

The locations of the ten sites are presented in Figure 2.



LEGEND

⊗ MP 73 Mile Post Location

NOTE:
All Mile Post locations are referenced from Johnson's Crossing.

SCALE 1:2,000,000

0 10 20 40 60 KM

Drawn By: B. Belzac | Project No. 96769
Site Name: Canol Road | File Name: D:\96769\769-2

CANOL ROAD & PRIORITY SITES

Canol Road
Site Assessments

Gartner Lee

Figure No. 2

3.3 SITE INVESTIGATIONS

3.3.1 Approach

Once the sites had been selected, the investigative phase of the project commenced. This was completed through the combination of both a preliminary desktop review and visits to each site.

The desktop review was carried out to gather as much information as possible about the priority sites prior to commencing the field program. This information was considered essential in order to gain an advance understanding of the expected site conditions. Information was compiled from a review of two of the Canol Road reports (Synergy and Bisset), topographic and surficial geological maps, and from a review of air photographs of the areas surrounding the sites. Additional information was provided by members of the Ross River Dena First Nation who were familiar with the sites, including the local forestry crew.

The site visits were conducted in two stages: the first being site reconnaissance and the second, mapping and sampling.

The reconnaissance visits to all sites were conducted on August 10, 11 and 14, 1996. This involved driving both the North and South Canol Roads and confirming the location of the 10 priority sites. Once the sites were located, a site walkover was conducted to identify site features and conditions. Features such as drums, foundations and areas of visible contamination were noted and flagged with orange flagging tape. These features would then be located more accurately during the mapping and sampling stage. Prior to leaving the site, a marker was left along the side of the road in order to easily locate the site upon return.

The second stage of the site investigations involved mapping the site and collecting soil, surface water and vegetation samples. Complete mapping and sampling methodologies are presented in the Methodologies section in Appendix A.

Site mapping was critical in order to produce a good quality reference plan of each site. Features identified during the site walkover were located, as were slopes, water courses and discernible boundaries.

Upon completion of the mapping, samples were collected from the site. Prior to the field program commencing, a grid sampling program for soils had been recommended. However, once the site conditions were observed, this sampling strategy was modified in favour of "hot spot" sampling.

This concentrated on sampling from areas which appeared visually contaminated, and from areas down-gradient of the "hot spots". Soil samples were collected as surficial samples from the near surface area and as deeper samples from the sidewalls and base of test pits. This sampling methodology was used to assess the maximum levels of contamination on the site.

Selected samples were submitted for analytical testing and results compared to established criteria, as discussed in the next two sections. The results for each site were also assessed in the context of the site setting. As part of that assessment, the project team considered Gartner Lee's standard "Source-Pathway-Receptor" model. It is based on the integrated way in which contaminants disperse from the source and then impact on the natural environment. The focus of this project was to identify sources of contamination, as well as the presence of pathways for contaminants to move or migrate toward potential receptors. Although beyond the scope of work for this study, the potential impact on receptors could then also be assessed, determined, and documented. One of the interesting considerations in this project was that at several sites significant contamination was found at or near surface and therefore an immediate pathway may exist for plant, animal, and human uptake and potential impacts.

3.3.2 Analytical Program

The analytical program concentrated on the potential contaminants of concern (PCC) identified through previous work along the Canol Road and other northern sites. These contaminants were primarily metals, petroleum hydrocarbons and pesticides, specifically DDT.

Soil, water, and vegetation samples were collected at most sites. At all sites, more samples were collected and inspected for indications of contamination, than were submitted for analytical testing. This provided field staff an opportunity to develop a strong professional opinion on the degree and significance of the contamination, if any, found.

Soil samples were subjected to two levels of analytical testing:

a) field screening with portable meters or test kits; and
b) analytical testing by an accredited environmental laboratory using approved and standard procedures and quality assurance methods.

Soil samples were screened in the field using a Photoionization Detector (PID) to detect the presence of volatile organic vapours and thereby the potential for petroleum hydrocarbon contamination. Selected soil samples were tested for DDT using immunoassay field test kits.

The test kits work on the basis that chemical solutions provided with the kit will react with the pesticide, if any is present, to produce a colour change. The colour change can be calibrated to provide a preliminary, semi-qualitative indication of the amount of DDT present.

Both field screening procedures, the PID and immunoassay test kits, provided a valuable way to strategically select key soil samples for more accurate, and more expensive, laboratory testing.

The specific laboratory tests performed and the criteria against which the results were compared are outlined in Table 2.

Selected soil samples were analyzed for:

a) metals using an ICP scan;
b) petroleum hydrocarbons (e.g., gasoline, diesel fuel, and crude oil) using a number of different gross parameter or investigative scans, namely:
   i) total oil and grease;
   ii) light and heavy extractable petroleum hydrocarbons (LEPH/HEPH);
   iii) polycyclic aromatic hydrocarbons (PAH's);
c) organochlorine pesticide (OCP) scan which includes several DDT compounds.

A description of the methodologies used for each of these analyses is provided with the analytical reports from Zenon Environmental and reproduced in the Technical Appendix.

Surface water samples were collected at sites where a body of water, creek, or river was identified in close proximity to the site and was considered a potential receptor. Selected water samples were analyzed for total metals and oil and grease.

Vegetation samples of leaves and berries were collected from a variety of plants, but mainly from Labrador tea and low bush cranberry plants, which were common to all the sites and were used as food seasonally. Selected samples, as well as background samples, were analyzed for metals to determine plant uptake of individual elements.

3.3.3 Analytical Criteria

Interpretation of analytical data was based on a comparison against published federal and provincial guidelines and criteria, as well as on professional experience and judgment.

TABLE 2: SUMMARY OF REGULATORY CRITERIA USED FOR SOIL AND WATER SAMPLES

PARAMETERS	REGULATORY CRITERIA FOR SOIL			... FOR WATER
	Park Land / Residential (mg/kg = ppm)	Industrial / Commercial (mg/kg = ppm)	Special Waste (mg/kg = ppm)	Aquatic Life (µg/L = ppb)
PETROLEUM INDICATORS				
Mineral Oil & Grease	1,000 [3]	5,000 [3]	30,000 [6]	100 [4]
Total Extractable Hydrocarbons (TEH)	400 [4]	2,000 [4]		100 [4]
Light Extractable Hydrocarbons (LEPH)	1,000 [5]	2,000 [5]		NA
Heavy Extractable Hydrocarbons (HEPH)	1,000 [5]	5,000 [5]		NA
Polycyclic Aromatic Hydrocarbons (PAHs)				
benzo (a) pyrene	1 [1&2]	10 [1&2]		0.01 [2]
napthalene	5 [1&2]	50 [1&2]		1 [2]
pyrene	10 [1&2]	100 [1&2]		0.02 [2]
METALS				
Arsenic (As)	30 [1&2]	50 [1&2]	100 [6]	50 [1&2]
Barium (Ba)	500 [1&2]	2,000 [1&2]		1,000 [2]
Chromium (Cr)	250 [1&2]	800 [1&2]		2 [1&2]
Lead (Pb)	500 [1&2]	1,000 [1&2]		1-7 [1]
Molybdenum (Mo)	10 [1&2]	40 [1&2]		1,000 [2]
Tin (Sn)	50 [1&2]	300 [1&2]		NA
Zinc (Zn)	500 [1&2]	1,500 [1&2]		30 [1&2]
PESTICIDES				
Total Pesticides	2 [7]	20 [7]		
DDT	NA	NA	3 [6] mg/L	0.001 [1&2]
Endosulfan II	NA	NA	as leachate	0.02 [1&2]
Endosulfan Sulphate	NA	NA		0.02 [1&2]
Endrin	NA	NA		0.0023 [1&2]

NOTES:

1 Interim Canadian Environmental Quality Criteria for Contaminated Sites, Canadian Council of Ministers of the Environment (CCME), July 1991

2 Criteria for Managing Contaminated Sites (CMCS) in British Columbia, B.C. Environment, July 1995

3 Criteria for Managing Contaminated Sites (CMCS) in British Columbia, B.C. Environment, November 1989 (Draft 6)

4 Memorandum - Measuring Petroleum Hydrocarbon Concentrations in Soil and Water, B.C. Environment, Contaminated Sites Unit, October 1991

5 Memorandum - New Petroleum Hydrocarbon Criteria for Contaminated Sites, B.C. Environment, Contaminated Sites & Toxicology, August 1995

6 Waste Management Act, Special Waste Regulation, Province of British Columbia, consolidated April 1992

7 British Columbia Standards for Managing Contamination at the Pacific Place Site, B.C. Environment, May 1990

NA Not Available, not listed in regulations referenced

For the most part, the results are compared to federal criteria developed by the Canadian Council of Ministers of the Environment and published as the "Interim Canadian Environmental Quality Criteria for Contaminated Sites" (July 1991). However, the Yukon Government is currently developing its own Territorial criteria. A draft set of criteria is being developed, which is apparently very similar to the "Criteria for Managing Contaminated Sites (CMCS) in British Columbia" published by the B.C. Ministry of Environment in July 1995.

Given this, the analytical results in this report are compared to the federal CCME criteria, and where no federal criteria exist, the results are compared to B.C. Environment's CMCS criteria. In addition, several guidelines and investigative criteria developed by B.C. Environment are referenced.

A complete list of the criteria and guidelines used in evaluating the analytical data presented in this report is contained below:

1. "Interim Canadian Environmental Quality Criteria For Contaminated Sites," Canadian Council of Ministers of the Environment (CCME), July 1991.

2. "Criteria For Managing Contaminated Sites (CMCS) in British Columbia," B.C. Environment, July 1995, as well as Draft Six of the same criteria from November 1989 [1] and "British Columbia Standards for Managing Contamination at the Pacific Place Site" from May 2, 1990 [2].

3. Special Waste Regulation, Waste Management Act, Province of British Columbia, 1992.

4. "Memorandum: New Petroleum Hydrocarbon Criteria for Contaminated Sites," Contaminated Sites Remediation Unit, B.C. Environment, September 1995.

5. "Memorandum: Measuring Petroleum Hydrocarbon Concentrations in Soil and Water," Contaminated Sites Remediation Unit, B.C. Environment, August 1993.

A complete set of the above mentioned criteria are provided in Appendix C.

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[1] Draft Six of the CMCS guidelines included criteria for several investigative parameters, such as oil and grease, not included in the July 1995 version.

[2] The Standards for Pacific Place included limits for total pesticides in soil. It is referenced for that reason only. It is important to note that the Standards and Draft Six of the CMCS guidelines were modified in July 1995 and limits for oil and grease and total pesticides were not carried forward in the newer version.

Within most of these references, criteria are provided based on land use in urban areas. There are different criteria for each parameter based on park land, agricultural, residential, commercial, and industrial land use. For this report and project, the analytical results were contrasted to the Park Land Use criteria.

The issue of which criteria are appropriate for First Nations in terms of maintaining the traditional lifestyle of utilizing the land is beyond the scope of this report. The important point here is that these criteria might not be appropriate from a First Nations perspective. Gartner Lee Limited has used the existing criteria for contaminated sites as a guide. The final decision on whether the recommendations are appropriate rests with the Ross River Dena Council.

Immunoassay Test Kit Results

With respect to DDT analysis, selected soil samples were submitted for analytical testing of pesticides to confirm the results obtained in the field from the immunoassay test kits. In most cases, the field results were not confirmed in the laboratory. Generally, the field results were false positive.

The poor correlation between test kit and laboratory results may reflect limitations on the part of the test kits at the low end of their detection range. It may also be due to interference from pesticides other than DDT, for example the pesticides Endosulfan II, Endosulfan Sulphate, or Endrin that were detected by laboratory testing, albeit still in trace amounts.

As well, the test kits provided results in the range of 0-0.2 ppm. This low detection limit is not considered accurate or significant, in fact the B.C. Standards for Managing Contamination at the Pacific Place Site indicate 0.2 ppm as a background level for total pesticides. As a result, positive results from the test kits in this range were discounted and not reported as being significant. Significant results for the field kits were assumed to be those in the 0.2 - 1.0 ppm and the 1.0 - 10.0 ppm range.

Field testing results, from both the PID and immunoassay kits, are summarized in Table 3.

TABLE 3. CANOL ROAD FIELD TESTING RESULTS

Site	Sample Location	Depth (m)	PID (ppm)	DDT[1] (ppm)
MP-73	SS-1	0.07	29	0
	SS-2	0.04	2	0
	SS-3	0.04	11	0
	SS-4	0.04	18	0
	SS-5	0.04	10	0
	SS-6	0.04	2	0
	SS-7	0.06	5	0
	SS-8	0.08	2	0
	SS-9	0.07	2	0
	SS-10	0.09	31	0.0 - 0.2
	SS-11	0.09	0	0
	SS-12	0.07	4	0
	TP-1	0.34	45	0
	TP-1	1.98	33	0
	TP-2	0.43	195	0.0 - 0.2
	TP-2	1.08	1225	-
	TP-2	1.46	499	0.0 - 0.2
	TP-3	0.41	168	0
	TP-3	1.9	183	0
	TP-4	0.39	7	0
	TP-4	1.12	9	0
	TP-5	Fill Pipe	39	0
	TP-5	0.76	72	0.2
	TP-6	0.71	16	[redacted]
	TP-6	1.15	15	0
MP-99	SS-1	0.08	3	0
	SS-2	0.1	7	0
	SS-3	0.04	1	0
	SS-4	0.06	5	0
	SS-5	0.03	11	0.0 - 0.2
	SS-6	0.07	2	0
	SS-7	0.04	3	0
	SS-8	0.04	21	0.0 - 0.2
	SS-9	0.1	12	0.0 - 0.2
	SS-10	0.06	4	0
	SS-11	0.04	2	0
	SS-12	0.05	0.9	0
	SS-13	0.1	1	0
	SS-14	0.09	3	0
	SS-15	0.12	2	0
	SS-16	0.07	2	0

TABLE 3. CANOL ROAD FIELD TESTING RESULTS

Site	Sample Location	Depth (m)	PID (ppm)	DDT[1] (ppm)
MP-124.5	SS-1	0.2	161	0
	SS-2	0.14	234	0
	SS-3	0.1	5	0.0 - 0.2
	SS-4	0.25	35	0.0 - 0.2
	SS-5	0.05	24	0
	SS-6	0.1	19	0
	SS-7	0.2	19	0
	SS-8	0.1	6	0.0 - 0.2
	SS-9	0.15	27	0
	SS-10	0.2	31	0.0 - 0.2
	SS-11	0.15	40	0
	SS-12	0.2	19	0
	SS-13	COMP.	13	0
	SS-14	0.15	3	-
	SS-15	0.2	19	0
	SS-16	0.15	36	0.0 - 0.2
	TP-1	1.75	59	1.0 - 10
	TP-2	0.29	1.6	0.0 - 0.2
	TP-2	2.2	0.1	0.0 - 0.2
	TP-3	1.6	3	0.0 - 0.2
	TP-4	1.58	0	-
	TP-5	0.9	0.1	0.0 - 0.2
Old Ross	TP-1	0.46	0.7	0
	TP-1	1.08	0.9	0.0 - 0.2
	TP-2	0.24	1.1	0.0 - 0.2
	TP-2	1.12	1.6	0.0 - 0.2
	TP-3	0.31	0.8	0
	TP-3	0.96	1.3	0
	TP-4	0.34	1.7	0
	TP-4	0.94	1.4	0
MP-174	SS-1	0.08	4	-
	SS-2	0.1	21	-
	SS-3	0.06	0.3	0.0 - 0.2
	SS-4	0.04	7	-
	SS-5	0.04	8	1.0 - 10
	SS-6	0.04	9	0.2 - 1.0
	SS-7	0.1	2	0.2 - 1.0
	SS-8	0.04	4	0.0 - 0.2
	SS-9	0.07	5	0.0 - 0.2
	SS-10	0.05	4	-
	SS-11	0.06	2	-
	SS-12	0.04	3	-
	SS-13	0.04	6	0.0 - 0.2
	SS-14	0.04	5	0.0 - 0.2

TABLE 3. CANOL ROAD FIELD TESTING RESULTS

Site	Sample Location	Depth (m)	PID (ppm)	DDT[1] (ppm)
MP-174 Cont'd.	SS-15	0.04	3	0.0 - 0.2
	TP-1	0.31	4	0
	TP-2	0.41	17	0.0 - 0.2
	TP-3	0.42	11	0.0 - 0.2
	TP-4	0.3	1	0.0 - 0.2
	TP-5	0.28	4	0.2 - 1.0
	TP-6	0.18	6	0.0 - 0.2
	TP-7	0.23	7	0.0 - 0.2
MP-212	TP-1	0.24	2	0.0 - 0.2
	TP-1	0.59	0.8	0
	TP-2	0.23	2	0
	TP-2	0.62	1.2	0
	TP-3	0.18	1	0
	TP-3	0.52	12	0
	TP-4	0.3	2	0
	TP-4	0.7	4	0
	TP-5	0.32	18	0
	TP-5	0.77	2	0
	TP-6	0.21	3	0
	TP-6	0.48	0.8	0
	TP-7	0.32	2	0
	TP-7	0.61	5	0
MP-213	TP-1	0.16	15	0
	TP-2	surface	2	0.2 - 1.0
	TP-2	0.64	15	-
	TP-3	0.19	5	0
	TP-3	0.73	6	0
	TP-4	0.23	4	0.0 - 0.2
	TP-4	0.63	0.9	-
	TP-5	0.29	3	0
	TP-5	0.84	4	-
	TP-6	0.28	1	0
	TP-6	0.75	8	-
	TP-7	0.17	0.8	0
	TP-8	0.17	2	0
	TP-8	0.39	1	0
	SS-1	surface	3	1.0 - 10
MP-233	SS-1	0.1	11	-
	SS-2	0.1	8	0.2 - 1.0
	SS-3	0.18	0.9	0.2 - 1.0
	SS-4	0.13	4	0
	SS-5	0.14	7	0.0 - 0.2
	SS-6	0.16	10	0.2 - 1.0
	SS-7	0.18	11	0.2 - 1.0

TABLE 3. CANOL ROAD FIELD TESTING RESULTS

Site	Sample Location	Depth (m)	PID (ppm)	DDT[1] (ppm)
MP-233 Cont'd.	SS-8	0.1	11	0.2 - 1.0
	SS-9	0.17	0	0.0 - 0.2
	SS-10	0.13	3	-
	SS-11	0.1	5	1.0 - 10
	SS-12	0.15	4	0.0 - 0.2
	SS-13	0.12	0.3	0.0 - 0.2
	SS-14	0.12	7	0.0 - 0.2
	SS-15	0.14	4	0
	SS-16	0.14	7	0
	SS-18	0.1	8	0
	SS-19	0.1	2	0.0 - 0.2
	SS-20	0.1	9	0
	SS-21	0.06	0.1	0
	SS-22	0.1	5	0
	TP-1	0.93	1323	-
	TP-1	1.23	126	-
	TP-3	0.71	6	-
	TP-4	0.51	6	-
	TP-4	0.6	8	-
	TP-5	0.31	5	-
	TP-5	0.91	11	-
	TP-7	0.31	20	-
	TP-7	0.72	11	-
MP-234	SS-1	0.04	10	1.0 - 10
	SS-2	0.04	18	0.2 - 1.0
	SS-3	0.03	18	0.2 - 1.0
	SS-4	0.05	10	0.2 - 1.0
	SS-5	0.06	19	-
	SS-6	0.02	6	0.0 - 0.2
	SS-7	0.05	11	0.0 - 0.2
	SS-8	0.06	7	0.0 - 0.2
	SS-9	0.05	16	0.0 - 0.2
	SS-10	0.06	25	-
	TP-1	0.21	30	0.2 - 1.0
	TP-1	0.8	5	0.0 - 0.2
	TP-2	0.61	2660	1.0 - 10
	TP-2	1.2	201	0.0 - 0.2
	TP-3	0.56	354	0.0 - 0.2
	TP-3	0.82	10	-
	TP-4	0.25	11	0.0 - 0.2
	TP-6	0.29	3	0.0 - 0.2
	TP-6	0.99	1	-

TABLE 3. CANOL ROAD FIELD TESTING RESULTS

Site	Sample Location	Depth (m)	PID (ppm)	DDT[1] (ppm)
MP-268	SS-1	0.04	7	0
	SS-2	0.04	9	0.0 - 0.2
	SS-3	0.04	7	0.0 - 0.2
	SS-4	0.08	9	0
	SS-5	0.06	11	0.0 - 0.2
	SS-6	surface	7	0.0 - 0.2
	SS-6-1	0.47	8	0.2 - 1.0
	SS-7	0.04	13	0.2 - 1.0
	SS-8	0.04	9	0.0 - 0.2
	SS-9	0.08	11	0.0 - 0.2
	SS-10	0.04	3	0.0 - 0.2
	SS-11	0.05	9	0
	SS-12	0.07	17	0
	SS-13	0.04	14	0.2 - 1.0
	SS-14	0.04	6	0.0 - 0.2
TOTALS	186		186	158

NOTES

1. DDT concentrations are based on field kit calibrants and selected samples will be analysed for confirmation and accurracy.

4.0 FINDINGS - SITE INVESTIGATIONS

This section provides a summary of field observations for each site as well as analytical results, a discussion of the findings, conclusions and recommendations. All ten sites are included in this section of the report, with each site represented as a separate subsection from 4.2 to 4.11.

4.1 REGIONAL GEOCHEMISTRY

The analytical criteria used in this report to classify a site as contaminated or not have been prepared based on background soil conditions in non-mineralized areas where individual concentrations of elements are naturally low. This must be taken into account when interpreting the analytical data from areas of known mineralization. In mineralized areas, trace metal concentrations can exceed the established criteria naturally and may not necessarily be the result of man-made contamination.

The anomalous geochemical results found at many of the sites investigated appear to be related to the background concentrations of naturally occurring trace metals found in soil and stream sediments. This linkage has been established primarily by reviewing the regional geochemistry which has been done for this area (Friske et. al., 1991).

The Canol Road is located in an area well known for its mineral deposits, especially the areas to the north and east of Ross River. Base metal deposits dominate the known mineralization and appear to be related to the elevated concentrations of many elements in the soils.

Sediments deposited in the region by glacial processes and/or rivers flowing from the north, have resulted in widespread redistribution of metals throughout the region from areas near the Yukon - North West Territories border. Geochemical maps of selected individual elements from areas to the north of Ross River are presented in Appendix C to show this widespread distribution and the following table compares the established regulatory criteria to naturally occurring concentrations for several elements found in stream sediments.

Table 4 Metals Criteria vs. Naturally Occurring Concentrations

Parameter	CCME Parkland Criteria (ppm)	Background Concentrations (maximum ppm)
As	30	75
Ba	500	6000
Cd	5	52
Mo	10	163
Ni	100	700
Zn	500	1100

- Note: The above background concentrations are from Friske et. al., 1991.

4.1.1 Vegetation Background Samples

Control, or background, samples from four different species of vegetation were collected from an undisturbed area along the South Canol Road. Samples of Labrador Tea, Fireweed, Low Bush Cranberry and Wild Red Raspberry were analyzed for metal concentrations and, in this report, were used to represent the naturally occurring concentrations of individual elements in each of the species of vegetation. The analytical results from the four control samples are presented in Table 4.1.1.

The analytical results of the vegetation samples collected at each of the ten sites were then compared to the control sample concentrations to determine if site activities had impacted the vegetation.

TABLE 4.1.1: VEGETATION CHEMISTRY - METAL RESULTS

Parameter	Zenon ID : Sample ID : MDC	Background 96025356 VEG 20 LT	Background 96025358 VEG 22 Fw	Background 96025359 VEG 23 R	Background 96025360 VEG 25 LBC
METALS TOTAL					
Aluminum	2	45	27	107	4
Antimony	2	< 2	< 2	2	3
Arsenic	8	< 8	< 8	< 8	< 8
Barium	0.1	81.6	10.1	19.8	14.7
Beryllium	0.1	< 0.1	< 0.1	< 0.1	< 0.1
Bismuth	2	< 2	< 2	< 2	< 2
Cadmium	0.2	< 0.2	< 0.2	< 0.2	< 0.2
Calcium	1	4650	12500	4800	1580
Chromium	0.2	0.8	0.8	1.1	0.7
Cobalt	0.3	0.6	0.5	0.7	0.4
Copper	0.1	5.6	5.2	4.8	3
Iron	0.3	48.4	94.9	91.6	16.3
Lead	2	4	2	< 2	< 2
Magnesium	2	1020	2990	2160	549
Manganese	0.2	1300	54.4	29.7	5
Mercury	0.05	< 0.05	< 0.05	< 0.05	< 0.05
Molybdenum	0.4	< 0.4	< 0.4	0.6	< 0.4
Nickel	0.8	1.6	1	1.7	1
Phosphorus	4	1470	233	3300	1090
Potassium	40	4740	4520	13100	6660
Selenium	5	< 5	< 5	< 5	< 5
Silver	1	< 1	< 1	< 1	< 1
Sodium	1	9	114	7	13
Strontium	0.1	12.8	34.8	13.7	3.3
Sulphur	3	869	288	941	335
Tellurium	2	< 2	< 2	< 2	< 2
Thallium	1	< 1	< 1	< 1	< 1
Tin	2	2	< 2	< 2	< 2
Titanium	0.3	0.9	< 0.3	0.6	< 0.3
Vanadium	0.3	< 0.3	< 0.3	0.3	< 0.3
Zinc	0.2	31.9	44.3	25.5	16.2
Zirconium	0.3	< 0.3	< 0.3	< 0.3	< 0.3

Notes:

1. All concentrations in mg/kg (ppm).
2. MDC - Method Detection Concentration.
3. LT - Labrador Tea.
4. Fw - Fireweed.
5. LBC - Low Bush Cranberry.
5. R - Raspberry.

4.2 SITE NO. 1 - MILE POST 73

4.2.1 Physical Setting

General Description

MP 73 is located 97 km south of Ross River, 0.5 km south of Gravel Creek, on the South Canol Road (Figure 3). The site is located on a local topographic high which is bounded by low-lying wetland areas to the north, south and west, and by Gravel Creek down a steep embankment to the east. The site is found on a relatively gentle, north facing slope. There were no visible surface drainage courses on the site, likely owing to the permeable nature of the site soils.

The site (see Figure 4) is found on both sides of the road with the east side formerly occupied by a pumping station and the west side being an abandoned camp dump. A gravel access road provides access to the east side of the site while the west side of the site is partially cleared.

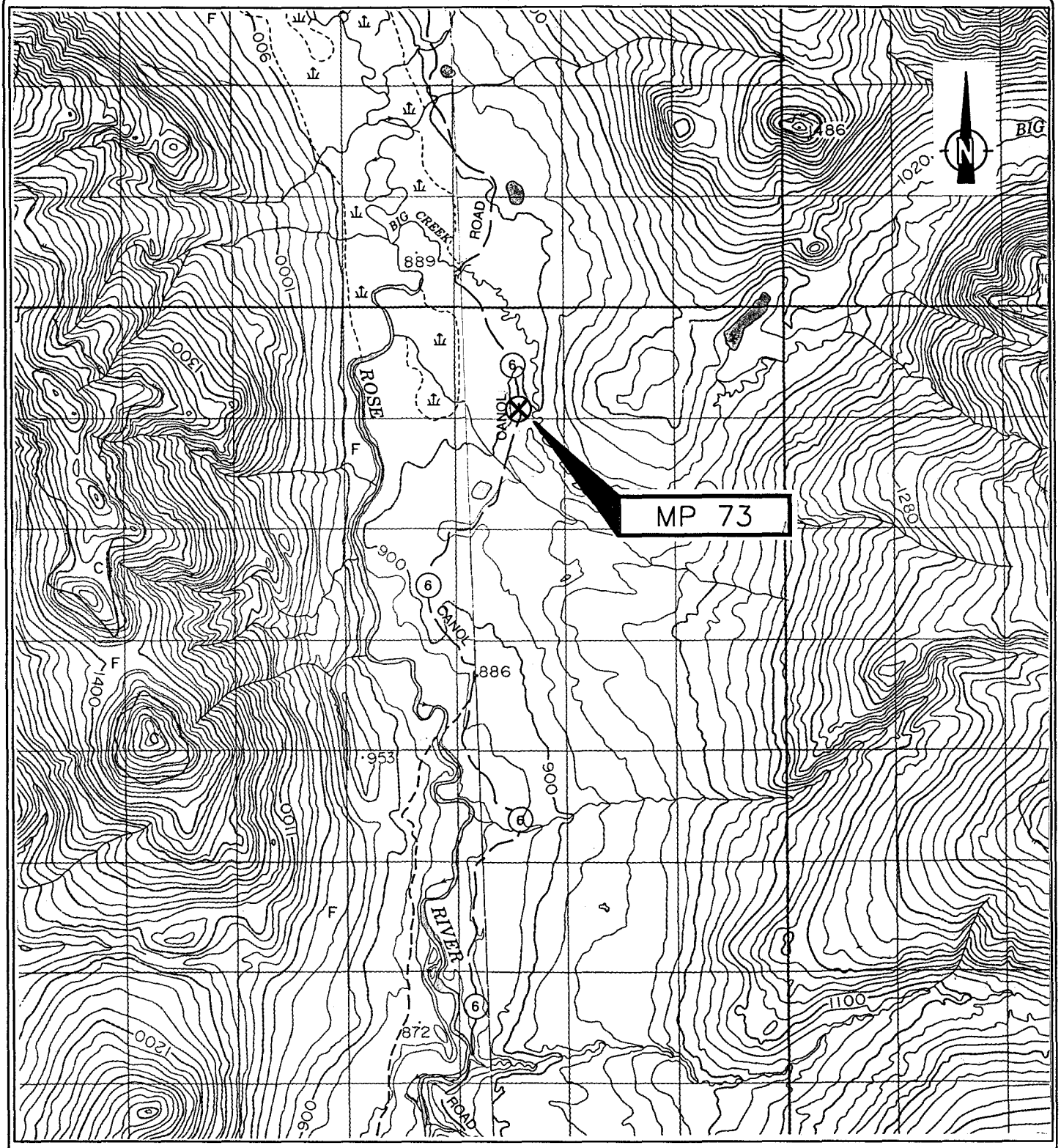
Three cleared areas at the south end of the site, Area A, showed signs of being saturated with oil on the surface, and little or no vegetative cover.

Remnants of the pumping station were observed in the form of three concrete foundations located near the south end of the site (see Photograph 3). These foundations presumably had been used as pump mounts. Adjacent to one of the foundations, in Area B, was an underground storage tank (UST) encountered just below the surface (see Photograph 5). The underground storage tank consisted of three 45 gallon drums welded together in a lengthwise direction and was connected to the largest concrete foundation via a 0.05 m diameter transport line. The UST appeared to be an overflow tank for oil spilled inside the pump station.

Metal debris scattered about the south and central areas of the site included steel pipe, cans and drums, and assorted vehicle and heavy equipment parts.

In the east-central area of the site, there was an area where garbage and other debris has been dumped down the embankment towards the creek. At the north end of the site there remain several rectangular berms approximately 0.3 m high (see Photograph 4).

The alignment and size of these features suggests that this area may have been where the camp buildings once stood. Also, two metal pipes are found east of the berm area, which outlet down the embankment towards the creek.



LEGEND

⊗ MP 73 Mile Post Location

Source:
NTS 105 F/6, F/7 EDITION 1

SCALE 1:50,000

0 500 1000 1500 Metres

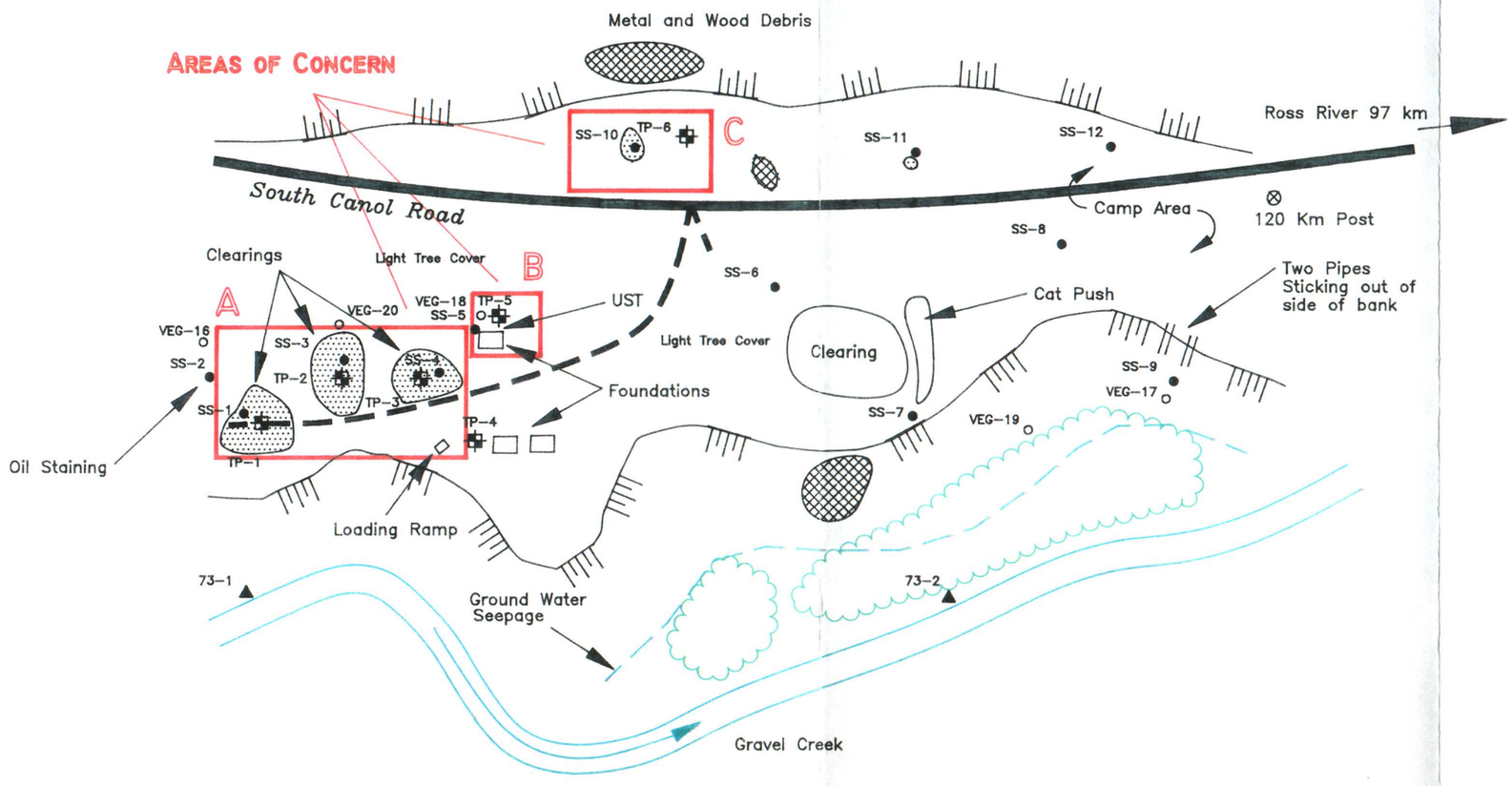
Drawn By: B. Belzac	Project No. 96769
Site Name: South Canol Road	File Name: D:\96769\769-3

MILE POST 73 SITE LOCATION

Canol Road
Site Assessments

Gartner Lee

Figure No. 3



LEGEND

- Canol Road
- Secondary Road
- Abandoned Road
- Oil Staining
- Metal Debris
- Drainage Course
- Surface Water Flow
- Ponded Water
- Swamp/Bog
- Slope
- Tree Line
- Bedrock Outcrop
- SS-1 — Soil Sampling Location
- TP-1 — Test Pit Location
- 73-1 — Water Sampling Location
- BER-1 / VEG-1 — Vegetation Sampling Location

Scale 1:2000 (approximate)

0 10 20 40 60 metres

Drawn By: B. Belzac | Project No. 96769
Site Name: South Canol Road | File Name: D:\96769\769-73

SKETCH MAP MILE POST 73

Canol Road
Site Assessments

Gartner Lee

Figure No. 4

On the west side of the road a few of the rectangular berms were also observed near the north end of the site. The remainder of the west side of the road showed various small concentrations of metal and wood debris, except for a large 5 m diameter oil-stained area with a small pit near the west-central portion of the site referred to as Area C. A test-pit was excavated within the small pit and numerous empty and full drums and cans of automotive fluids and grease were removed from the excavation. This area appeared to be a waste disposal site for the camp and pumping station (see Photograph 8).

Geology

Regional mapping of the area shown on GSC Surficial Geology Map 1792A (Jackson, 1993) indicates that the shallow surficial geology is comprised of a glaciofluvial complex of sand, gravel, diamicton (e.g. poorly sorted sediments) and minor silts. These sediments were deposited by streams flowing from, or in contact with, glacial ice and have formed a glaciofluvial terrace.

Mapping and test pitting found the shallow surficial geology to consist of shallow dipping beds of mostly coarse sand and gravel, with some cobbles and occasional boulders, to depths of greater than 2.1 m. The individual beds varied from thin to massive. A thin (0.15 m) horizon of grey fine sand and silt was encountered at a depth of 1.06 m in one of the test pits.

Hydrogeology

No ground water was encountered at the site during the test pitting program indicating a deep water table, although a seepage zone was observed near the base of the embankment on the east side of the site. From the location of the seepage zone, it is inferred that the water table occurs at a depth of approximately 10 m. The direction of ground water flow is inferred to follow the topography of the site. A large component of the flow on the east side of the site is expected to travel in the direction of Gravel Creek. Ground water flow on the west side of the site likely follows the topography with both a northern and western component. The latter likely flows toward the low lying wet areas surrounding the site.

Vegetation

The tree canopy consists mainly of a Lodgepole Pine (*Pinus contorta*) stand with a few scattered Trembling Aspen (*Populus tremuloides*). The understory consisted of occasional shrub willows (*Salix sp.*) and ground cover was sparse with some patches of Bearberry (*Arctostaphylus uva-ursi*). Some areas showed little or no plant regrowth other than lichen

and mosses. Understory and ground cover were more prevalent towards the lowland areas that bordered the site.

Large areas on both the east and west portions of the site show obvious signs of disturbance due to the historical clearing and activities conducted on this site. The very coarse soils are likely poor in nutrients and have low water holding capacity which may be the limiting factor for successful regeneration of ground cover on this site. In addition, a uniform-aged stand of Lodgepole Pine like this one is frequently an indication of a past forest fire. There appeared to be no obvious signs of stress on the vegetation except for some very localized chlorosis on plants near oil-stained areas.

Surface Water

Gravel Creek, bordering the site on the east side, is a fast flowing stream that is deeply entrenched. The substrates consist mainly of boulders and cobbles with some pockets of sand and gravel. The average width of the creek was approximately 3.5 to 4.0 m and had depths ranging from 0.40 to 0.80 m. There was no obvious signs of impacts on the creek such as staining, discoloration of the water or odor observed.

4.2.2 Test Results

Field Screening

A total of 25 soil samples were screened in the field using a PID and 24 soil samples were screened for concentrations of DDT using the immunoassay field kits. The results from both field screening techniques are presented in Table 3 starting on Page 14.

Several of the soil samples screened with the PID from TP-2 and TP-3 showed organic vapour concentrations of between 150 and 1200 ppm. These are considered elevated, and indicative of hydrocarbon contamination, compared to typical background readings of 2 to 10 ppm.

Only one of the samples field screened for DDT suggested positive results for the occurrence of pesticides, indicating a concentration of between 1.0 and 10.0 ppm. Four other samples indicated concentrations of between 0.0 and 0.2 ppm, which are considered background.

Soil Chemistry

Selected soil samples were submitted to the analytical laboratory for analysis of potential contaminants of concern as identified in previous report by K. Bisset and Associates. This section provides a summary of the analytical results with the complete results presented in Tables 4.2.1, 4.2.2 and 4.2.3 in Appendix B.

Concentrations of total oil and grease which exceeded the CCME Parkland criteria were detected in six of the seven samples analyzed. Of these six, three samples in Area A had concentrations which exceeded the CCME Industrial Land use criterion, one sample in Area B had a concentration which exceeded the Industrial criterion and a second sample in Area B had a concentration which exceeded the B.C. Special Waste criterion.

LEPH/HEPH were detected in all three of the samples analyzed from Area A. Concentrations of LEPH in all three samples exceeded the Parkland criterion, with two of the samples having concentrations which exceed the Industrial criterion. Concentrations of HEPH in all three samples exceeded the Parkland criterion.

Thirteen samples were analyzed for metals and the analytical results showed no concentrations which exceeded the Parkland criterion.

Two pesticides, Endosulfan II and Endrin were detected in trace amounts in one of the soil samples collected from Area C, but the more accurate laboratory methodology did not confirm the presence of DDT as suggested by the field screening techniques.

Surface Water Chemistry

Two surface water samples were collected at this site; one at an upstream location (73-1) and one adjacent to the site (73-2) as shown on Figure 4. Sample results show similar concentrations at both the upstream and adjacent locations, and levels for all constituents except for zinc in the upstream sample, were within established Freshwater Aquatic Life (FAL) criteria. The zinc concentration was slightly above the FAL criteria, but appears to be naturally occurring. The complete analytical results are presented in Table 4.2.5 in Appendix B.

Both samples were also analyzed for oil and grease and the analytical results showed no impacts of petroleum hydrocarbons in the creek.

Due to the high volumes of water flowing through this system it is unlikely that there would be any visible localized impacts from contamination associated with this site.

Vegetation Samples

A total of five vegetation samples were taken at Site 73 representing two species: Labrador Tea and Fireweed.

All five samples exhibit similar concentrations of metals and elements to the control samples. The complete analytical results are presented in Table 4.2.4 in Appendix B.

4.2.3 Discussion

Three areas of concern, Areas A, B and C, have been identified at this site and each of the areas is highlighted on the site plan (Figure 4).

In Area A soil contamination extends to a depth of more than 2m in depth, as observed in test pits 2 and 3, and may extend downward into coarse gravelly sediments up to 10 m, where the water table is thought to occur. The assumed extent of this contamination is a result of the coarse and porous nature of the underlying gravelly soils which allow unrestricted and easy infiltration of spilled or leaked hydrocarbons into the subsurface environment, and into the ground water, which is likely in hydraulic contact with the creek.

Immediate hydrocarbon impacts on the creek were not observed in the analytical results which may be the result of dilution by the sheer volume of water flowing past the site.

The UST in Area B appeared to be nearly empty, with a small amount of sludge remaining in the bottom. Soils immediately under the tank (depth 0.76 m) have been impacted with hydrocarbons at B.C. Special Waste levels. The extent and depth of the contamination is not known, but visual and olfactory indications of the soils on the sidewalls and base of the excavation, suggest that contamination is not extensive.

A test pit was excavated within a small depression in Area C next to a large surficial oil stain. The test pit revealed that the area had been used as a dump for the camp and pumping station, and that cans of automobile fluids and grease as well as camp debris were buried in this location. The full extent of the area of refuse was not determined in this phase of the project, but could be assessed if additional investigations or remediation are planned.

Remediation action for this site would likely be limited to partial excavation of the contaminated soils. The remoteness of the site and lack of access to electrical power eliminate many remediation options.

Soil contamination in Area A is expected to continue throughout the soil column to a depth of approximately 10 m. Excavation of soils to this depth is not feasible, however, removal of the upper 1 to 2 m of the contaminated soils and replacement of the excavated soil with clean fill would minimize impacts on wildlife and vegetation in the area. This would remove the most heavily contaminated materials and source of contamination. The remaining lower soils would still contain residual contamination, however, they can be expected to naturally bioremediate over time.

Soils surrounding the UST in Area B could be removed in the same manner and to similar depths. Confirmation sampling of the resulting excavation should then be conducted to ensure that this isolated area has been cleaned up.

The excavated soils from both areas could be handled in either of the three following manners:

1. The soils could be placed in a lined bio-cell possibly located at the Ross River landfill. With the installation of a passive venting system combined with nutrient addition and turning of the soils during the summer, the soils may bioremediate.

2. The soils could be placed in a lined holding facility for permanent storage . The holding facility could be located at the Ross River landfill.

3. The coarse granular nature of the soils might allow the material to be recycled and incorporated in chip sealing of roads.

4.2.4 Conclusions

Based upon the findings of the site investigation, the following conclusions can be made:

a) soils in Area A in excess of **2 m in depth have been impacted by petroleum hydrocarbons at concentrations which exceed the Parkland and Industrial criteria;**

b) **a UST is located adjacent to one of the foundations** in Area B and the **soils beneath the tank have been impacted by petroleum hydrocarbons at concentrations which exceed the B.C. Special Waste criteria;**

c) **buried refuse, including full cans of oil and grease**, are located on the west side of the road in Area C, and the **underlying soils have been impacted with petroleum hydrocarbons at concentrations which exceed the Parkland criteria;**

d) no immediate impacts from the site were observed in Gravel Creek.

4.2.5 Recommendations

The following recommendations area made based on the conclusions outlined above:

a) The UST located in Area B should be removed from the site and disposed of at a scrap metal yard.

b) Impacted soils in Areas A and B should be excavated (to reasonable depths of approximately 2m) and removed from the site. The excavated soils should then be dealt with in a manner consistent with either of the three options presented in the Discussion section. The excavations should then be backfilled with clean materials to minimize surface exposure to the underlying impacted soils.

c) While heavy equipment is on-site, the refuse in Area C, should have its limits defined and the waste materials removed from the site and disposed of at the Ross River landfill. Any impacted soils should be excavated (to reasonable depths) and disposed of in the same manner as mentioned above.

TABLE 4.2.1: SOIL CHEMISTRY - HYDROCARBON RESULTS

Parameter	CCME/ CMCS Parkland Criteria	CCME/ CMCS Industrial Criteria	B.C. Special Waste	Zenon ID : Sample ID : MDC	MP73 96025211 TP5 0.76M	MP73 96025200 TP2 0.43M	MP73 96025187 TP2 1.08m	MP73 96025189 TP2 1.46m	MP73 96025190 TP1 1.98m	MP73 96025191 TP5 TANK FILL PIPE	MP73 96025195 TP3 1.9m
HYDROCARBONS											
TEH (C10 - C30)				5	—	—	6500	2800	—	—	4200
TEH Heavy Oil (>C30)				5	—	—	890	510	—	—	670
EPH (C10 - <C19)	1000	2000		5	—	—	3900	1600	—	—	2400
EPH (C19 - C32)	1000	5000		5	—	—	2800	1400	—	—	2000
Oil & Grease Total	100	5000	30000	100	***31000***	21000	5700	3800	< 100	29000	6500
POLYAROMATIC HYDROCARBONS											
Benz(a)anthracene	1	10		0.01	—	—	< 0.01	—	—	—	< 0.01
Dibenz(a,h)anthracene	1	10		0.02	—	—	< 0.02	—	—	—	< 0.02
Chrysene				0.01	—	—	< 0.27	—	—	—	0.32
Benzo(b)Fluoranthene	1	10		0.01	—	—	0.03	—	—	—	< 0.03
Benzo(k)fluoranthene	1	10		0.01	—	—	< 0.01	—	—	—	< 0.01
Benzo(j)fluoranthene				0.01	—	—	< 0.01	—	—	—	< 0.01
Benzo(g,h,i)perylene				0.02	—	—	< 0.02	—	—	—	< 0.02
Pyrene	10	100		0.01	—	—	0.18	—	—	—	0.13
Benzo(a)pyrene	1	10		0.01	—	—	< 0.01	—	—	—	< 0.01
Indeno(1,2,3-c,d)pyrene	1	10		0.02	—	—	< 0.02	—	—	—	< 0.02
Acenaphthene				0.01	—	—	< 0.15	—	—	—	< 0.35
Acenaphthylene				0.01	—	—	< 0.17	—	—	—	< 0.05
Anthracene				0.01	—	—	< 0.01	—	—	—	< 0.04
Fluoranthene				0.01	—	—	< 0.01	—	—	—	< 0.01
Fluorene				0.01	—	—	0.71	—	—	—	< 0.01
Naphthalene	5	50		0.01	—	—	< 1.4	—	—	—	< 0.16
Phenanthrene	5	50		0.01	—	—	1.2	—	—	—	< 0.01
Total PAH's					—	—	2.1	—	—	—	0.45
Total Low MW PAH's					—	—	1.9	—	—	—	< 0.62
Total High MW PAH's					—	—	0.21	—	—	—	0.45

Notes:

1. All concentrations in mg/kg (ppm).
2. MDC - Method Detection Concentration.
3. 1000 — Concentration exceeds Parkland criteria.
4. 2000 — Concentration exceeds Industrial criteria.
5. ***42000*** — Concentration exceeds B.C. Special Waste criteria.
6. — Parameter not determined.

(96769-1/15/97-MP73.XLS)

TABLE 4.2.2: SOIL CHEMISTRY - METAL RESULTS

Parameter	CCME/ CMCS Parkland Criteria	CCME/ CMCS Industrial Criteria	Zenon ID : Sample ID : MDC	MP73 96025210 SS2	MP73 96025201 SS-1	MP73 96025203 SS3	MP73 96025204 SS5	MP73 96025207 SS6	MP73 96025208 SS9	MP73 96025209 SS8	MP73 96025187 TP2 1.08m	MP73 96025194 TP6 0.71m	MP73 96025196 TP3 0.41m
METALS TOTAL													
Aluminum			2	3900	3870	5590	4930	5080	3630	14900	5810	4440	4110
Antimony	20	40	2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Arsenic	30	50	8	< 8	< 8	< 8	< 8	< 8	< 8	< 8	8	< 8	< 8
Barium	500	2000	0.1	48.9	44.2	41	39	45.3	60.2	60.7	56.2	46.8	27.2
Beryllium	4	8	0.1	0.3	0.2	0.5	0.4	0.5	0.4	0.6	0.5	0.4	0.3
Bismuth			2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Cadmium	5	20	0.2	< 0.2	< 0.2	0.8	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Calcium			1	400	368	1280	1030	1180	1670	464	1980	1280	1030
Chromium	250	800	0.2	3.6	4.5	6.1	6.5	6.2	6.4	10.6	9.7	6.8	4.5
Cobalt	50	300	0.3	1.5	2.2	2.6	2.4	2.5	2.5	3.5	3.5	2.8	1.9
Copper	100	500	0.1	8	6.8	4.1	6.1	4.6	30.3	9.3	5.8	6.7	6.6
Iron			0.3	7390	11300	8740	10100	8850	7740	18700	12100	8170	6210
Lead	500	1000	2	5	11	6	18	8	51	11	8	14	6
Magnesium			2	931	1160	2080	1720	2020	1760	2110	3030	1970	1580
Manganese			0.2	71.7	241	153	155	190	201	162	181	163	86.9
Mercury	2	10	0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Molybdenum	10	40	0.4	0.6	0.8	0.5	< 0.4	< 0.4	0.5	0.4	< 0.4	< 0.4	0.5
Nickel	100	500	0.8	4.1	4	10.2	8.8	10.3	9.7	7.7	13.3	12.5	8.6
Phosphorus			4	406	366	726	568	610	597	711	799	527	559
Potassium			40	611	918	1110	800	916	960	834	1170	834	872
Selenium	3	10	5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Silver	20	40	1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Sodium			1	59	53	50	58	47	94	44	35	67	68
Strontium			0.1	7.5	4.3	5.7	5.5	4.6	7.9	4.3	7.7	7.6	4.4
Sulphur			3	123	120	92	170	27	67	136	41	46	69
Tellurium			2	2	< 2	< 2	< 2	< 2	< 2	4	3	< 2	< 2
Thallium			1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Tin	50	300	2	2	3	4	3	3	26	2	4	< 2	< 2
Titanium			0.3	369	524	353	386	264	203	482	378	244	224
Vanadium	200		0.3	10.9	14	10.3	14.2	10.3	6.9	22.2	15.7	8.9	7.4
Zinc	500	1500	0.2	17	21	19.1	19.3	19.3	64.9	48.5	21.6	26.8	14.5
Zirconium			0.3	< 0.3	< 0.3	0.6	< 0.3	0.5	< 0.3	1.2	0.4	0.4	0.4

Notes:

1. All concentrations in mg/kg (ppm).
2. MDC - Method Detection Concentration.
3. 500 Concentration exceeds Parkland criteria.
4. 2000 Concentration exceeds Industrial criteria.

(96769-1/13/97-MP73.XLS)

TABLE 4.2.3: SOIL CHEMISTRY - PESTICIDE RESULTS

Parameter	CCME/ CMCS Parkland Criteria[1]	Zenon ID : Sample ID : MDC	MP73 96025199 SS10	MP73 96025194 TP6 0.71m
Aldrin		0.0004	<0.0004	<0.0004
BHC, alpha-		0.0004	<0.0004	<0.0004
BHC, beta-		0.0004	<0.0004	<0.0004
BHC, delta-		0.0004	<0.0004	<0.0004
Chlordane, alpha-		0.002	<0.002	<0.002
Chlordane, gamma-		0.002	<0.002	<0.002
DDE, p,p'-		0.001	<0.001	<0.001
DDT, o,p'-		0.002	<0.002	<0.002
DDD, p,p'-		0.002	<0.002	<0.002
DDT, p,p'-		0.002	<0.002	<0.002
Dieldrin		0.002	<0.002	<0.002
Endosulfan I		0.002	<0.002	<0.002
Endosulfan II		0.002	<0.002	0.018
Endosulfan Sulphate		0.004	<0.004	<0.004
Endrin		0.002	<0.002	0.015
Heptachlor		0.0004	<0.0004	<0.0004
Heptachlor epoxide		0.0008	<0.0008	<0.0008
Hexachlorobenzene		0.0002	<0.0002	<0.0002
Lindane, BHC, gamma-		0.0004	<0.0004	<0.0004
Methoxychlor		0.004	<0.004	<0.004
Mirex		0.004	<0.004	<0.004
Nonachlor, trans-		0.002	<0.002	<0.002
Oxychlordane		0.002	<0.002	<0.002
POLYCHLORINATED BIPHENYLS				
PCB's - Totals		0.01	<0.01	<0.01
Dibromobiphenyl			100	91

Notes:

1. All concentrations in mg/kg (ppm).
2. MDC - Method Detection Concentration.
3. [1] Total pesticide concentration not to exceed 2 ppm.

TABLE 4.2.4: VEGETATION CHEMISTRY - METAL RESULTS

Parameter	Zenon ID : Sample ID : MDC	MP73 96025352 VEG 16 LT	MP73 96025353 VEG 17 LT	MP73 96025354 VEG 18 LT	MP73 96025355 VEG 19 Fw	MP73 96025356 VEG 20 LT
METALS TOTAL						
Aluminum	2	38	45	60	27	45
Antimony	2	2	< 2	3	2	< 2
Arsenic	8	< 8	< 8	< 8	< 8	< 8
Barium	0.1	105	113	84.4	47	81.6
Beryllium	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Bismuth	2	< 2	< 2	< 2	< 2	< 2
Cadmium	0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Calcium	1	4890	4830	5060	17700	4650
Chromium	0.2	0.9	0.7	0.8	1.1	0.8
Cobalt	0.3	0.7	< 0.3	0.8	0.6	0.6
Copper	0.1	7.3	4.8	7.4	5.7	5.6
Iron	0.3	44.9	58.7	98.6	89.8	48.4
Lead	2	< 2	< 2	< 2	< 2	4
Magnesium	2	764	1030	933	3160	1020
Manganese	0.2	1170	1260	1440	69.3	1300
Mercury	0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Molybdenum	0.4	< 0.4	< 0.4	< 0.4	4	< 0.4
Nickel	0.8	< 0.8	1.7	4	1	1.6
Phosphorus	4	1120	1330	1720	1920	1470
Potassium	40	3780	4420	5070	8310	4740
Selenium	5	< 5	< 5	< 5	< 5	< 5
Silver	1	< 1	< 1	< 1	< 1	< 1
Sodium	1	11	7	11	85	9
Strontium	0.1	24	9.7	8.1	48.9	12.8
Sulphur	3	758	771	946	493	869
Tellurium	2	< 2	< 2	< 2	< 2	< 2
Thallium	1	3	2	< 1	6	< 1
Tin	2	< 2	< 2	2	< 2	2
Titanium	0.3	0.7	1.2	2.6	0.4	0.9
Vanadium	0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Zinc	0.2	34.4	27.2	32	43.5	31.9
Zirconium	0.3	0.3	< 0.3	0.4	< 0.3	< 0.3

Notes:

1. All concentrations in mg/kg (ppm).
2. MDC - Method Detection Concentration.
3. LT - Labrador Tea.
4. Fw - Fireweed.

TABLE 4.2.5: SURFACE WATER CHEMISTRY RESULTS

Parameter	CCME/ CMCS Fresh Water Aquatic Life	Zenon ID : Client ID : MDC	MP73 96025373 73-1	MP73 96025374 73-2
METALS TOTAL				
Aluminum	0.02	0.06	< 0.06	< 0.06
Antimony		0.02	< 0.02	< 0.02
Arsenic	0.05	0.04	< 0.04	< 0.04
Barium	1	0.001	0.01	0.01
Beryllium	0.053	0.001	< 0.001	< 0.001
Bismuth		0.02	< 0.02	< 0.02
Boron		0.04	< 0.04	< 0.04
Cadmium	0.0008	0.002	< 0.002	< 0.002
Calcium		0.05	8.99	9.27
Chromium	0.002	0.002	< 0.002	0.002
Cobalt	0.05	0.004	< 0.004	< 0.004
Copper	0.004	0.002	< 0.002	< 0.002
Iron	0.300	0.05	0.07	< 0.05
Lead	0.006	0.03	< 0.03	< 0.03
Magnesium		0.02	2.53	2.6
Manganese	0.100	0.002	0.003	< 0.002
Mercury	0.0001	0.00005	< 0.00005	< 0.00005
Molybdenum	1.000	0.004	< 0.004	< 0.004
Nickel	0.065	0.01	< 0.01	< 0.01
Phosphorus		0.04	< 0.04	< 0.04
Potassium		0.4	0.5	0.4
Selenium	0.001	0.03	< 0.03	< 0.03
Silicon		0.8	3.8	3.7
Silver	0.0001	0.03	< 0.03	< 0.03
Sodium		0.4	1.5	1.6
Strontium		0.001	0.039	0.04
Sulphur		0.1	2.7	2.6
Tellurium		0.02	< 0.02	< 0.02
Thallium		0.03	< 0.03	< 0.03
Tin		0.02	< 0.02	< 0.02
Titanium		0.003	< 0.003	< 0.003
Vanadium		0.003	< 0.003	< 0.003
Zinc	0.03	0.01	0.04	0.02
Zirconium		0.003	< 0.003	< 0.003
HYDROCARBONS				
Oil & Grease Total		1	1	1

Notes:

1. All concentrations in mg/L (ppm).
2. MDC - Method Detection Concentration.
3. 0.02 Concentration exceeds Fresh Water Aquatic Life criteria.

4.3 SITE NO. 2 - MILE POST 99.5

4.3.1 Physical Setting

General Description

MP 99.5 is located 60 km south of Ross River on the South Canol Road. The site, on the west side of the road, is situated near the middle of the Lapie Lakes (Figure 5) and is found on an alluvial fan.

Access is along a gravel road which extends westward from the South Canol Road to the lake.

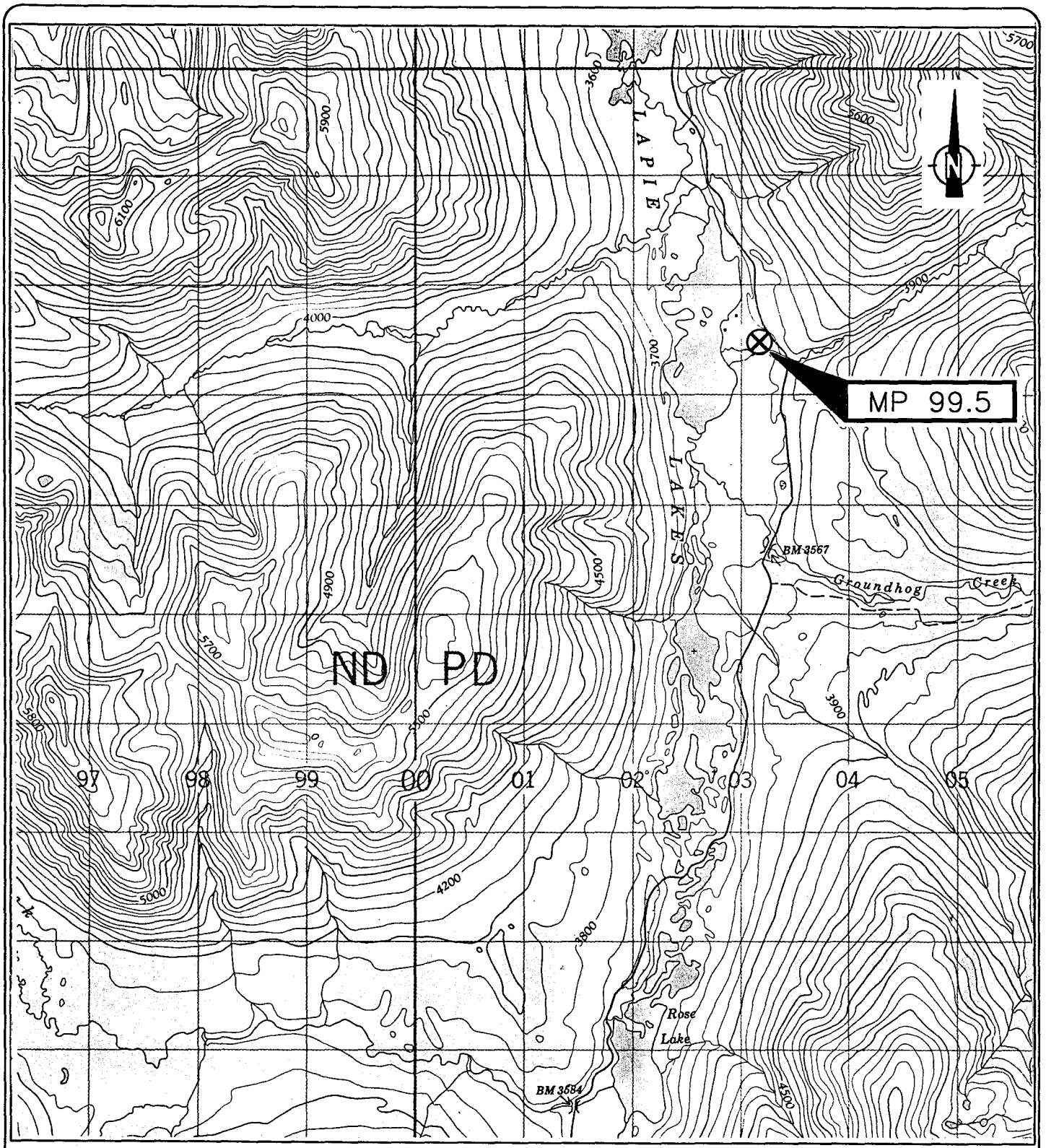
The area to the south is mostly flat with a gentle slope to the west and the topography rises to a gently rolling area to the north. The site is bounded by the South Canol Road and then a steep embankment to the east, and by the lake to the west (Figure 6). Drainage on the site is to the west towards the lake. A small creek, Groundhog Creek, is located south of the site and also flows towards the lake.

The site was formerly occupied by a small camp consisting of eleven wooden buildings and a graveled storage area (Synergy, 1975). An inspection of the site failed to produce any evidence of the structures, although there were several overgrown former roadways and a cleared area with a gravel surface. Much of the site was heavily overgrown with willows (see Photographs 9 and 10). There were no visual indications of surface staining

Geology

The regional geological mapping of this area as shown on GSC Surficial Geology Map 1790A (Jackson, 1993) indicates that the surface geology in this area is comprised of alluvial deposits of gravel, sand, silt and diamicton up to 10 m or more thick deposited by streams.

Terrain analysis by GLL has determined that this site is on an alluvial fan complex with abandoned braided channels which trend downslope in the direction of Lapie Lake. Shallow soil samples collected at the site also confirm the regional mapping with silty sands and sands and gravels exposed at depths of 0.1 to 0.2 m. Glaciofluvial terraces and ice contact terraces are also found beside the alluvial fan. The surface soils at site MP 99.5 appear to be well drained and there is no evidence of permafrost.



LEGEND

⊗ MP 99.5 Mile Post Location

Source:
NTS 105 F/11 EDITION 1

SCALE 1:50,000

0 500 1000 1500 Metres

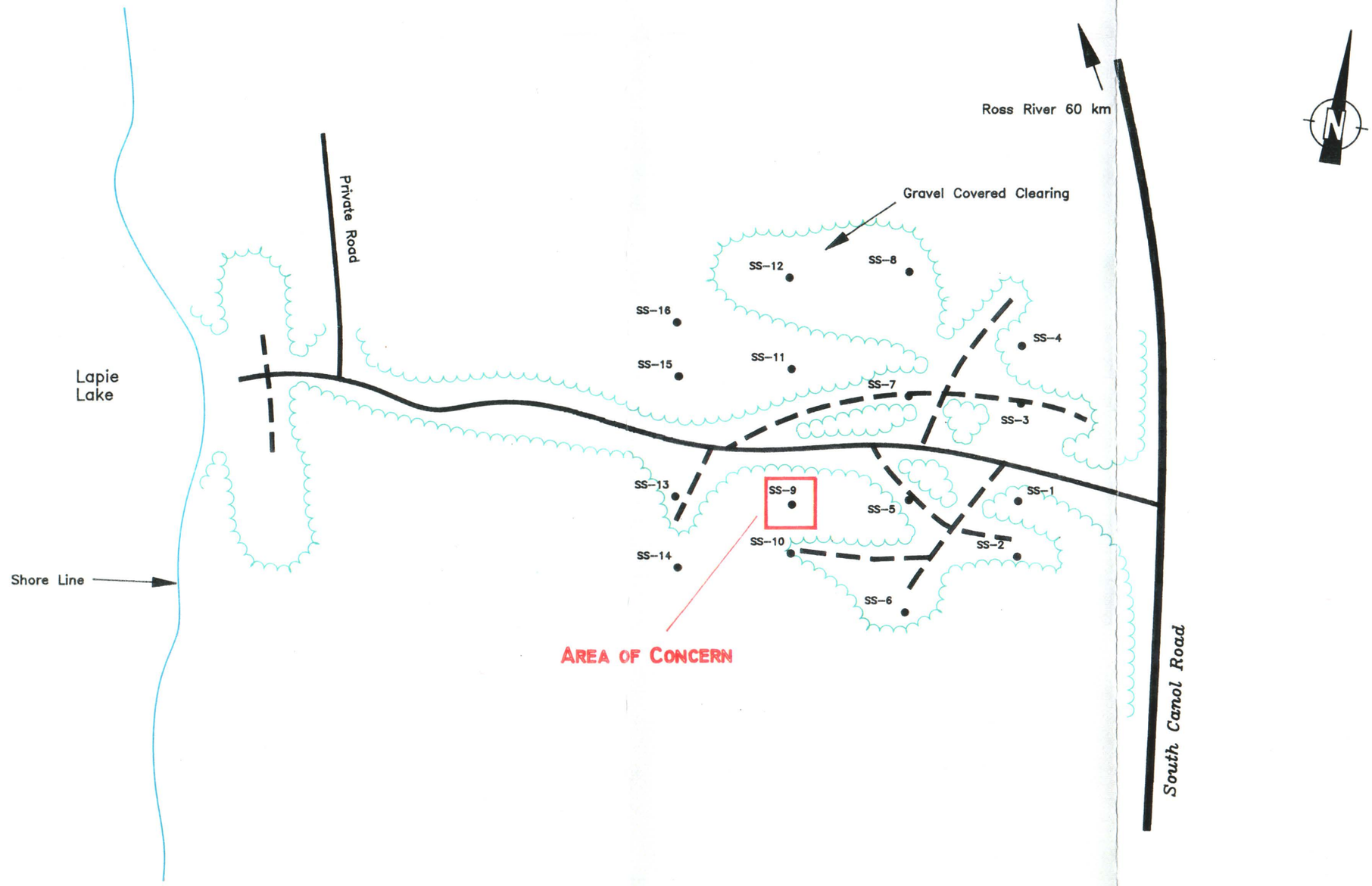
MILE POST 99.5 SITE LOCATION

Canol Road
Site Assessments

Gartner Lee

Figure No. 5

Drawn By: B. Belzac | Project No. 96769
Site Name: South Canol Road | File Name: D:\96769\769-5



LEGEND

- Canol Road
- Secondary Road
- Abandoned Road
- Oil Staining
- Metal Debris
- Drainage Course
- Surface Water Flow
- Ponded Water
- Swamp/Bog
- Slope
- Tree Line
- Bedrock Outcrop
- SS–1 Soil Sampling Location
- TP–1 Test Pit Location
- 73–1 Water Sampling Location
- BER–1 / VEG–1 Vegetation Sampling Location

Scale 1:2000 (approximate)

0 10 20 40 60 metres

Drawn By: B. Belzac | Project No. 96769

Site Name: South Canol Road | File Name: D:\96769\769-99

SKETCH MAP MILE POST 99.5

Canol Road
Site Assessments

Gartner Lee

Figure No. 6

Hydrogeology

The hydrogeology of the area is characterized by a shallow unconfined aquifer with the depth to ground water at less than 2 m for most of this site. Further to the west, the depth to the water table decreases and ground water is observed at or near the surface as the terrain becomes swampy. The inferred direction of flow is to the west towards the lake, however, there is also likely a southerly component towards Groundhog Creek.

Vegetation

The site is located in a lowland area on the shores of Lapie Lake. The vegetation community found in this area is dominated by shrub willow thickets 2 to 4 m tall. Occasional White Spruce (*Picea glauca*) are regenerating among the willows. The surrounding lands contain an open forest of spruce and Subalpine Fir (*Abies lasiocarpa*). There is evidence of cleared areas where roads and buildings once existed yet regeneration is quite good. There has been recent clearing and ground cover is sparse due to grazing by horses that are used for hunting in the area.

Surface Water

The middle lake of the chain of lakes referred to as the Lapie Lakes is located approximately 150 m to the west, and down-gradient, of the site. A single surface water sample was collected from the near-shore area of the lake.

4.3.2 Test Results

Field Testing

A total of 16 soil samples were collected at this site. All were field screened for organic vapours using the PID, and the occurrence of DDT using the field immunoassay kits. The results from both field screening procedures are presented in Table 3, starting on Page 14.

Three of the samples screened for organic vapour concentrations revealed concentrations slightly above background conditions with values ranging between 11 and 21 ppm. Background readings usually range between 0 and 10 ppm, based on professional experience.

Three of the 16 samples field screened for the occurrence of DDT indicated background concentrations of between 0 and 0.2 ppm, while the remainder indicated no presence of the pesticide.

Soil Chemistry

Selected soil samples were submitted to the analytical laboratory for analysis of potential contaminants of concern previously identified by K. Bisset and Associates. This section provides a summary of the analytical results with the complete results presented in Tables 4.3.1 and 4.3.2 in Appendix B.

Petroleum hydrocarbons were detected in the shallow surficial soils of the site. Total oil and grease was detected in four of the eight samples analyzed with only one sample having a concentration which exceeded the Parkland criterion. This area is highlighted as an Area of Concern on the Site Plan, Figure 6.

The eight samples submitted for metals analysis revealed concentrations which were within the Parkland criterion.

Surface Water Chemistry

The analytical results of the surface water indicate that the concentrations of all parameters are within the Freshwater Aquatic Life criteria. The complete analytical results are presented in Table 4.3.3 in Appendix B.

Vegetation Samples

No vegetation samples were collected at this site.

4.3.3 Discussion

The field observations and analytical results indicate that impacts from past site activities are minimal. There is very little evidence remaining of the small camp that once was located on the site, with the only visual indications being the overgrown roads and gravel covered clearing on the north side.

The concentrations of oil and grease detected in the shallow soils are well below the Parkland criteria in all the samples analyzed, except for one. This sampling location has been identified as an Area of Concern on the Site Plan. Impacts on the surrounding environment from this isolated occurrence are predicted to be negligible.

4.3.4 Conclusions

Based on the findings of the site investigation, the following conclusions can be made:

a) the site is nearly completely revegetated and there is very little evidence of past activities;
b) [redacted] sample exceeds the Parkland criteria for oil and grease concentration;
c) impacts from previous site activities appear to be minimal.

4.3.5 Recommendations

The following recommendations can be made based upon the conclusions outlined above:

a) Based upon site observations and the analytical data, no further investigation of this site is warranted.
b) Should the exceedance of the Parkland criteria in the one soil sample remain a concern to the Ross River people, the shallow soils surrounding the sample location could be excavated and removed from the site in conjunction with remedial activities at MP 73.

TABLE 4.3.1: SOIL CHEMISTRY - HYDROCARBON RESULTS

Parameter	CCME/ CMCS Parkland Criteria	CCME/ CMCS Industrial Criteria	B.C. Special Waste	Zenon ID : Sample ID : MDC	MP99.5 96025141 SS-7 surface	MP99.5 96025143 SS-9 0.10M	MP99.5 96025145 SS-11 0.04M	MP99.5 96025147 SS-13 0.10M	MP99.5 96025149 SS-15 0.12M	MP99.5 96025158 SS-1 0.08M	MP99.5 96025160 SS-3 0.04M	MP99.5 96025162 SS-5 0.03M
HYDROCARBONS												
TEH (C10 - C30)				5	---	---	---	---	---	---	---	---
TEH Heavy Oil (>C30)				5	---	---	---	---	---	---	---	---
EPH (C10 - <C19)	1000	2000		5	---	---	---	---	---	---	---	---
EPH (C19 - C32)	1000	5000		5	---	---	---	---	---	---	---	---
Oil & Grease Total	100	5000	30000	100	< 100	1700	130	< 100	270	< 100	210	< 100

Notes:

1. All concentrations in mg/kg (ppm).
2. MDC - Method Detection Concentration.
3. 1000 — Concentration exceeds Parkland criteria.
4. 2000 — Concentration exceeds Industrial criteria.
5. *30000* — Concentration exceeds B.C. Special Waste criteria.
6. --- — Parameter not determined.

TABLE 4.3.2: SOIL CHEMISTRY - METAL RESULTS

Parameter	CCME/ CMCS Parkland Criteria	CCME/ CMCS Industrial Criteria	Zenon ID : Sample ID : MDC	MP99 96025141 SS-7 surface	MP99.5 96025143 SS-9 0.10M	MP99.5 96025145 SS-11 0.04M	MP99.5 96025147 SS-13 0.10M	MP99.5 96025149 SS-15 0.12M	MP99.5 96025158 SS-1 0.08M	MP99.5 96025160 SS-3 0.04M	MP99.5 96025162 SS-5 0.03M
METALS TOTAL											
Aluminum			2	11300	11600	11700	11700	8050	11700	10600	11800
Antimony	20	40	2	2	3	< 2	< 2	2	< 2	3	< 2
Arsenic	30	50	8	9	9	9	< 8	< 8	8	< 8	17
Barium	500	2000	0.1	40.3	23.7	29.4	22.5	31.7	39.2	29.1	47
Beryllium	4	8	0.1	0.4	0.3	0.3	0.3	0.3	0.4	0.3	0.4
Bismuth			2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Cadmium	5	20	0.2	0.2	< 0.2	0.3	0.2	< 0.2	0.3	0.3	0.2
Calcium			1	47800	21600	43500	27700	12000	27500	38100	46200
Chromium	250	800	0.2	18.7	22.9	21.7	21.9	17.5	22.4	19.3	20.3
Cobalt	50	300	0.3	9.8	11.2	12.1	12.6	10.8	12.8	10.1	10.7
Copper	100	500	0.1	26.3	26.3	26.8	25.6	24.2	30	24.1	31.2
Iron			0.3	30300	28300	29800	28300	23100	29200	27100	29400
Lead	500	1000	2	19	16	16	15	18	17	16	19
Magnesium			2	13900	10300	11700	10700	7340	10300	10600	13400
Manganese			0.2	696	289	542	438	230	419	414	431
Mercury	2	10	0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.05	< 0.05
Molybdenum	10	40	0.4	0.7	1	0.9	0.6	1	0.8	0.7	0.5
Nickel	100	500	0.8	21.2	28.7	27.7	28.8	24.5	29.4	24.8	24.1
Phosphorus			4	695	806	748	694	819	735	744	707
Potassium			40	1050	222	331	246	947	287	346	1250
Selenium	3	10	5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Silver	20	40	1	< 1	< 1	1	< 1	< 1	1	1	1
Sodium			1	126	26	40	25	34	38	45	113
Strontium			0.1	112	62.5	127	78.9	35	77.4	103	106
Sulphur			3	180	186	154	191	845	223	295	131
Tellurium			2	4	4	5	4	3	5	4	4
Thallium			1	< 1	< 1	< 1	1	< 1	< 1	1	< 1
Tin	50	300	2	4	< 2	< 2	< 2	4	< 2	< 2	2
Titanium			0.3	313	50.3	28.6	24.9	58.9	44.5	48.2	360
Vanadium	200		0.3	21.7	15	14.7	13.8	13	15.3	13.6	22.2
Zinc	500	1500	0.2	54.2	75.6	73.6	75.1	156	75.5	61.2	74.6
Zirconium			0.3	0.5	1.1	1.1	1.1	1.3	1.3	1.2	0.6

Notes:

1. All concentrations in mg/kg (ppm).
2. MDC - Method Detection Concentration.
3. 500 Concentration exceeds Parkland criteria.
4. 1000 Concentration exceeds Industrial criteria.

(96769-1/13/97-99_5.XLS)

TABLE 4.3.3: SURFACE WATER CHEMISTRY RESULTS

Parameter	CCME/ CMCS Fresh Water Aquatic Life	Zenon ID : Client ID : MDC	MP99 96025375 99.9-1
METALS TOTAL			
Aluminum	0.02	0.06	< 0.06
Antimony		0.02	< 0.02
Arsenic	0.05	0.04	< 0.04
Barium	1	0.001	0.046
Beryllium	0.053	0.001	< 0.001
Bismuth		0.02	< 0.02
Boron		0.04	< 0.04
Cadmium	0.0008	0.002	< 0.002
Calcium		0.05	52
Chromium	0.002	0.002	< 0.002
Cobalt	0.05	0.004	< 0.004
Copper	0.004	0.002	< 0.002
Iron	0.300	0.05	0.05
Lead	0.006	0.03	< 0.03
Magnesium		0.02	17.1
Manganese	0.100	0.002	0.002
Mercury	0.0001	0.00005	< 0.00005
Molybdenum	1.000	0.004	< 0.004
Nickel	0.065	0.01	< 0.01
Phosphorus		0.04	< 0.04
Potassium		0.4	< 0.4
Selenium	0.001	0.03	< 0.03
Silicon		0.8	2.6
Silver	0.0001	0.03	< 0.03
Sodium		0.4	1.4
Strontium		0.001	0.171
Sulphur		0.1	21.9
Tellurium		0.02	< 0.02
Thallium		0.03	< 0.03
Tin		0.02	< 0.02
Titanium		0.003	< 0.003
Vanadium		0.003	< 0.003
Zinc	0.03	0.01	0.01
Zirconium		0.003	< 0.003
HYDROCARBONS			
Oil & Grease Total		1	2

Notes:

1. All concentrations in mg/L (ppm).
2. MDC - Method Detection Concentration.
3. 0.02 Concentration exceeds Fresh Water Aquatic Life criteria
4. This is a background sample.

4.4 SITE NO. 3 - MP 124.5: LAPIE RIVER

4.4.1 Physical Setting

General Description

MP 124.5 is located 21 km south of Ross River, 0.5 km before Glacier Creek, on the South Canol Road (Figure 7). The site is located on both the north side and south side of the road in an area that slopes southward to the Lapie River. The northern portion of this site is bounded by a rock face to the north and the South Canol Road to the south, and was used as a dump for the camp. The southern portion of the site is bounded by the South Canol Road to the north and by the Lapie River and was used as a pumping station and the main camp area (Figure 8).

As stated above, the site slopes to the south and flattens out to a more gentle slope nearer the river. The west and east areas of the site slope steeply from the road and then the slopes flatten out nearer the river as well.

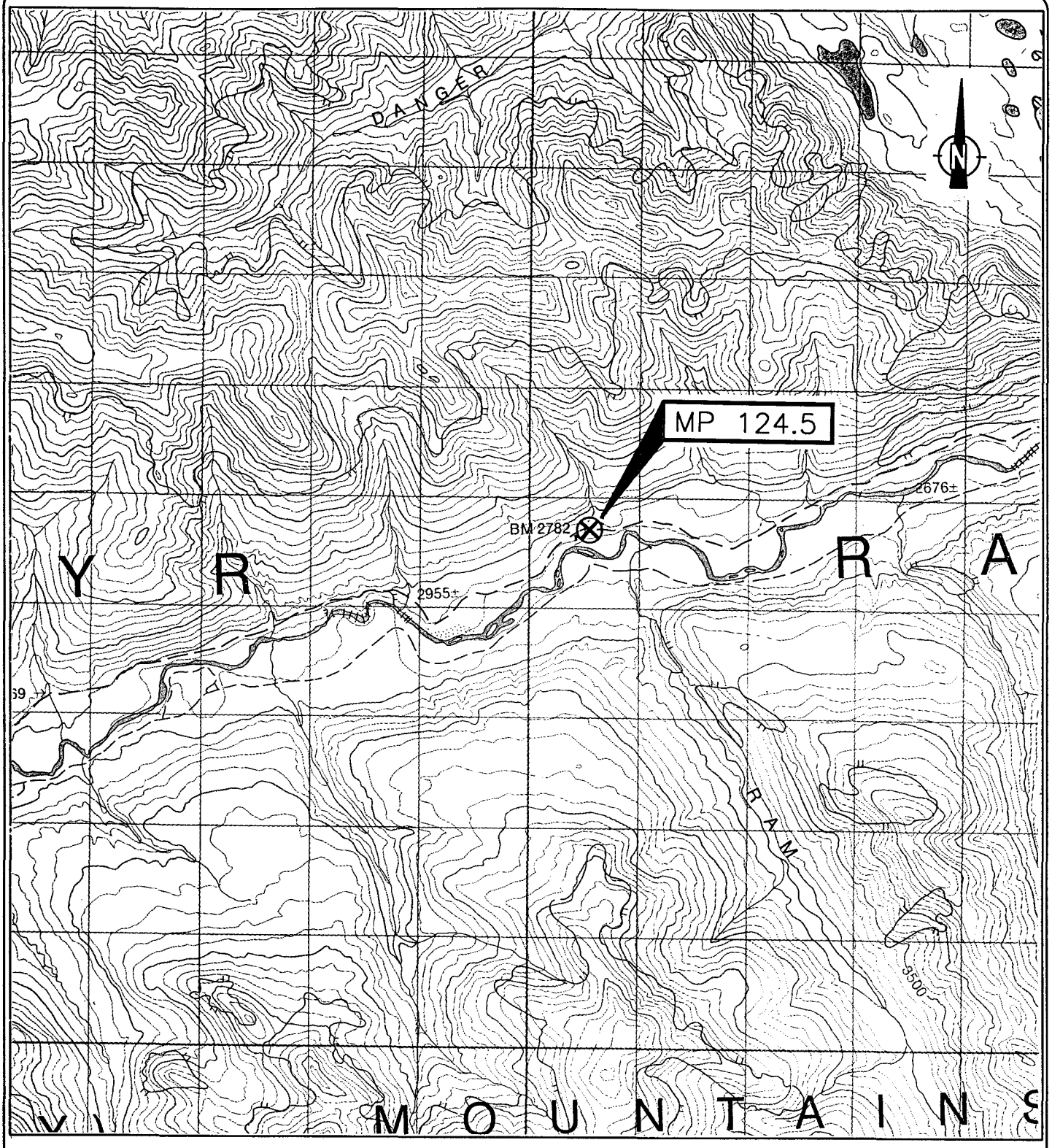
Access to the site is by partially overgrown roads that traverse the site from the road to near the river. A few other old roads lead east-west across the site.

Remnants of the pumping station were observed at the east end of the site. Three concrete foundations, various lengths of steel pipe, valves and other metal debris associated with previous activities were concentrated at this end of the site. This area is referred to as Area A (see Photographs 13 and 14).

Adjacent to the southernmost foundation was an underground storage tank (UST). The configuration of the UST was nearly identical to the UST found at MP 73, in that the tank consisted of three 45 gallon drums welded together. The contents of the UST were checked by running a steel measuring tape down the length of the fill pipe to the base of the tank. The tank was found to contain 0.35m of a dark brown petroleum-like liquid which presumably is crude oil (see Photographs 17 and 18).

Also included in Area A, to the west, is a set of eight 0.6 x 0.6m concrete pads which were likely used as supports for an above-ground storage tank (see Photograph 15).

To the east of the concrete foundations, in Area B, a small drainage swale was found to contain solidified petroleum that extended downslope into a low lying discharge area that was underlain by permafrost. The petroleum contamination appears to originate from a bermed area near the northeast corner of the site.



LEGEND

⊗ MP 124.5 Mile Post Location

Source:
NTS 105 F/15 EDITION 1

SCALE 1:50,000

0 500 1000 1500 Metres

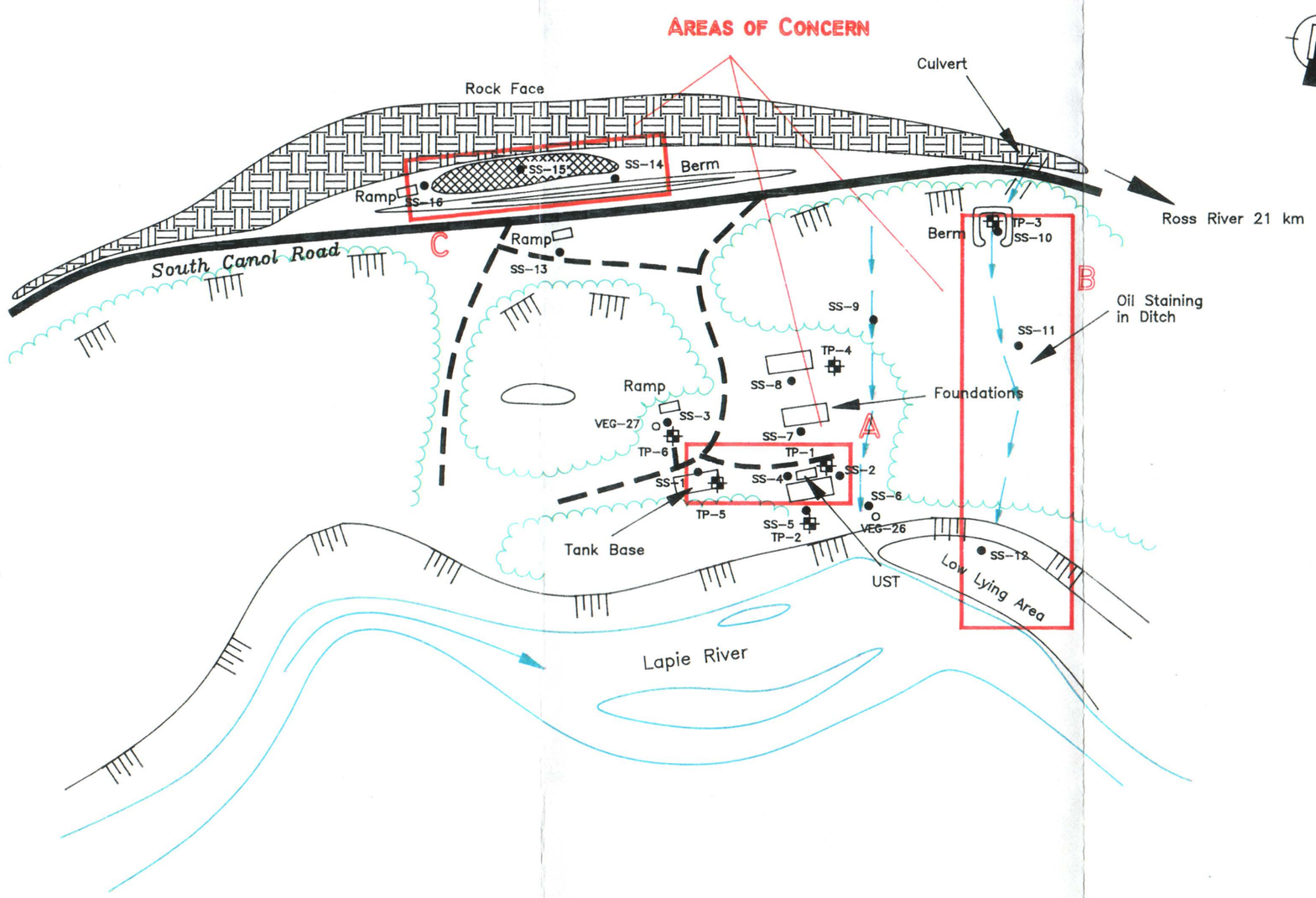
MILE POST 124.5 SITE LOCATION

Canol Road
Site Assessments

Drawn By: B. Belzac	Project No. 96769
Site Name: South Canol Road	File Name: D:\96769\769-7

Gartner Lee

Figure No. 7



LEGEND

- Canol Road
- Secondary Road
- Abandoned Road
- Oil Staining
- Metal Debris
- Drainage Course
- Surface Water Flow
- Ponded Water
- Swamp/Bog
- Slope
- Tree Line
- Bedrock Outcrop
- SS-1 — Soil Sampling Location
- TP-1 — Test Pit Location
- 73-1 — Water Sampling Location
- BER-1 / VEG-1 — Vegetation Sampling Location

Scale 1:2000 (approximate)

0 10 20 40 60 metres

Drawn By: B. Belzac | Project No. 96769
Site Name: South Canol Road | File Name: D:\96769\769-124

SKETCH MAP MILE POST 124.5

Canol Road
Site Assessments

Gartner Lee

Figure No. 8

The west end of the site appeared to be the main camp area with a few scattered piles of wooden debris which are likely the remnants of some of the old buildings which once stood on the site. There was little else remaining of the camp except for some small piles of metal debris.

The portion of the site located on the north side of the road appears to have been used as a dump for the camp and pumping station. This area is referred to as Area C. There were several empty drums and metal cans as well as vehicle and heavy equipment parts scattered about the area and partially buried (see Photograph 16). One feature of note is an earthen berm which runs parallel to the road along the length of the refuse area. The berm appears to be a composite of earth, wood and metal debris.

Geology

The regional geological mapping shown on GSC Surficial Geology map 1791A (Jackson, 1993) indicates that the surface geology in this area is comprised of undivided alluvial sediments that cannot be subdivided at the scale of the map. These sediments were deposited by streams flowing from the highland areas to the north of the site.

Terrain analysis of this site has determined that the site is found on an alluvial fan which has dissected a glaciofluvial terrace. The soils appear to be well drained and there is no evidence of active down gradient surface water. Test pits excavated on the site confirmed both the regional geology and the terrain analysis with the presence of sandy and gravelly sediments which appear to be fluvial in origin.

Hydrogeology

Ground water was not encountered in any of the test pits excavated on the site, to a maximum depth of 3.0 m. Further downslope, the drop-off from the south bank of the site to the river is approximately 2 to 3 m indicating the depth to ground water at that point as the water table flattens out near the river. The direction of flow is inferred to be to the south towards the river. There was one discharge zone observed at the southeast corner of the site in a low lying area underlain by permafrost.

Vegetation

Throughout the whole site there is evidence of historic clearing for buildings and roadways. However, there is significant regeneration of vegetation and the tree health throughout the

area is good. The vegetation community present on this site is a mixed deciduous and coniferous forest. The dominant species which make up the canopy are Balsam Poplar (*Populus balsamifera*) and White Spruce (*Picea glauca*) with a minor component of Black Spruce (*Picea mariana*), Trembling Aspen (*Populus tremuloides*) and White Birch (*Betula papyrifera*). The understory was generally made up of saplings of canopy species. Ground cover consists of a mixture of low shrubs such as Labrador Tea (*Ledum groenlandicum*) Fireweed (*Epilobium angustifolium*) and herbaceous plants. In the low lying area towards the Lapie River, the ground is covered by a layer of mosses. In localized areas of hydrocarbon staining and obvious surface soil contamination, the ground cover showed observable chlorosis and necrosis in foliage. In some areas, vegetation was absent, perhaps as a result of contamination.

Surface Water

The Lapie River is a wide, fast flowing, and high gradient river. The substrate is characterized by boulders, cobbles and some finer gravels. The approximate width of the Lapie River at this site was 15 m with some secondary channels (1 to 2 m) toward the opposite bank. Stream depths range from 0.7 m in the riffle areas to 1.0 to 1.5 m in pools. There were some abandoned stream channels at the site, however, no visible impacts or obvious signs of contamination were observed. Due to the high water velocities of the Lapie River and the associated dilution potential, it is unlikely that there would be any localized impacts in the surface water as a result of historic contaminants at this site.

4.4.2 Test Results

Field Testing and Observations

A total of 22 soil samples were collected and field screened for organic vapour concentrations using the PID. Twenty (20) soil samples were field screened for the occurrence of DDT using the immunoassay field kits. The results from both field screening procedures are presented in Table 3, starting on Page 14.

Fourteen of the 22 samples revealed organic vapour concentrations above what are considered typical background readings. The concentrations recorded ranged from 13 to 234 ppm. It should be noted that the samples in which these concentrations were detected were both surface and test pit soil samples.

Of the twenty samples field screened for the occurrence of DDT, only one indicated the presence of the pesticide with a suggested concentration of between 1 and 10 ppm.

Soil Chemistry

Selected soil samples were submitted to the analytical laboratory for analysis of potential contaminants of concern previously identified by K. Bisset and Associates. This section provides a summary of the analytical results with the complete results presented in Tables 4.4.1, 4.4.2 and 4.4.3 in Appendix B.

Within Area A, several occurrences of petroleum hydrocarbons exceeded the Parkland criterion. Surficial samples collected above the UST, near the fill pipe, and in the area of the concrete pads exceeded the B.C. Special Waste criterion for oil and grease as well as the Industrial criterion for both LEPH/HEPH. A surficial sample collected south of the foundation also exceeded the Parkland criterion for oil and grease. At the base of the UST, oil and grease and LEPH/HEPH concentrations exceeded the Industrial criterion.

One of the surficial samples collected from Area B had a concentration which exceeded the B.C. Special Waste criterion for oil and grease. A second sample exceeded the Industrial criterion and another, had a concentration which exceeded the Parkland criterion.

In Area C, two surficial samples were collected. One had concentrations of oil and grease which exceeded the Parkland criterion. The other exceeded the Industrial criterion.

Metal concentrations which exceeded the Parkland criterion were detected in six of the ten samples analyzed. Concentrations of barium were found to exceed the criterion in three of the samples mainly centered around Area A, although one sample was located just south of the South Canol Road. Concentrations of lead were found to exceed the criterion in three samples, also in the vicinity of Area A.

The pesticide, Endosulfan II, was detected in trace amounts in one sample, although DDT was not detected.

Surface Water Chemistry

One water sample was collected near the downstream site boundary. Results showed no elevated parameter concentrations when compared to background levels and no exceedances of established objectives were noted. These results suggest that the site conditions are not impacting the surface water. Complete analytical results are presented in Table 4.4.5 in Appendix B.

Vegetation Samples

Two foliage samples of Fireweed were collected downgradient of potential contamination areas. The two samples show similar concentrations of metals and elements observed in the control samples. Complete analytical results are presented in Table 4.4.4 in Appendix B.

4.4.3 Discussion

Three areas of concern, Area A, Area B and Area C, have been identified at this site and are highlighted on the site plan, Figure 8.

In Area A, the UST contained approximately 50 gallons of product and the soils sampled at the fill pipe and below the tank have been impacted by petroleum hydrocarbons at concentrations which exceed the B.C. Special Waste criterion. The shallow contamination, around the fill pipe, is likely the result of poor filling practises while the deeper contamination, below the tank, may be a result of a small leak in the tank or from spilled product percolating down through the soil column.

To the west of the of the UST and foundation, shallow soil contamination exists in the area formerly occupied by an above ground storage tank. Concentrations of oil and grease exceed the Special Waste criterion and LEPH/HEPH concentrations exceed the Industrial criterion. A test pit excavated in this area unearthed a 0.05m diameter, steel transport line that connects to the west side of the foundation. Soils sampled and screened in the field indicated that the contamination was confined to the upper 0.3m of the soil column in the area of the concrete pads.

Soils sampled within the swale in Area B had concentrations of oil and grease which exceeded the Parkland and Industrial criterion. The receiving area at the southeast corner of the site had concentrations of oil and grease which exceeded the Special Waste criterion. A test pit was excavated within the bermed area to determine if this was the source area of the contamination, however the field screening showed no signs of contamination in this area.

Shallow soils sampled amongst the refuse in Area C showed oil and grease contamination at levels above the Parkland criterion, and one sample had a concentration above the Industrial criterion. The source of the contamination is likely the refuse itself as numerous empty cans of oil and other fluids constitute a large portion of the waste.

Concentrations of lead and barium were found to exceed the Parkland criterion in several samples. The lead contamination is isolated to two areas where fuel handling may have occurred within Area A, with leaded fuels likely being the source. The barium appears to widespread about the site and likely is attributable to regional geochemistry.

The petroleum hydrocarbons in the soils and in the UST remain as a potential source of contamination which could impact on the Lapie River or wildlife. The coarse nature of the site soils provides a highly permeable subsurface environment for the migration of hydrocarbons in the ground water towards the river and low lying floodplain, which has already been impacted.

The lead occurrences in the shallow soils could potentially be a source of contamination that may affect vegetation and subsequently wildlife feeding on the affected vegetation. However, analytical results from the two vegetation samples collected on-site show no increased lead uptake.

4.4.4 Conclusions

Based on the field investigation, the following conclusions can be made:

a) soils in Area A have been impacted by petroleum hydrocarbons at levels which exceed the Special Waste criterion;
b) soils in Area B have also been impacted with petroleum hydrocarbons at levels which exceed the Special Waste criterion, including an area adjacent to the Lapie River;
c) a UST with approximately 50 gallons of product remains in the ground adjacent to the foundation in Area A;
d) soils in Area C on the north side of the road have been impacted with petroleum hydrocarbons.

4.4.5 Recommendations

The following recommendations can be made based upon the conclusions outlined above:

a) The contents of the UST in Area A should be pumped out and disposed of in an appropriate manner. The metal tank should then be cleaned and removed from the site. The buried transport line should also be excavated at the same time and both the tank and the transport line should be disposed of at a scrap metal yard.

b) The hydrocarbon affected shallow soils in Areas A, B and C should be excavated and removed to a treatment or holding facility. Soil recycling is not likely an option due to the physical nature of the soils. Further delineation of the entire area affected in Areas B and C through additional test pitting will be required prior to commencing soil removal.

c) The metal debris and refuse in Area C should be removed from the site to a scrap metal yard prior to excavating the soils.

d) All of the excavated soil should be replaced with clean fill to bring the excavations up to grade.

TABLE 4.4.1: SOIL CHEMISTRY - HYDROCARBON RESULTS

Parameter	CCME/ CMCS Parkland Criteria	CCME/ CMCS Industrial Criteria	B.C. Special Waste	Zenon ID : Sample ID : MDC	MP124.5 96025186 TP-1 1.75 CM	MP124.5 96025287 SS1	MP124.5 96025289 SS11	MP124.5 96025290 SS10	MP124.5 96025291 SS2	MP124.5 96025292 SS15	MP124.5 96025293 SS16	MP124.5 96025294 SS9	MP124.5 96025295 SS12	MP124.5 96025296 SS5
HYDROCARBONS														
TEH (C10 - C30)				5	4400	28000	—	—	35000	—	—	—	—	—
TEH Heavy Oil (>C30)				5	850	850	—	—	1200	—	—	—	—	—
EPH (C10 - <C19)	1000	2000		5	2400	15000	—	—	18000	—	—	—	—	—
EPH (C19 - C32)	1000	5000		5	2300	13000	—	—	17000	—	—	—	—	—
Oil & Grease Total	100	5000	30000	100	6500	*47000*	12000	1900	*74000*	2000	17000	< 100	*51000*	1700
POLYAROMATIC HYDROCARBONS														
Benz(a)anthracene	1	10		0.01	—	< 0.01	—	—	< 0.01	—	—	—	—	—
Dibenz(a,h)anthracene	1	10		0.02	—	< 0.02	—	—	< 0.02	—	—	—	—	—
Chrysene				0.01	—	< 0.89	—	—	< 1.1	—	—	—	—	—
Benzo(b)Fluoranthene	1	10		0.01	—	< 0.11	—	—	< 0.12	—	—	—	—	—
Benzo(k)fluoranthene	1	10		0.01	—	< 0.01	—	—	< 0.01	—	—	—	—	—
Benzo(j)fluoranthene				0.01	—	< 0.01	—	—	< 0.01	—	—	—	—	—
Benzo(g,h,i)perylene				0.02	—	0.05	—	—	< 0.04	—	—	—	—	—
Pyrene	10	100		0.01	—	0.57	—	—	0.72	—	—	—	—	—
Benzo(a)pyrene	1	10		0.01	—	< 0.01	—	—	< 0.01	—	—	—	—	—
Indeno(1,2,3-c,d)pyrene	1	10		0.02	—	< 0.02	—	—	< 0.02	—	—	—	—	—
Acenaphthene				0.01	—	< 0.01	—	—	< 0.01	—	—	—	—	—
Acenaphthylene				0.01	—	< 0.16	—	—	< 0.13	—	—	—	—	—
Anthracene				0.01	—	< 0.01	—	—	< 0.01	—	—	—	—	—
Fluoranthene				0.01	—	< 0.01	—	—	< 0.01	—	—	—	—	—
Fluorene				0.01	—	< 0.01	—	—	< 0.01	—	—	—	—	—
Naphthalene	5	50		0.01	—	< 0.48	—	—	< 0.23	—	—	—	—	—
Phenanthrene	5	50		0.01	—	< 0.01	—	—	< 0.01	—	—	—	—	—
Total PAH's					—	0.62	—	—	0.72	—	—	—	—	—
Total Low MW PAH's					—	< 0.68	—	—	< 0.40	—	—	—	—	—
Total High MW PAH's					—	0.62	—	—	0.72	—	—	—	—	—

Notes:

1. All concentrations in mg/kg (ppm).
2. MDC - Method Detection Concentration.
3. 1000 — Concentration exceeds Parkland criteria.
4. 2000 — Concentration exceeds Industrial criteria.
5. *30000* — Concentration exceeds B.C. Special Waste criteria.
6. — — Parameter not determined.

(96769-1/15/97-MP124_5.XLS)

TABLE 4.4.2: SOIL CHEMISTRY - METAL RESULTS

Parameter	CCME/ CMCS Parkland Criteria	CCME/ CMCS Industrial Criteria	Zenon ID : Sample ID : MDC	MP124.5 96025186 TP-1 1.75 CM	MP124.5 96025163 TP-2 0.29 CM	MP124.5 96025165 TP-5 0.9 CM	MP124.5 96025286 SS3	MP124.5 96025287 SS1	MP124.5 96025290 SS10	MP124.5 96025291 SS2	MP124.5 96025294 SS9	MP124.5 96025296 SS5	MP124.5 96025299 SS13
METALS TOTAL													
Aluminum			2	2880	3380	3080	4780	5500	3210	3380	2150	4440	4260
Antimony	20	40	2	< 2	< 2	4	19	3	3	4	5	4	4
Arsenic	30	50	8	15	13	20	15	11	11	10	22	24	18
Barium	500	2000	0.1	528	443	444	708	448	209	255	421	542	643
Beryllium	4	8	0.1	0.2	0.2	0.2	0.4	0.3	0.2	0.2	0.2	0.3	0.3
Bismuth			2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Cadmium	5	20	0.2	1	1.5	1.1	2.4	3.3	0.9	1.9	1.5	3.3	1.2
Calcium			1	31600	19000	27900	31900	14400	42300	14000	36300	29600	30900
Chromium	250	800	0.2	7.9	10.5	8.2	13.5	13.9	8.9	8.8	5.6	10.3	9.2
Cobalt	50	300	0.3	6.1	6.2	6.1	8.1	7.6	5.4	5.3	6.1	8.6	7.1
Copper	100	500	0.1	42.5	31.3	36.7	50.1	45.2	19.4	29	37.9	41	42.7
Iron			0.3	19100	16000	17900	20900	19300	15500	17500	17400	21300	17800
Lead	500	1000	2	24	12	15	1410	1030	11	566	17	43	96
Magnesium			2	11600	6750	10100	9940	6840	15100	5850	13300	7300	10600
Manganese			0.2	348	319	308	452	175	279	148	475	453	356
Mercury	2	10	0.05	< 0.05	< 0.05	0.05	0.15	0.08	< 0.05	0.06	< 0.05	0.1	0.06
Molybdenum	10	40	0.4	4.6	3.8	4.8	4.2	5.4	1.7	3.3	4.8	4.1	3.9
Nickel	100	500	0.8	37.4	32.3	39.5	39.9	59.9	23.2	37.6	37.7	43.9	40.9
Phosphorus			4	1590	1450	1460	1200	1100	897	942	1610	1200	1190
Potassium			40	450	547	416	947	972	416	592	358	921	414
Selenium	3	10	5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Silver	20	40	1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Sodium			1	55	61	61	71	63	60	59	41	75	83
Strontium			0.1	105	71	87.6	93.1	55.9	92.9	51.6	105	80.9	94.6
Sulphur			3	294	407	342	582	524	291	429	297	622	367
Tellurium			2	< 2	4	< 2	< 2	< 2	< 2	< 2	< 2	< 2	2
Thallium			1	< 1	< 1	< 1	2	< 1	< 1	2	< 1	1	< 1
Tin	50	300	2	3	3	2	3	< 2	< 2	< 2	3	< 2	< 2
Titanium			0.3	53.6	66.8	67.3	73.2	110	55.2	66	30.5	90.5	75.5
Vanadium	200		0.3	18.3	22.7	18.1	21.9	27.6	14.7	18.6	15.1	21.4	21.3
Zinc	500	1500	0.2	143	125	154	220	338	107	206	141	310	146
Zirconium			0.3	0.6	0.9	1.1	1.4	1.4	0.5	0.9	0.7	1.2	1.7

Notes:

1. All concentrations in mg/kg (ppm).
2. MDC - Method Detection Concentration.
3. 500 Concentration exceeds Parkland criteria.
4. 2000 Concentration exceeds Industrial criteria.

(96769-1/14/97-MP124_5.XLS)

TABLE 4.4.3: SOIL CHEMISTRY - PESTICIDE RESULTS

Parameter	CCME/ CMCS Parkland Criteria [1]	Zenon ID : Sample ID : MDC	MP124.5 96025186 TP-1 1.75 CM
ORGANOCHLORINE PESTICIDES			
Aldrin		0.0004	<0.0004
BHC, alpha-		0.0004	<0.0004
BHC, beta-		0.0004	<0.0004
BHC, delta-		0.0004	<0.0004
Chlordane, alpha-		0.002	<0.002
Chlordane, gamma-		0.002	<0.002
DDE, p,p'-		0.001	<0.001
DDT, o,p'-		0.002	<0.002
DDD, p,p'-		0.002	<0.002
DDT, p,p'-		0.002	<0.002
Dieldrin		0.002	<0.002
Endosulfan I		0.002	<0.002
Endosulfan II		0.002	0.011
Endosulfan Sulphate		0.004	<0.004
Endrin		0.002	<0.002
Heptachlor		0.0004	<0.0004
Heptachlor epoxide		0.0008	<0.0008
Hexachlorobenzene		0.0002	<0.0002
Lindane, BHC, gamma-		0.0004	<0.0004
Methoxychlor		0.004	<0.004
Mirex		0.004	<0.004
Nonachlor, trans-		0.002	<0.002
Oxychlordane		0.002	<0.002
POLYCHLORINATED BIPHENYLS			
PCB's - Totals		0.01	<0.01
Dibromobiphenyl			110

Notes:

1. All concentrations in mg/kg (ppm).
2. MDC - Method Detection Concentration.
3. [1] Total pesticide concentration not to exceed 2 ppm.

TABLE 4.4.4: VEGETATION CHEMISTRY - METAL RESULTS

Parameter	Zenon ID : Sample ID : MDC	MP124.5 96025361 VEG 26 Fw	MP124.5 96025362 VEG 27 Fw
METALS TOTAL			
Aluminum	2	7	16
Antimony	2	3	< 2
Arsenic	8	< 8	< 8
Barium	0.1	8.1	46.1
Beryllium	0.1	< 0.1	< 0.1
Bismuth	2	< 2	3
Cadmium	0.2	< 0.2	< 0.2
Calcium	1	4710	19900
Chromium	0.2	0.3	0.9
Cobalt	0.3	0.6	0.5
Copper	0.1	1.6	6.1
Iron	0.3	23.6	76.2
Lead	2	< 2	< 2
Magnesium	2	1560	6520
Manganese	0.2	24.2	66.2
Mercury	0.05	< 0.05	< 0.05
Molybdenum	0.4	< 0.4	11.3
Nickel	0.8	< 0.8	< 0.8
Phosphorus	4	320	1190
Potassium	40	2310	9040
Selenium	5	< 5	< 5
Silver	1	< 1	< 1
Sodium	1	10	56
Strontium	0.1	8.6	50
Sulphur	3	161	480
Tellurium	2	< 2	< 2
Thallium	1	4	1
Tin	2	< 2	< 2
Titanium	0.3	< 0.3	< 0.3
Vanadium	0.3	< 0.3	< 0.3
Zinc	0.2	10.5	48
Zirconium	0.3	< 0.3	< 0.3

Notes:

1. All concentrations in mg/kg (ppm).
2. MDC - Method Detection Concentration.
3. Fw - Fireweed.

TABLE 4.4.5: SURFACE WATER CHEMISTRY RESULTS

Parameter	CCME/ CMCS Fresh Water Aquatic Life	Zenon ID : Client ID : MDC	MP124.5 96026162 124.5-1 (12435-1)
METALS TOTAL			
Aluminum	0.02	0.06	0.1
Antimony		0.02	< 0.02
Arsenic	0.05	0.04	< 0.04
Barium	1	0.001	0.045
Beryllium	0.053	0.001	< 0.001
Bismuth		0.02	< 0.02
Boron		0.04	< 0.04
Cadmium	0.0008	0.002	< 0.002
Calcium		0.05	48.3
Chromium	0.002	0.002	0.003
Cobalt	0.05	0.004	< 0.004
Copper	0.004	0.002	0.003
Iron	0.300	0.05	0.08
Lead	0.006	0.03	< 0.03
Magnesium		0.02	16.3
Manganese	0.100	0.002	0.005
Mercury	0.0001	0.00005	< 0.00005
Molybdenum	1.000	0.004	< 0.004
Nickel	0.065	0.01	< 0.01
Phosphorus		0.04	< 0.04
Potassium		0.4	0.7
Selenium	0.001	0.03	< 0.03
Silicon		0.8	2.6
Silver	0.0001	0.03	< 0.03
Sodium		0.4	1.4
Strontium		0.001	0.163
Sulphur		0.1	20.8
Tellurium		0.02	< 0.02
Thallium		0.03	< 0.03
Tin		0.02	< 0.02
Titanium		0.003	< 0.003
Vanadium		0.003	< 0.003
Zinc	0.03	0.01	0.02
Zirconium		0.003	< 0.003
HYDROCARBONS			
Oil & Grease Total		1	< 1

Notes:

1. All concentrations in mg/L (ppm).
2. MDC - Method Detection Concentration.
3. 0.02 Concentration exceeds Fresh Water Aquatic Life criteria.

4.5 SITE NO. 4 - OLD ROSS TOWNSITE

4.5.1 Physical Setting

General Description

The Old Ross Townsite is located approximately 0.5 km north of the Pelly River, on the south side of the North Canol Road (Figure 9). The site is accessed from a gravel road that leads to a cut line which was formerly a power line corridor to the old townsite. The area is relatively flat with a slight increase in elevation to the west. To the east and south, the area is bounded by the Ross and Pelly Rivers and to the north by the North Canol Road. Across the road, the topography rises steeply to rolling mountainous terrain.

There were no surface water drainage courses observed on the site.

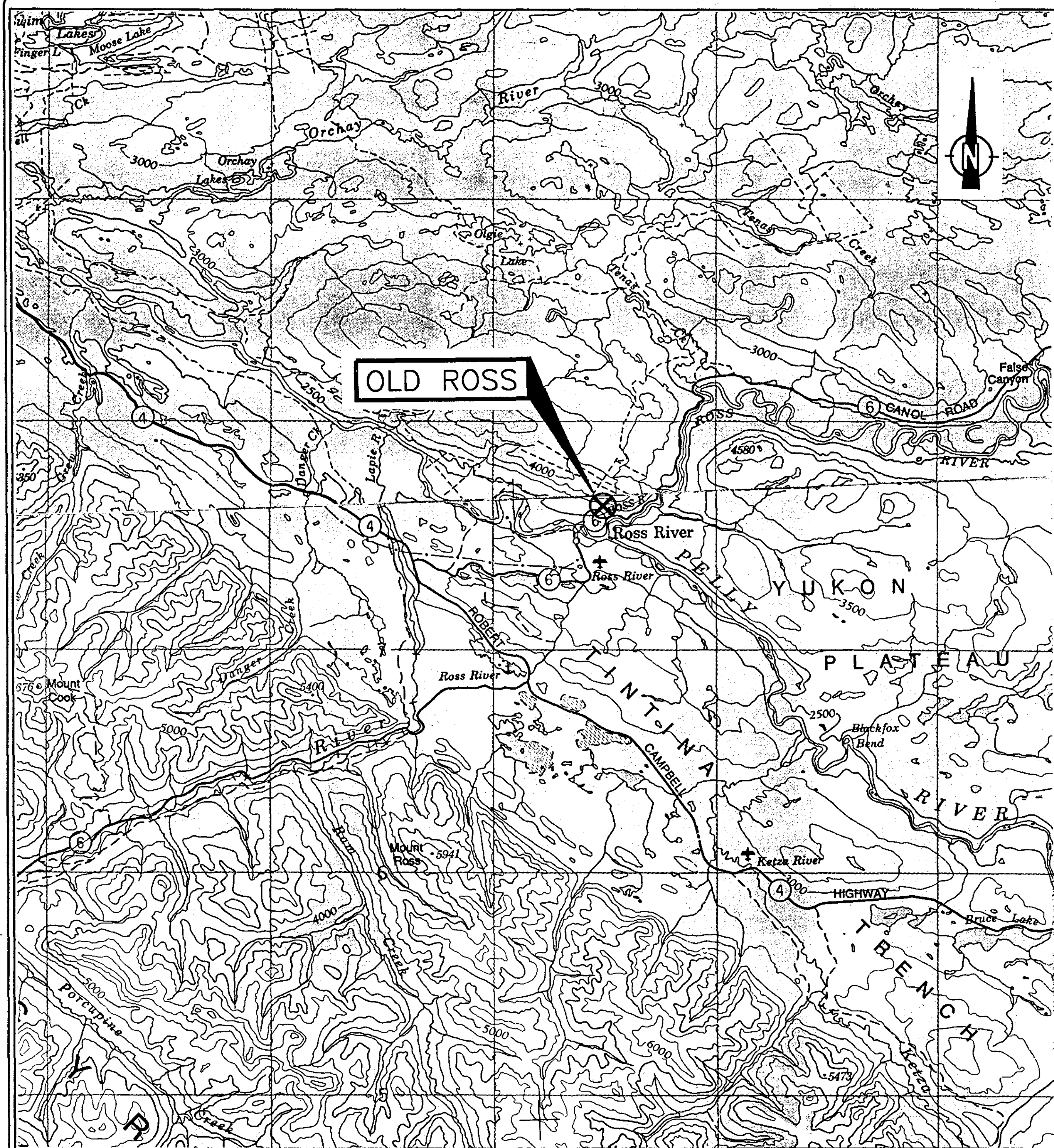
Two areas of the site were investigated as part of the site assessment. The first was an old garbage dump located at the east end of the site and the second was an area of wooden and metal debris located approximately 200 m to the west (Figure 10).

The garbage dump area consists of a 17 x 5 m shallow pit (0.6 m deep) that was full of metal cans and some vehicle parts (see Photographs 19, 20 and 21). This pit is located at the base of a small embankment and it is likely that the refuse may have been dumped over the edge of the embankment. Within the area surrounding the pit there were a few small areas of other metal and wooden debris. No areas of surface staining by petroleum were observed.

To the west of the garbage dump area, approximately 200m up the cut line, are the remains of two quonset huts. The buildings had either been flattened or collapsed and there was metal debris scattered about. Two steel pipes which resembled UST fill pipes were noticed protruding from the ground. This area was excavated and it was determined that these pipes were not connected to an underground storage tank.

Geology

The regional geological mapping of this area shown on GSC Surficial Geology Map1791A (Jackson, 1993) indicates that the surface geology in this area is comprised of undivided alluvial deposits consisting of sand, gravel, silt, and diamicton. These sediments were deposited as floodplain and alluvial terrace deposits by the Ross and Pelly Rivers.



LEGEND

⊗ Old Ross Site Location

Source:
NTS 105 F, K EDITION 3 and 4

SCALE 1:250,000

0 2.5 5 7.5 KM

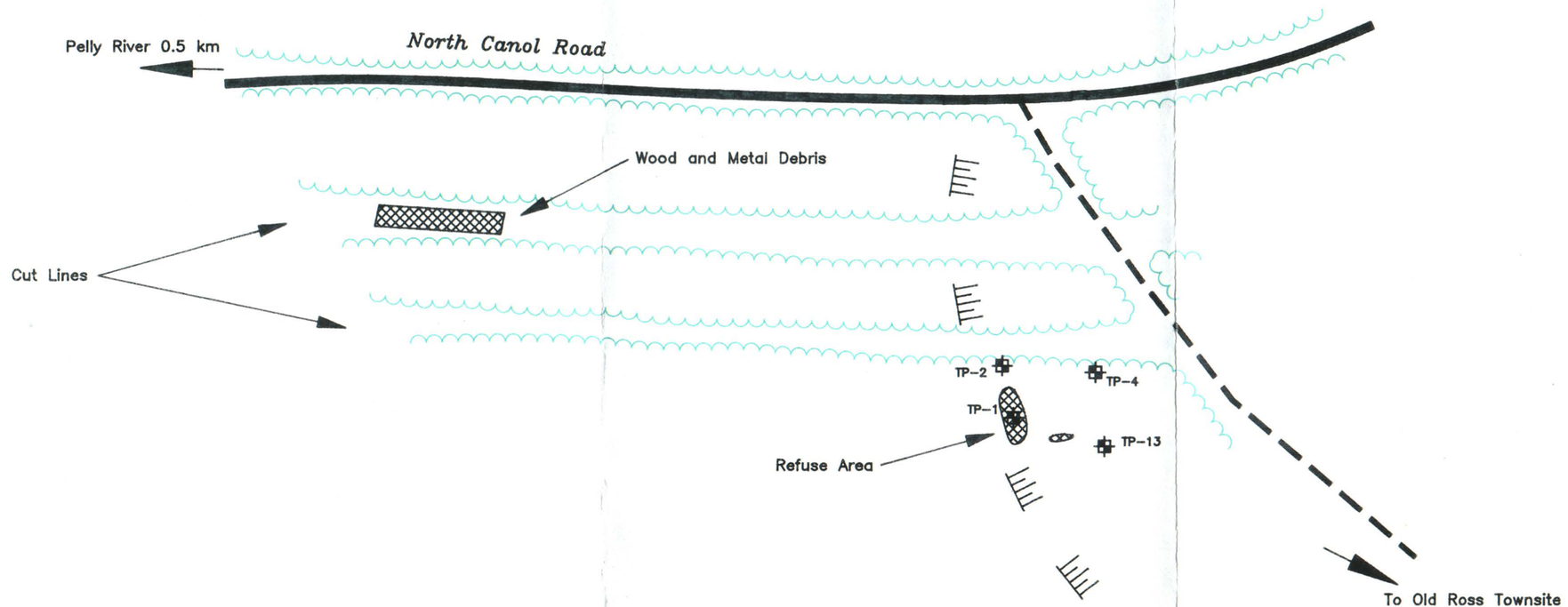
Drawn By: B. Belzac | Project No. 96769
Site Name: North Canol Road | File Name: D:\96769\769-9

OLD ROSS TOWNSITE SITE LOCATION

Canol Road
Site Assessments

Gartner Lee

Figure No. 9



LEGEND

- Canol Road
- Secondary Road
- Abandoned Road
- Oil Staining
- Metal Debris
- Drainage Course
- Surface Water Flow
- Ponded Water
- Swamp/Bog
- Slope
- Tree Line
- Bedrock Outcrop
- SS-1 — Soil Sampling Location
- TP-1 — Test Pit Location
- 73-1 — Water Sampling Location
- BER-1 / VEG-1 — Vegetation Sampling Location

SCALE 1:2000

0 10 20 40 60 metres

Drawn By: B. Belzac | Project No. 91769

Site Name: North Canol Road | File Name: D:\96769\769-OLD

OLD ROSS TOWNSITE

Canol Road Site Assessments

Gartner Lee

Figure No. 10

Test pits excavated to a maximum depth of 2 m confirmed the regional mapping of the area revealing white volcanic ash and silty sand overlying shallow angle bedded sands and gravels with cobbles and occasional boulders.

Hydrogeology

There was no ground water observed in any of the test pits excavated during the soil sampling program. Ground water is expected to occur at depths of between 3 to 5 m as the elevation of the site is approximately 3 to 5 m above that of the Pelly River. The direction of ground water flow is inferred to be to the south towards the confluence of the Pelly and Ross rivers. The coarse grained nature of the deeper soils indicates that the aquifer in the area of the site is likely in direct contact with the two rivers.

Vegetation

This site is located within forest habitat dominated by Trembling Aspen (*Populus tremuloides*) and Balsam Poplar (*Populus balsamifera*) with a minor component of White Spruce (*Picea glauca*). A moderately dense understory shrub layer of willows is present. The ground layer consists largely of Fireweed (*Epilobium angustifolium*) and grasses with some other broad-leaved herbs. Vegetation on-site appears to be healthy.

4.5.2 Test Results

Field Testing and Observations

A total of eight soil samples were field screened for organic vapour concentrations using the PID and the same eight samples were also field screened for DDT concentrations using the immunoassay field kits. The results from both field screening procedures is presented in Table 3, starting on Page 14.

There were no indications of organic vapour concentrations above background levels detected in any of the eight samples.

DDT was not detected above background concentration in any soil samples screened.

Soil Chemistry

Selected soil samples were submitted to the analytical laboratory for analysis of potential contaminants of concern previously identified by K. Bisset and Associates. This section provides a summary of the analytical results with the complete results presented in Tables 4.5.1 to 4.5.3 in Appendix B.

Petroleum hydrocarbons were not detected in any of the eight samples analyzed.

Concentrations of arsenic which exceeded the Parkland criterion were detected in two of the eight samples analyzed. Both samples were collected from a test pit excavated in the refuse material.

Barium concentrations in a separate sample also exceeded the Parkland criterion.

No traces of pesticides were detected in the one sample analyzed.

Surface Water Chemistry

No permanent water courses were observed on this site. The coarse nature of the underlying soils precludes the formation of any surface water courses.

Vegetation

No vegetation samples were collected from this site.

4.5.3 Discussion

Soil samples collected in and around the dump area revealed that arsenic concentrations in two samples, from the same test pit, exceeded the Parkland criterion. This particular test pit was excavated in the middle of the refuse. The arsenic concentration in the upper sample was found to be the higher of the two sample concentrations, approaching the limit of the Industrial criterion. With depth, the concentration decreased to slightly above the Parkland criterion in the second sample, indicating that the elevated arsenic concentration in the soil may be related to the refuse. This seems likely as there were no other arsenic exceedances observed in the other six samples collected from nearby test pits.

Impacts from the arsenic on the surrounding environment are predicted to be minimal. In the area where the contamination exists there is very little vegetation and thus uptake by plants is not an issue. Impacts on ground water are also predicted to be minimal. The ground water flows towards the Pelly River, approximately 200 m to the south, and should any arsenic be dissolved in the ground water when it enters the river, the sheer volume of water flowing past the site would have a huge dilution effect on the ground water, negating any impacts on the river.

The barium concentration which exceeded the Parkland criterion appears to reflect the variability of the regional geochemistry. Geochemical maps from areas just north of the site show barium concentrations in stream sediments to range up to 1400 ppm, almost three times higher than the Parkland criteria. As well, the concentrations of barium and numerous other elements in samples collected at other Canol Road sites increase to well above the Parkland criterion.

4.5.4 Conclusions

Based upon the findings of the site investigation, the following conclusions can be made:

a) two areas of debris were observed at this site; one area is a former dump and the other consisted of wooden and metal remnants of buildings;
b) [redacted];
c) [redacted] however it is likely that this value can be [redacted] which occur naturally as shown in the regional geochemistry of this area.

4.5.5 Recommendations

The following recommendations are made based on the conclusions outlined above:

a) The metal debris located in the dump area should be removed and disposed of at the Ross River landfill.
b) This work could be conducted while equipment has already been mobilized to carry out remediation at a site further to the north.

TABLE 4.5.1: SOIL CHEMISTRY - HYDROCARBON RESULTS

Parameter	CCME/ CMCS Parkland Criteria	CCME/ CMCS Industrial Criteria	B.C. Special Waste	Zenon ID : Sample ID : MDC	OLD ROSS 96025174 TP-1 0.46M	OLD ROSS 96025151 TP-1 1.08M	OLD ROSS 96025152 TP-2 0.24M	OLD ROSS 96025153 TP-2 1.12M	OLD ROSS 96025154 TP-3 0.31M	OLD ROSS 96025155 TP-3 0.96M	OLD ROSS 96025156 TP-4 0.34M	OLD ROSS 96025157 TP-4 0.94M
HYDROCARBONS												
TEH (C10 - C30)				5	—	—	—	—	—	—	—	—
TEH Heavy Oil (>C30)				5	—	—	—	—	—	—	—	—
EPH (C10 - <C19)	1000	2000		5	—	—	—	—	—	—	—	—
EPH (C19 - C32)	1000	5000		5	—	—	—	—	—	—	—	—
Oil & Grease Total	100	5000	30000	100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100

Notes:

1. All concentrations in mg/kg (ppm).
2. MDC - Method Detection Concentration.
3. 1000 Concentration exceeds Parkland criteria.
4. 2000 Concentration exceeds Industrial criteria.
5. *30000* Concentration exceeds B.C. Special Waste criteria.
6. — Parameter not determined.

(96769-1/15/97-OLDROSS.XLS)

TABLE 4.5.2: SOIL CHEMISTRY - METAL RESULTS

Parameter	CCME/ CMCS Parkland Criteria	CCME/ CMCS Industrial Criteria	Zenon ID : Sample ID : MDC	OLD ROSS 96025174 TP-1 0.46M	OLD ROSS 96025151 TP-1 1.08M	OLD ROSS 96025152 TP-2 0.24M	OLD ROSS 96025153 TP-2 1.12M	OLD ROSS 96025154 TP-3 0.31M	OLD ROSS 96025155 TP-3 0.96M	OLD ROSS 96025156 TP-4 0.34M	OLD ROSS 96025157 TP-4 0.94M
METALS TOTAL											
Aluminum			2	4740	4490	7280	8400	4570	12600	4670	4680
Antimony	20	40	2	< 2	< 2	3	< 2	2	< 2	3	< 2
Arsenic	30	50	8	104	38	21	< 8	16	10	19	17
Barium	500	2000	0.1	267	221	801	42.8	469	62.2	331	194
Beryllium	4	8	0.1	0.3	0.3	0.6	0.2	0.3	0.2	0.4	0.3
Bismuth			2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Cadmium	5	20	0.2	1	1.3	1.7	< 0.2	1.1	< 0.2	1	0.6
Calcium			1	12300	14600	10700	2190	22500	3030	18000	11400
Chromium	250	800	0.2	24.6	29.4	17.6	23.1	13.9	24	13.7	13.1
Cobalt	50	300	0.3	5.2	10.4	9.2	6.4	7.8	8.1	7.2	6.9
Copper	100	500	0.1	33.4	38.4	32.1	21.3	31.4	26.9	30.6	24.1
Iron			0.3	26600	23600	27400	15000	19900	18200	21200	15800
Lead	500	1000	2	12	17	17	8	12	4	12	10
Magnesium			2	7790	8230	4630	5140	6780	5440	7860	6590
Manganese			0.2	366	472	741	231	480	326	463	218
Mercury	2	10	0.05	0.07	0.18	< 0.05	< 0.05	0.13	< 0.05	0.1	0.06
Molybdenum	10	40	0.4	1.4	1.6	2.1	< 0.4	1.3	< 0.4	1.9	1.8
Nickel	100	500	0.8	40.5	62	42.5	24.6	34.4	28.2	38.8	29
Phosphorus			4	1890	1390	1010	483	1270	565	1340	1540
Potassium			40	904	766	691	582	410	712	396	450
Selenium	3	10	5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Silver	20	40	1	1	1	1	< 1	1	< 1	1	< 1
Sodium			1	95	61	81	141	60	206	55	97
Strontium			0.1	61.7	67.1	59.6	10.4	83.3	16.7	67.8	53.2
Sulphur			3	549	897	241	79	374	88	196	248
Tellurium			2	3	4	4	3	4	3	4	< 2
Thallium			1	2	< 1	< 1	< 1	< 1	< 1	< 1	2
Tin	50	300	2	11	10	2	< 2	3	2	3	< 2
Titanium			0.3	47.1	55.2	60.1	285	45.5	402	35	71.5
Vanadium	200		0.3	23.6	23.3	41.1	28.8	26.7	35	27.9	19.9
Zinc	500	1500	0.2	122	130	157	33.5	119	50.1	153	108
Zirconium			0.3	0.3	2	1.6	1.2	1.1	1.1	1	1.5

Notes:

1. All concentrations in mg/kg (ppm).
2. MDC - Method Detection Concentration.
3. 500 Concentration exceeds Parkland criteria.
4. 2000 Concentration exceeds Industrial criteria.

(96769-1/14/97-OLDROSS.XLS)

TABLE 4.5.3: SOIL CHEMISTRY - PESTICIDE RESULTS

Parameter	CCME/ CMCS Parkland Criteria [1]	Zenon ID : Sample ID : MDC	OLD ROSS 96025174 TP-1 0.46M
ORGANOCHLORINE PESTICIDES			
Aldrin		0.0004	<0.0004
BHC, alpha-		0.0004	<0.0004
BHC, beta-		0.0004	<0.0004
BHC, delta-		0.0004	<0.0004
Chlordane, alpha-		0.002	<0.002
Chlordane, gamma-		0.002	<0.002
DDE, p,p'-		0.001	<0.001
DDT, o,p'-		0.002	<0.002
DDD, p,p'-		0.002	<0.002
DDT, p,p'-		0.002	<0.002
Dieldrin		0.002	<0.002
Endosulfan I		0.002	<0.002
Endosulfan II		0.002	<0.002
Endosulfan Sulphate		0.004	<0.004
Endrin		0.002	<0.002
Heptachlor		0.0004	<0.0004
Heptachlor epoxide		0.0008	<0.0008
Hexachlorobenzene		0.0002	<0.0002
Lindane, BHC, gamma-		0.0004	<0.0004
Methoxychlor		0.004	<0.004
Mirex		0.004	<0.004
Nonachlor, trans-		0.002	<0.002
Oxychlordane		0.002	<0.002
POLYCHLORINATED BIPHENYLS			
PCB's - Totals		0.01	<0.01
Dibromobiphenyl			84

Notes:

1. All concentrations in mg/kg (ppm).
2. MDC - Method Detection Concentration.
3. [1] Total pesticide concentration not to exceed 2 ppm.

4.6 SITE NO. 5 - MP 174: FLAT CREEK

4.6.1 Physical Setting

General Description

MP 174 is located 60 km north of Ross River on the North Canol Road (Figure 11). The site is situated on both sides of the road, with the west side formerly occupied by a pumping station and the east side the former camp location (Figure 12).

The site is in a small, flat lying area which is a local topographic high which is surrounded by low lying wetland areas. The site also has gentle slopes located at both the north and south ends and a bowl shaped low lying area near the southwest corner of the site. This site is heavily vegetated with poplars and willows and has cleared areas which likely represent the former locations of the pumping station and camp areas as well as camp roads.

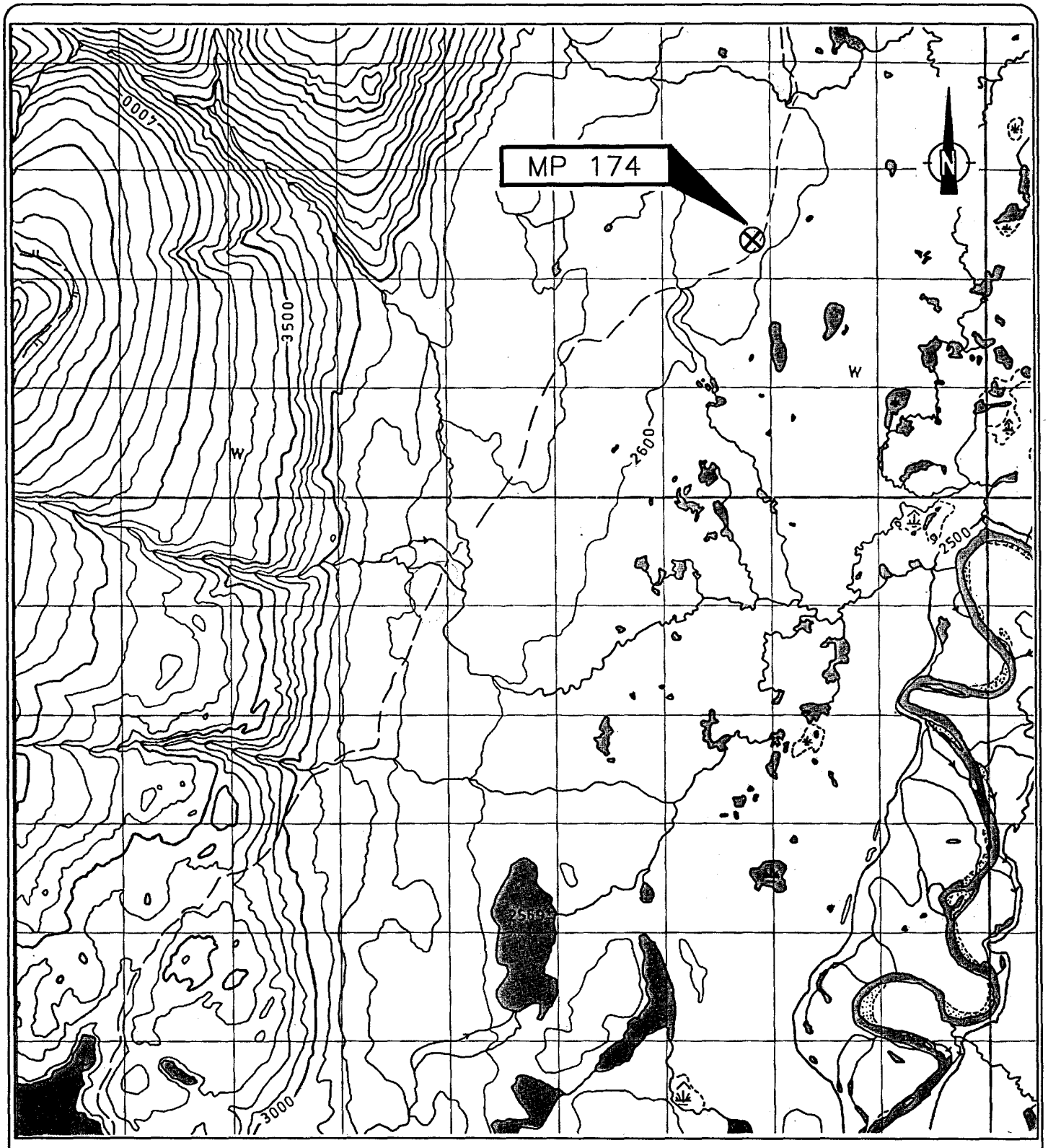
Active drainage of surface water on the site was not observed although it is inferred to be to the south as well as to the north towards low lying wetland areas.

Remnants of concrete foundations as well as small piles of metal and wood debris were found on the west side of the road. Two cleared areas with gravel surfaces were observed to be stained with petroleum and both had a distinct petroleum odour. Near the west edge of the site there were two 40 x 3 m strip-like areas of desiccated oil up to 0.05 m thick that ran parallel to each other (see Photographs 24, 25 and 26). This contamination appeared to be the result of either a pipeline spill or a ruptured storage tank. The two areas covered with the spilled material lead out from a gravel area which is heavily stained with petroleum.

At the east side of the site, across the road is the main camp area which has overgrown roads and small piles of wooden and metal debris which is all that remains from the camp. There were no noticeable stained areas or foundations, although a wooden framed pit with several pipes likely associated with plumbing was observed near the south end (see Photograph 28).

Geology

The regional geological mapping of this area as shown on GSC Surficial Geology Map 1834A (Jackson, 1993) indicates that the surface geology in this area is comprised of a till blanket which has a silty sand matrix and pebbles, cobbles and minor boulders. These sediments were deposited by either directly by glacial ice or by gravity flow from glacier ice.



LEGEND

⊗ MP 174 Mile Post Location

Source:
NTS 105 J/4 EDITION 1

SCALE 1:50,000

0 500 1000 1500 Metres

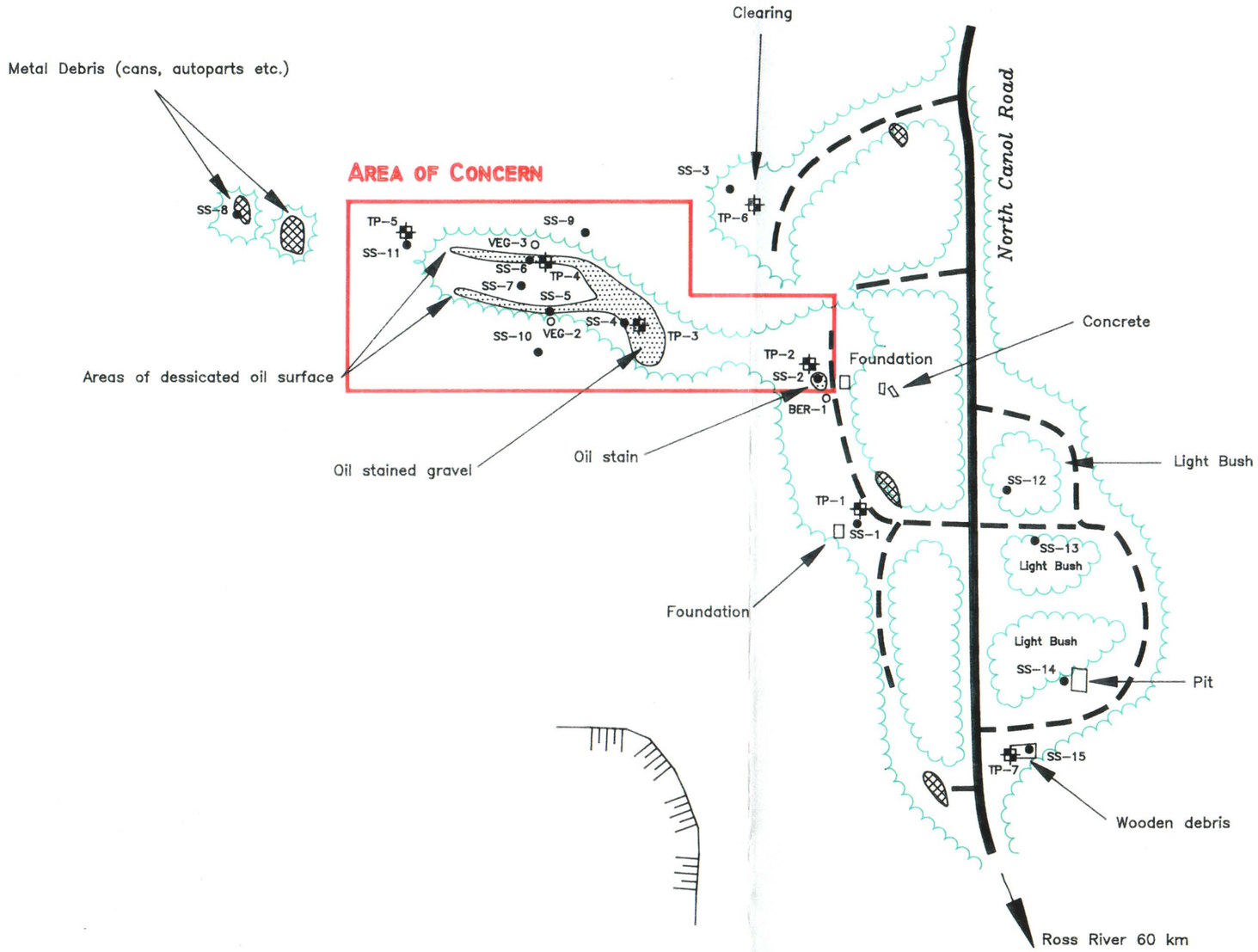
MILE POST 174 SITE LOCATION

Canol Road
Site Assessments

Gartner Lee

Figure No. 11

Drawn By: B. Belzac	Project No. 96769
Site Name: North Canol Road	File Name: D:\96769\769-11



LEGEND

- Canol Road
- Secondary Road
- Abandoned Road
- Oil Staining
- Metal Debris
- Drainage Course
- Surface Water Flow
- Ponded Water
- Swamp/Bog
- Slope
- Tree Line
- Bedrock Outcrop
- SS-1 — Soil Sampling Location
- TP-1 — Test Pit Location
- 73-1 — Water Sampling Location
- BER-1 / VEG-1 — Vegetation Sampling Location

Scale 1:2000 (approximate)

0 10 20 40 60 metres

Drawn By: B. Belzac | Project No. 96769
Site Name: North Canol Road | File Name: D:\96769\769-174

SKETCH MAP MILE POST 174

Canol Road
Site Assessments

Gartner Lee

Figure No. 12

Terrain analysis in the area of this site supports the regional interpretation by Jackson (1993) as a rolling morainal blanket. Test pits at this site also confirm the regional mapping revealing a layer of volcanic ash overlying a silty sand with gravel, which in turn overlies a dense silty sand till with gravel and cobbles.

Hydrogeology

Ground water was not encountered in any of the test pits excavated during the soil sampling program as this sampling was carried out during one of the driest times of the year (mid August). In the wet season or during snow melt ground water will likely occur as a shallow perched water table on top of the dense glacial till. The direction of flow will be governed mainly by topography and the continuity of the till layer over the site. Locally, on the west side of the road, ground water near the south end of the site is inferred to flow towards the bowl shaped topographic depression at that end of the site. Over the remainder of the site ground water flow is inferred to have two components, one to the north and one to the east.

Vegetation

The vegetation community observed on this site was primarily a mixed forest of Trembling Aspen (*Populus tremuloides),* Black Spruce (*Picea mariana*) and White Birch (*Betula papyrifera*) (see Photograph 23). The understory consisted of various shrubs and immature trees including Bog Birch (*Betula glandulosa*), various willow species, Prickly Rose (*Rosa acicularis*) and poplars. The ground cover consisted of numerous vascular plants including Labrador Tea (*Ledum goenlandicum*), Low Bush Cranberry (*Vaccinium vitis-idaea*), Fireweed (*Epilodium angustifolium*), Arctic Lupine (*Lupinus arcticus*), Wild Carrot (*Daucus carota*), Bunch Berry (*Cornus canadensis*) and grasses. Areas that had been cleared for roadways, buildings and pipeline corridors exhibited good regeneration and overall health of vegetation appeared to be good. The low lying areas to the south and north of the site are dominated by Black Spruce.

There were no surface water drainages observed on or near the site. General topography would seem to indicate general drainage off-site towards the low lying areas.

4.6.2 Test Results

Field Testing and Observations

A total of 22 soil samples were field screened for organic vapour concentrations using the PID and 16 soil samples were field screened for the occurrence of DDT using the

immunoassay field kits. The results from both field screening procedures are presented in Table 3, starting on Page 14.

Of the 22 soil samples screened for organic vapours, only three showed concentrations above background readings with values ranging between 11 and 21 ppm.

The occurrence of DDT was suggested in four of the 16 samples screened. Three samples indicated concentrations of between 0.2 and 1.0 ppm, and the fourth indicated a concentration of between 1 and 10 ppm.

Soil Chemistry

Selected soil samples were submitted to the analytical laboratory for analysis of potential contaminants of concern previously identified by K. Bisset and Associates. This section provides a summary of the analytical results with the complete results presented in Tables 4.6.1, 4.6.2 and 4.6.3 in Appendix B.

Petroleum hydrocarbons were detected in the surficial soils and also from samples collected from the test pits. Total oil and grease concentrations exceeded the B.C. Special Waste criterion in five of the samples collected within the Area of Concern outlined on the Site Plan, Figure 12. Two other samples exceeded the Industrial criterion and two exceeded the Parkland criterion.

LEPH/HEPH concentrations which exceeded the Parkland criterion were detected in all three samples analyzed, with all three samples exceeding the Industrial criterion for LEPH and two samples exceeding the Industrial criterion for HEPH.

No metals concentrations were found to exceed the criterion in any of the ten samples analyzed.

Trace concentrations of the pesticide Endosulfan II were detected in one sample and trace concentrations of the Endosulfan Sulphate, a metabolite of Endosulfan I and II, were detected in another. No concentrations of DDT were detected.

Surface Water Chemistry

No surface water was found on the site and samples were not collected.

Vegetation Samples

A total of three vegetation samples were taken representing two species. Two samples of Labrador Tea foliage were collected from the area with a thick layer of solidified oil on the surface. The other sample consisted of berries from a patch of Low Bush Cranberry collected downgradient from the remnants of an overhead tank storage area. See Figure 12 for exact locations. All three vegetation samples indicated similar parameter concentrations to the control samples. Complete analytical results are presented in Table 4.6.4 in Appendix B.

4.6.3 Discussion

The area of concern consists of two elongated "fingers" of solidified crude oil on the ground surface extending outward from a graveled area, and a second graveled area approximately 40 m to the south. Shallow soils in these areas have been impacted by hydrocarbons to levels which exceed the B.C. Special Waste criterion. The impact on the soils appears to be limited to shallow depths of up to 0.5 m, as the site is underlain by a dense till, preventing the occurrence of a deep soil plume.

Impacts from the residual contamination were observed in the lack of vegetation on hydrocarbon saturated areas. The combination of the oil on the surface in the two elongated "fingers" and the gravel, which by itself provides poor growing conditions, have resulted in these areas being barren of vegetation. However, immediately adjacent to each of these affected areas the vegetation appears to be flourishing.

No immediate impacts on ground water were observed during the test pitting due to the lack of ground water occurrence. The soils were quite dry and no seepage into any of the test pits was observed. As mentioned, the site investigation was carried out during one of the driest times of the year and during wetter months a shallow perched water table likely exists in the site area.

Impacts on wildlife which frequent the site may be a concern. Anecdotal evidence provided by the students and local residents suggest that bears and other animals are attracted to the smell of the oil. This was witnessed in the numerous bear claw marks in the area of the desiccated oil on the ground surface.

4.6.4 Conclusions

Based on the findings of the site investigation, the following conclusions can be made:

a) shallow soils in the Area of Concern, outlined on the Site Plan, have been impacted by petroleum hydrocarbons at levels exceeding the B.C. Special Waste criterion;
b) there is a large area of solidified crude oil on the ground surface;
c) the site is underlain by a dense till at shallow depths (0.5 m) preventing the migration of contaminants to a greater depth.

4.6.5 Recommendations

The following recommendations are made based on the conclusions outlined above:

a) Shallow soils impacted by petroleum hydrocarbons should be excavated and removed from the site to a treatment or holding facility. The solidified crude oil on the surface should also be removed at this time and placed in a storage cell, or possibly be recycled and used in chip seal for road construction.

TABLE 4.6.1: SOIL CHEMISTRY - HYDROCARBON RESULTS

Parameter	CCME/ CMCS Parkland Criteria	CCME/ CMCS Industrial Criteria	B.C. Special Waste	Zenon ID : Sample ID : MDC	MP174 96025166 SS-3 0.06 M	MP174 96025167 SS-5 0.04 M	MP174 96025309 SS4	MP174 96025310 TP4 0.30m	MP174 96025311 TP3 0.42m	MP174 96025312 TP2 0.41m	MP174 96025314 TP5 0.28m	MP174 96025303 TP6 0.18m	MP174 96025307 SS2	MP174 96025308 SS6	MP174 96025376 MP174 OIL SAMPLE
HYDROCARBONS															
TEH (C10 - C30)				5	—	—	—	—	8300	7200	—	—	37000	—	—
TEH Heavy Oil (>C30)				5	—	—	—	—	1100	990	—	—	2400	—	—
EPH (C10 - <C19)	1000	2000		5	—	—	—	—	3300	2900	—	—	17000	—	—
EPH (C19 - C32)	1000	5000		5	—	—	—	—	5400	4600	—	—	21000	—	—
Oil & Grease Total	100	5000	30000	100	1400	*33000*	*94000*	5500	*32000*	10000	240	1300	*56000*	*110000*	—
POLYAROMATIC HYDROCARBONS															
Benz(a)anthracene	1	10		0.01	—	—	—	—	—	—	—	—	< 0.01	—	< 2.0
Dibenz(a,h)anthracene	1	10		0.02	—	—	—	—	—	—	—	—	< 0.02	—	< 4.0
Chrysene				0.01	—	—	—	—	—	—	—	—	2	—	2.5
Benzo(b)Fluoranthene	1	10		0.01	—	—	—	—	—	—	—	—	0.19	—	< 2.0
Benzo(k)fluoranthene	1	10		0.01	—	—	—	—	—	—	—	—	< 0.01	—	< 2.0
Benzo(j)fluoranthene				0.01	—	—	—	—	—	—	—	—	< 0.01	—	< 2.0
Benzo(g,h,i)perylene				0.02	—	—	—	—	—	—	—	—	< 0.06	—	< 2.0
Pyrene	10	100		0.01	—	—	—	—	—	—	—	—	< 0.01	—	< 0.50
Benzo(a)pyrene	1	10		0.01	—	—	—	—	—	—	—	—	< 0.13 (1)	—	< 2.0
Indeno(1,2,3-c,d)pyrene	1	10		0.02	—	—	—	—	—	—	—	—	< 0.02	—	< 4.0
Acenaphthene				0.01	—	—	—	—	—	—	—	—	< 0.01	—	< 2.0
Acenaphthylene				0.01	—	—	—	—	—	—	—	—	< 0.01	—	< 2.0
Anthracene				0.01	—	—	—	—	—	—	—	—	< 0.01	—	< 2.0
Fluoranthene				0.01	—	—	—	—	—	—	—	—	0.18	—	< 2.0
Fluorene				0.01	—	—	—	—	—	—	—	—	< 0.01	—	< 2.0
Naphthalene	5	50		0.01	—	—	—	—	—	—	—	—	< 0.02	—	< 2.0
Phenanthrene	5	50		0.01	—	—	—	—	—	—	—	—	< 0.01	—	0.85
Total PAH's					—	—	—	—	—	—	—	—	2.4	—	3.4
Total Low MW PAH's					—	—	—	—	—	—	—	—	< 0.070	—	0.85
Total High MW PAH's					—	—	—	—	—	—	—	—	2.4	—	2.5

Notes:

1. All concentrations in mg/kg (ppm).
2. MDC - Method Detection Concentration.
3. 1000 Concentration exceeds Parkland criteria.
4. 2000 Concentration exceeds Industrial criteria.
5. *30000* Concentration exceeds B.C. Special Waste criteria.
6. — Parameter not determined.

(96769-1/15/97-MP174.XLS)

TABLE 4.6.2: SOIL CHEMISTRY - METAL RESULTS

Parameter	CCME/ CMCS Parkland Criteria	CCME/ CMCS Industrial Criteria	Zenon ID : Sample ID : MDC	MP174 96025166 SS-3 0.06 M	MP174 96025167 SS-5 0.04 M	MP174 96025310 TP4 0.30m	MP174 96025311 TP3 0.42m	MP174 96025314 TP5 0.28m	MP174 96025317 SS12	MP174 96025304 SS1	MP174 96025306 SS10	MP174 96025307 SS2	MP174 96025308 SS6
METALS TOTAL													
Aluminum			2	6530	7420	5740	5160	7830	5570	6280	6310	6360	4840
Antimony	20	40	2	2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Arsenic	30	50	8	< 8	19	11	< 8	10	< 8	9	12	10	< 8
Barium	500	2000	0.1	267	212	309	437	478	382	267	217	251	208
Beryllium	4	8	0.1	0.3	0.4	0.4	0.4	0.5	0.4	0.4	0.4	0.4	0.3
Bismuth			2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Cadmium	5	20	0.2	< 0.2	< 0.2	< 0.2	0.4	0.4	< 0.2	< 0.2	< 0.2	0.2	< 0.2
Calcium			1	1010	1150	1530	1300	1620	2430	841	923	1060	964
Chromium	250	800	0.2	9.3	14.2	11.1	5.9	12.7	7.1	8.8	12	10.1	7.6
Cobalt	50	300	0.3	5.4	4.2	5	3.2	5.2	4.3	6	6.7	5.7	3.7
Copper	100	500	0.1	14.2	28.9	29.2	26.8	35.6	24.7	18.8	30.1	26.8	21.1
Iron			0.3	14600	23200	18000	6760	18600	10500	14700	19400	17400	10300
Lead	500	1000	2	15	17	11	6	12	9	9	12	13	9
Magnesium			2	1690	2370	2270	907	2280	1420	1520	2280	1960	1390
Manganese			0.2	227	179	258	75.8	201	166	205	282	249	111
Mercury	2	10	0.05	< 0.05	0.05	0.09	< 0.05	0.07	0.06	< 0.05	0.07	< 0.05	< 0.05
Molybdenum	10	40	0.4	1.6	2.7	1.7	0.8	2	1.3	2	2.5	2	1.4
Nickel	100	500	0.8	11.6	18.4	17.8	14.4	20.6	13.3	14.6	19.2	19	11.5
Phosphorus			4	518	965	680	511	850	461	526	619	642	535
Potassium			40	444	586	327	340	507	545	388	383	501	437
Selenium	3	10	5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Silver	20	40	1	< 1	1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Sodium			1	72	23	40	119	71	131	101	21	46	83
Strontium			0.1	9.9	16.1	17.9	14.8	21.3	23.6	11.5	14	12.3	13.4
Sulphur			3	66	263	71	175	95	160	61	64	196	270
Tellurium			2	4	4	2	< 2	3	< 2	< 2	3	3	2
Thallium			1	< 1	< 1	< 1	< 1	2	< 1	< 1	3	< 1	< 1
Tin	50	300	2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Titanium			0.3	36.5	47	32.3	36.8	42.8	52.3	34.6	28.5	53.5	57
Vanadium	200		0.3	34.5	42.6	33.1	16.8	39.2	21.2	33.5	38.3	34.3	22.9
Zinc	500	1500	0.2	61.6	82	83.5	36.5	87.2	46.3	67.6	99.2	80.5	54.9
Zirconium			0.3	< 0.3	< 0.3	0.5	0.6	0.4	< 0.3	< 0.3	0.3	< 0.3	0.4

Notes:

1. All concentrations in mg/kg (ppm).
2. MDC - Method Detection Concentration.
3. 500 Concentration exceeds Parkland criteria.
4. 2000 Concentration exceeds Industrial criteria.

(96769-1/14/97-MP174.XLS)

TABLE 4.6.3: SOIL CHEMISTRY - PESTICIDE RESULTS

Parameter	CCME/ CMCS Parkland Criteria [1]	Zenon ID : Sample ID : MDC	MP174 96025166 SS-3 0.06 M	MP174 96025167 SS-5 0.04 M
ORGANOCHLORINE PESTICIDES				
Aldrin		0.0004	<0.0004	<0.0004
BHC, alpha-		0.0004	<0.0004	<0.0004
BHC, beta-		0.0004	<0.0004	<0.0004
BHC, delta-		0.0004	<0.0004	<0.0004
Chlordane, alpha-		0.002	<0.002	<0.002
Chlordane, gamma-		0.002	<0.002	<0.002
DDE, p,p'-		0.001	<0.001	<0.001
DDT, o,p'-		0.002	<0.002	<0.002
DDD, p,p'-		0.002	<0.002	<0.002
DDT, p,p'-		0.002	<0.002	<0.002
Dieldrin		0.002	<0.002	<0.002
Endosulfan I		0.002	<0.002	<0.002
Endosulfan II		0.002	<0.002	0.016
Endosulfan Sulphate		0.004	<0.004	<0.004
Endrin		0.002	<0.002	<0.002
Heptachlor		0.0004	<0.0004	<0.0004
Heptachlor epoxide		0.0008	<0.0008	<0.0008
Hexachlorobenzene		0.0002	<0.0002	<0.0002
Lindane, BHC, gamma-		0.0004	<0.0004	<0.0004
Methoxychlor		0.004	<0.004	<0.004
Mirex		0.004	<0.004	<0.004
Nonachlor, trans-		0.002	<0.002	<0.002
Oxychlordane		0.002	<0.002	<0.002
POLYCHLORINATED BIPHENYLS				
PCB's - Totals		0.01	<0.01	<0.01
Dibromobiphenyl			97	93

Notes:

1. All concentrations in mg/kg (ppm).
2. MDC - Method Detection Concentration.
3. [1] Total pesticide concentration not to exceed 2 ppm.

TABLE 4.6.4: VEGETATION CHEMISTRY - METAL RESULTS

Parameter	Zenon ID : Sample ID : MDC	MP174 96025335 VEG 1 LT	MP174 96025336 VEG 2 LT	MP174 96025334 BERRY 1 LBC
METALS TOTAL				
Aluminum	2	36	27	23
Antimony	2	< 2	< 2	< 2
Arsenic	8	< 8	< 8	< 8
Barium	0.1	95.7	101	14
Beryllium	0.1	< 0.1	< 0.1	< 0.1
Bismuth	2	< 2	< 2	< 2
Cadmium	0.2	< 0.2	< 0.2	< 0.2
Calcium	1	5050	5060	1230
Chromium	0.2	0.5	0.7	0.6
Cobalt	0.3	< 0.3	< 0.3	< 0.3
Copper	0.1	6	4.4	4.1
Iron	0.3	57.6	39.2	30.1
Lead	2	< 2	2	< 2
Magnesium	2	1160	731	533
Manganese	0.2	1030	885	237
Mercury	0.05	< 0.05	< 0.05	< 0.05
Molybdenum	0.4	< 0.4	< 0.4	< 0.4
Nickel	0.8	3.8	4.5	1
Phosphorus	4	1300	1050	1060
Potassium	40	4030	4180	7110
Selenium	5	< 5	< 5	< 5
Silver	1	< 1	< 1	< 1
Sodium	1	14	11	36
Strontium	0.1	16.3	20.6	4.2
Sulphur	3	795	614	611
Tellurium	2	< 2	< 2	< 2
Thallium	1	< 1	< 1	1
Tin	2	3	< 2	2
Titanium	0.3	0.3	< 0.3	< 0.3
Vanadium	0.3	< 0.3	< 0.3	< 0.3
Zinc	0.2	33.7	27.9	12.1
Zirconium	0.3	< 0.3	< 0.3	< 0.3

Notes:

1. All concentrations in mg/kg (ppm).
2. MDC - Method Detection Concentration.
3. LT - Labrador Tea.
4. LBC - Low Brush Cranberry.

4.7 SITE NO. 6 - MP 212

4.7.1 Physical Setting

General Description

MP 212 is located 121 km north of Ross River on the west side of the North Canol Road (Figure 13). The site is located on a local topographic high which extends to the east across the road to a borrow pit. The site is bounded to the north by a steep slope that leads down to a wetland area, to the west by a gently sloping area covered with bush and to the south by a moderately sloping area which leads to another wetland (Figure 14).

The site and areas surrounding it to the east and south were burned by the fire of June 1996 that swept through the area. The result is that the site is blackened and very open since the vegetation had been consumed in the fire.

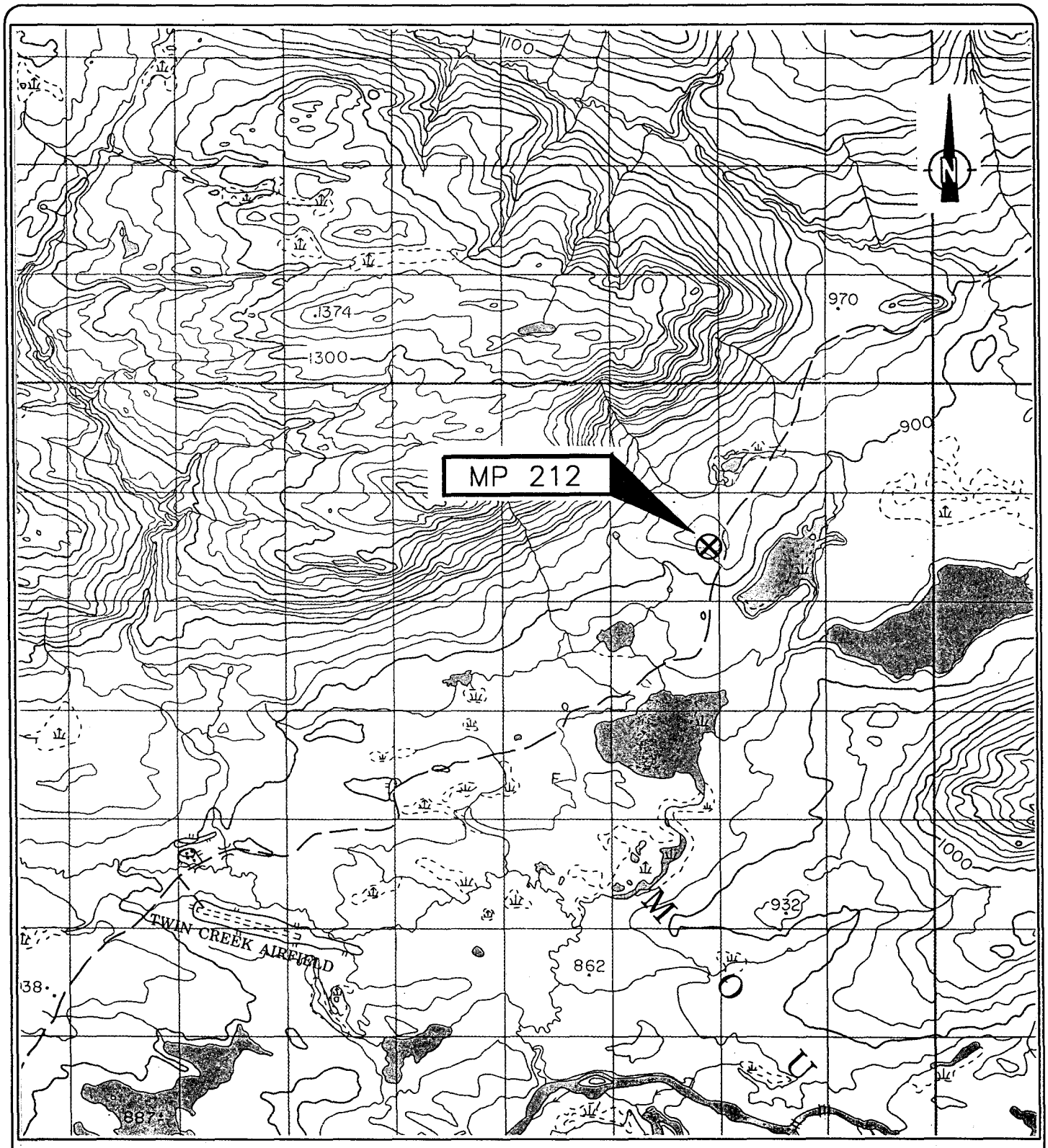
There were no visible drainage channels for surface water on the site, but, drainage is inferred to be to the north and south where small creeks and wetland areas are located.

The site was formerly used as a garbage dump for a camp located at MP 213. There is a large concentration of metal debris located at the end of a Cat trail near the middle of the site (see Photographs 29 to 33). The refuse consists mainly of automobile and heavy equipment parts, stoves, sawmill machinery, drums, cans, and many other items including heavy equipment batteries. Several other smaller metal debris piles are spread about the site.

Geology

The regional geological mapping of this area shown on GSC Surficial Geology Map 1832A (Jackson, 1993) indicates that the surface geology in this area is comprised of a till blanket which has a silty sand matrix, with pebbles, cobbles and occasional boulders, more than 1m thick. These sediments were deposited either directly by glacial ice or by gravity flow from glacier ice.

The terrain analysis for this site shows that the area is predominantly a morainal blanket with gullying and abandoned spillways. The gullies follow local slopes down from the morainal topographic high area in a downgradient direction into the wetland areas and receiving lakes. These gullies and spillways are particularly important as potential "pathways" for the migration of contaminants. The test pits excavated during the soil sampling program show that the surface deposits are primarily interbedded coarse sand, silty sand and gravel which are overlain by a thin layer of the White River ash up to a depth of 1.2 m below grade. It is likely that the sands and gravels which mantle the till deposits are a result of the fluvial processes associated with the gullies and spillways.



LEGEND

⊗ MP 212 Mile Post Location

Source:
NTS 105 J/11 EDITION 1

SCALE 1:50,000

0 500 1000 1500 Metres

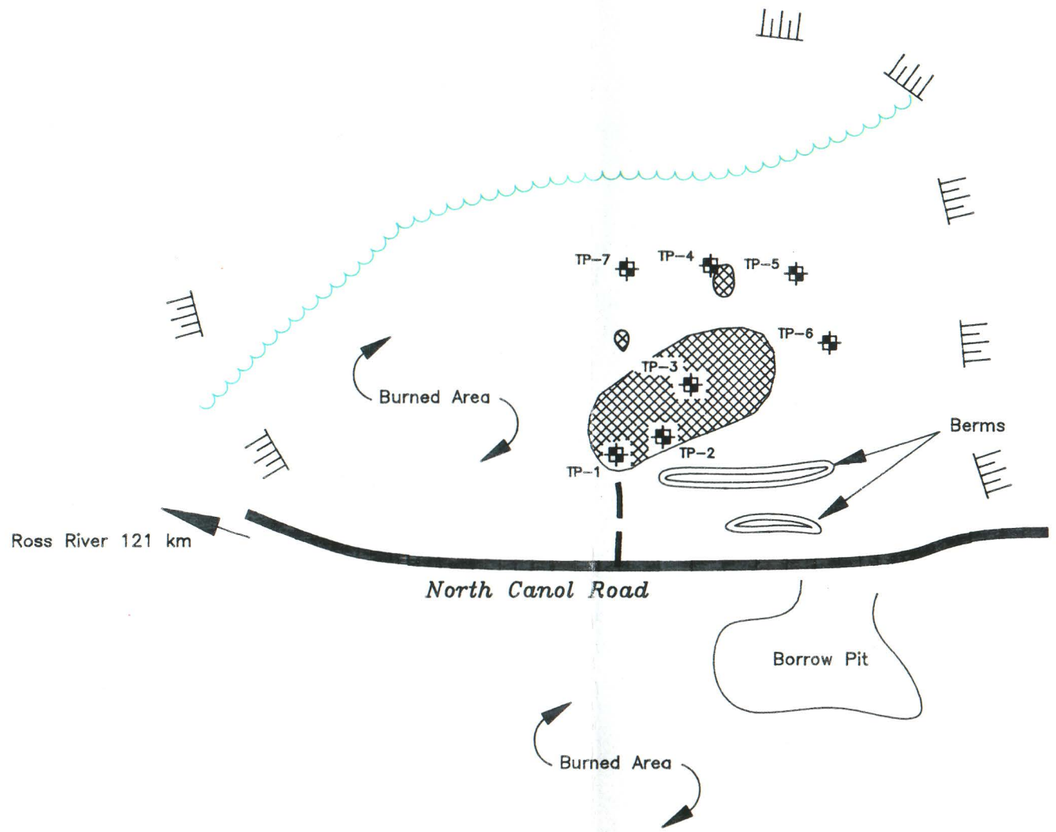
Drawn By: B. Belzac | Project No. 96769
Site Name: North Canol Road | File Name: D:\96769\769-13

MILE POST 212 SITE LOCATION

Canol Road
Site Assessments

Gartner Lee

Figure No. 13



LEGEND

- Canol Road
- Secondary Road
- Abandoned Road
- Oil Staining
- Metal Debris
- Drainage Course
- Surface Water Flow
- Ponded Water
- Swamp/Bog
- Slope
- Tree Line
- Bedrock Outcrop
- SS–1 ● Soil Sampling Location
- TP–1 ⊕ Test Pit Location
- 73–1 ▲ Water Sampling Location
- BER–1 / VEG–1 ○ Vegetation Sampling Location

Scale 1:2000 (approximate)

0 10 20 40 60 metres

Drawn By: B. Belzac | Project No. 96769
Site Name: North Canol Road | File Name: D:\96769\769-212

SKETCH MAP MILE POST 212

Canol Road Site Assessments

Gartner Lee

Figure No. 14

Hydrogeology

Ground water was encountered as seepage zones in the test pits at depths of between 0.6 and 0.7 m suggesting a perched water table on top of dense deeper soils (till). Other seepage areas were observed at the base of a steep slope located at the north end of the site. These seepage zones discharge off-site into a swampy area with a small creek running through it.

Ground water flow across the site is inferred to follow the topography with strong north and south components and a lesser component to the west

Vegetation

Due to the forest fire that swept through the area earlier in the summer, living vegetation noted during the site visit was minimal. The former forest was dominated by Black Spruce (*Picea mariana*) about 10 m tall with a minor component of Trembling Aspen (*Populus tremuloides*) and an understory shrub layer of willows. Many willows were already suckering from their bases, and Fireweed (*Epilobium angustifolium*) was beginning to establish itself on the charred ground. It is impossible to comment on the pre-fire conditions health of vegetation from potential on site contaminants.

4.7.2 Test Results

Field Testing and Observations

A total of fourteen soil samples collected at this site were field screened for organic vapour concentrations using the PID and the same number of samples were field screened for DDT using the immunoassay field kit. The results of both field screening procedures are presented in Table 3, starting on Page 14.

Two of the 14 soil samples screened for organic vapour concentrations showed concentrations above background, but only slightly. The values recorded were 12 and 18 ppm.

None of the 14 samples field screened for the occurrence of DDT suggested concentrations above background.

Soil Chemistry

Selected soil samples were submitted to the analytical laboratory for analysis of potential contaminants of concern previously identified by K. Bisset and Associates. This section provides a summary of the analytical results with the complete results presented in Tables 4.7.1 and 4.7.2 in Appendix B.

Petroleum hydrocarbons were detected in three of the nine soil samples analyzed. Total oil and grease was detected in three of the samples, but at concentrations below the Parkland criterion. None of the ten soil samples submitted for metals analysis showed concentrations above the Parkland criteria

Surface Water Chemistry

No permanent watercourses were observed on this site, thus no surface water samples were collected. The nature of the shallow soils allows precipitation and snowmelt to readily infiltrate into the subsoils of the site.

Vegetation Sampling

No vegetation samples were collected, as the fire of June 1996 had consumed almost all of the vegetation on the site.

4.7.3 Discussion

Site conditions observed in the field and the corresponding analytical data indicate that there are no pertinent environmental issues associated with contamination at this site. Minor occurrences of oil and grease in the shallow soils were well below the Parkland criterion and the fire had masked any areas of surficial staining.

The most pressing issues at this site are of aesthetic and safety concerns. The large accumulation of metal debris on the site likely appears as an eye sore to the local residents and poses a potential injury hazard to wildlife traffic on the site.

One item of note is that there were several heavy equipment batteries within the waste area. Elevated levels of metals associated with these types of batteries (lead and zinc) were not detected and there appeared to be no fluids remaining in the batteries. Since they have been on the site for fifty years and there were no impacts determined, the risk of future impacts is low.

4.7.4 Conclusions

Based on the findings of the site investigation, the following conclusions can be made:

a) petroleum hydrocarbons were detected in three samples but at concentrations below the Parkland criterion;
b) there is a large accumulation of metal debris on the site, including old batteries.

4.7.5 Recommendations

The following recommendations are made based on the conclusions outlined above:

a) The metal debris should either be removed or buried on-site. If the debris is taken off-site, it should then be taken to a scrap metal handling facility.
b) The old batteries should be separated from the metal debris and be disposed of at battery recycling/disposal centre.

TABLE 4.7.1: SOIL CHEMISTRY - HYDROCARBON RESULTS

Parameter	CCME/ CMCS Parkland Criteria	CCME/ CMCS Industrial Criteria	B.C. Special Waste	Zenon ID : Sample ID : MDC	MP212 96025231 TP4 0.70M	MP212 96025232 TP6 0.21M	MP212 96025233 TP4 0.30M	MP212 96025235 TP2 0.23M	MP212 96025236 TP7 0.32M	MP212 96025237 TP7 0.61M	MP212 96025241 TP5 0.32M	MP212 96025242 TP3 0.052M	MP212 96025183 TP-1 0.24 M	MP212 96025184 TP-2 0.62 CM
HYDROCARBONS														
TEH (C10 - C30)				5	---	---	---	---	---	< 5	32	< 5	---	---
TEH Heavy Oil (>C30)				5	---	---	---	---	---	< 5	74	< 5	---	---
EPH (C10 - <C19)	1000	2000		5	---	---	---	---	---	< 5	< 5	< 5	---	---
EPH (C19 - C32)	1000	5000		5	---	---	---	---	---	< 5	43	< 5	---	---
Oil & Grease Total	100	5000	30000	100	< 100	< 100	< 100	< 100	< 100	< 100	120	450	220	< 100

Notes:

1. All concentrations in mg/kg (ppm).
2. MDC - Method Detection Concentration.
3. 1000 Concentration exceeds Parkland criteria.
4. 2000 Concentration exceeds Industrial criteria.
5. *30000* Concentration exceeds B.C. Special Waste criteria.
6. --- Parameter not determined.

(96769-1/15/97-MP212.XLS)

TABLE 4.7.2: SOIL CHEMISTRY - METAL RESULTS

Parameter	CCME/ CMCS Parkland Criteria	CCME/ CMCS Industrial Criteria	Zenon ID : Sample ID : MDC	MP212 96025232 TP6 0.21M	MP212 96025233 TP4 0.30M	MP212 96025234 TP1 0.59M	MP212 96025235 TP2 0.23M	MP212 96025236 TP7 0.32M	MP212 96025238 TP3 0.18M	MP212 96025239 TP5 0.71M	MP212 96025240 TP6 0.48M	MP212 96025241 TP5 0.32M	MP212 96025183 TP-1 0.24 M
METALS TOTAL													
Aluminum			2	4500	8380	4260	8950	14800	4680	6880	7080	8940	7550
Antimony	20	40	2	< 2	< 2	< 2	< 2	3	< 2	< 2	< 2	< 2	2
Arsenic	30	50	8	17	27	15	21	12	16	17	21	20	22
Barium	500	2000	0.1	116	222	495	158	252	78	308	131	115	479
Beryllium	4	8	0.1	< 0.1	0.4	0.3	0.3	0.6	< 0.1	0.5	0.5	0.2	0.5
Bismuth			2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Cadmium	5	20	0.2	< 0.2	< 0.2	0.2	< 0.2	0.4	< 0.2	0.4	0.5	< 0.2	1.1
Calcium			1	262	1150	1580	525	877	165	2310	2030	1030	2010
Chromium	250	800	0.2	7.2	14.9	9	12.9	13.2	5.8	11.8	10.3	16.6	13.3
Cobalt	50	300	0.3	2.1	3.4	7.1	2.8	6.3	1.4	8.1	8.4	4.1	8.6
Copper	100	500	0.1	9.4	21	38.6	14.5	18	7	38.7	31.3	10.8	42.9
Iron			0.3	15200	26400	18400	28900	19700	12300	21900	19900	28400	22800
Lead	500	1000	2	11	14	10	31	10	9	11	12	11	21
Magnesium			2	693	2090	1730	1690	2100	660	2060	1660	2310	2250
Manganese			0.2	149	140	350	152	250	93.6	421	356	317	475
Mercury	2	10	0.05	< 0.05	0.06	0.17	0.08	0.11	< 0.05	0.12	0.09	0.06	0.13
Molybdenum	10	40	0.4	2.4	3.2	2.1	2.8	2	2	2.4	2.1	2.9	2.3
Nickel	100	500	0.8	5.8	15.3	21.7	11.3	15.4	4	25.9	27.7	8.8	30
Phosphorus			4	661	1490	892	985	618	486	1240	1170	1160	1110
Potassium			40	306	460	269	291	441	259	414	338	445	466
Selenium	3	10	5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Silver	20	40	1	< 1	1	< 1	1	1	< 1	1	< 1	1	1
Sodium			1	19	23	23	18	29	18	29	25	23	43
Strontium			0.1	6.1	16	20	9.7	12	4.3	30.1	27.3	11.5	26.6
Sulphur			3	62	122	142	182	191	73	189	130	99	219
Tellurium			2	5	5	4	7	5	3	4	4	6	4
Thallium			1	1	< 1	2	1	< 1	< 1	< 1	< 1	2	< 1
Tin	50	300	2	< 2	< 2	< 2	< 2	3	< 2	< 2	< 2	2	2
Titanium			0.3	128	62.4	49.9	57.8	129	102	52.7	47.1	78	87.8
Vanadium	200		0.3	50.5	50.1	27.1	61.8	33.6	46.7	31.8	26	46.3	36.1
Zinc	500	1500	0.2	32.4	104	121	118	95.9	27.1	128	143	71.6	138
Zirconium			0.3	< 0.3	0.7	1.1	1.4	1.1	< 0.3	1	1.1	0.7	0.6

Notes:

1. All concentrations in mg/kg (ppm).
2. MDC - Method Detection Concentration.
3. 500 Concentration exceeds Parkland criteria.
4. 2000 Concentration exceeds Industrial criteria.

(96769-1/14/97-MP212.XLS)

4.8 SITE NO. 7 - MP 213: SHELDON LAKE

4.8.1 Physical Setting

General Description

MP 213 is located 122.5 km north of Ross River on the west side of the North Canol Road (Figure 15). The site is located on the crest of a local topographic high with low lying poorly drained wetland areas at the base of the higher terrain.

There are no surface water drainage courses on the site, but surface water runoff is inferred to follow the topography down to the lower lying areas to the north and west.

As stated, the site is located on the west side of the road and is accessed through approximately 70 m of heavy bush consisting of willows and poplars. The site was formerly occupied by a large camp which was comprised of several wooden buildings and a vehicle maintenance area. At the time of the site visit, the entire area formerly occupied by the camp had been burned by the fire that swept through the area in June, 1996.

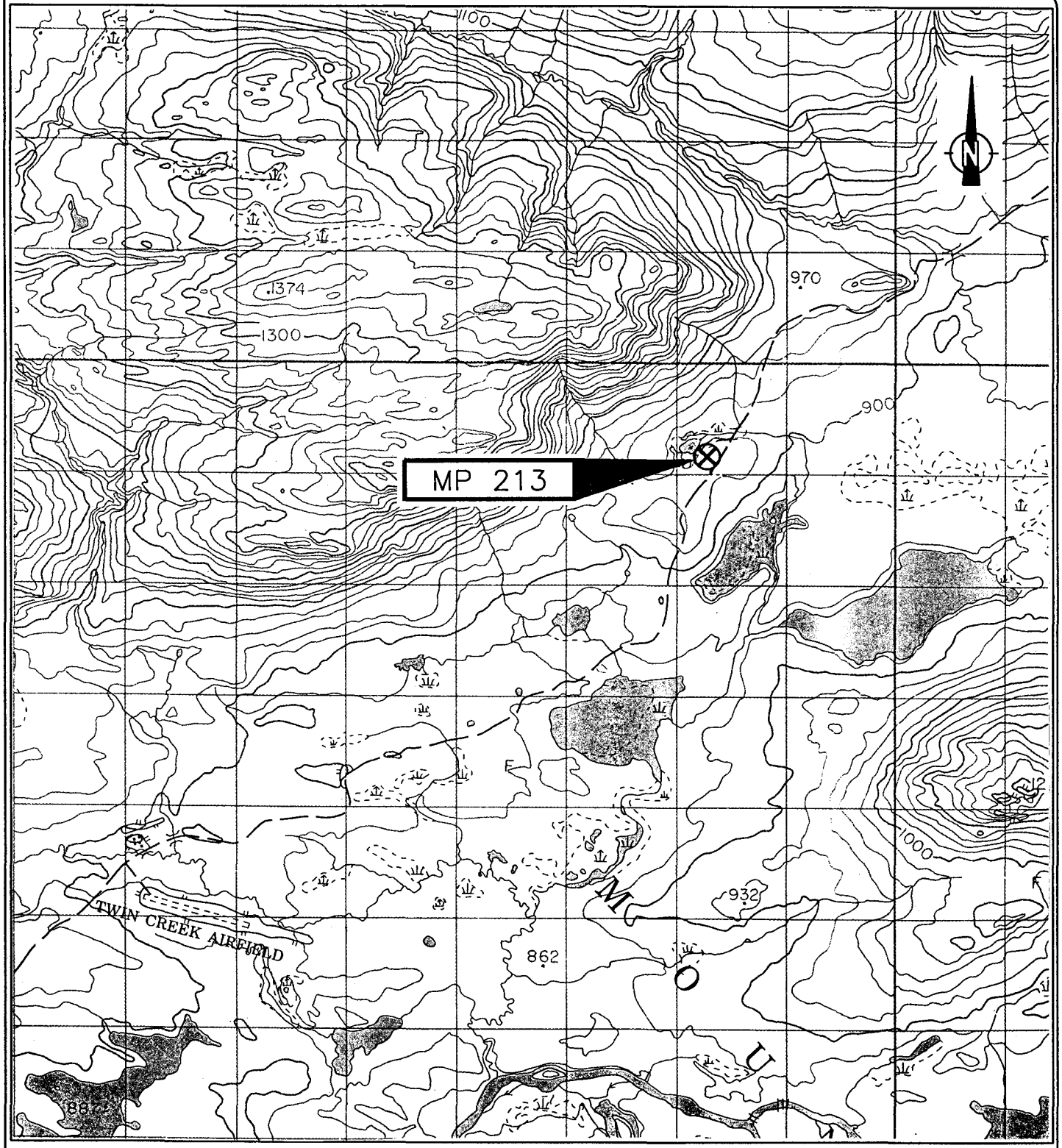
The scorched remnants of three wooden buildings were found as was a burned out vehicle frame and several small piles of assorted metal debris (Figure 16). One area of compacted gravel was observed on the west side of the site which had strong "oily" odour associated with it. This is referred to as Area A (see Photographs 34, 35 and 36).

A few small earth and wood berms were observed on the site and these were interpreted as consisting of materials removed from the surface while clearing the site. One item of note was a 0.05 m diameter pipeline which was laid down northwest from the site towards a wetland area (see Photograph 39). It was in this wetland area that the pipe terminated although airphotos show that this pipe may have run through the swamp and up the hillside to a nearby creek, providing water for the camp.

Across the road, in an area heavily grown over with willows, a small clearing was observed to have heavy oil staining on the surface and a number of empty drums located 15 m downslope. This area is referred to as Area B.

Geology

The regional geological mapping of this area as shown on GSC Surficial Geology Map 1832A (Jackson, 1993) indicates that the surface geology in this area is comprised of a till blanket with a silty sand matrix, pebbles, cobbles and occasional boulders, more than 1m in thickness. These sediments were deposited either directly by glacial ice or by gravity flow from glacier ice.



LEGEND

⊗ MP 213 Mile Post Location

Source:
NTS 105 J/11 EDITION 1

SCALE 1:50,000

0 500 1000 1500 Metres

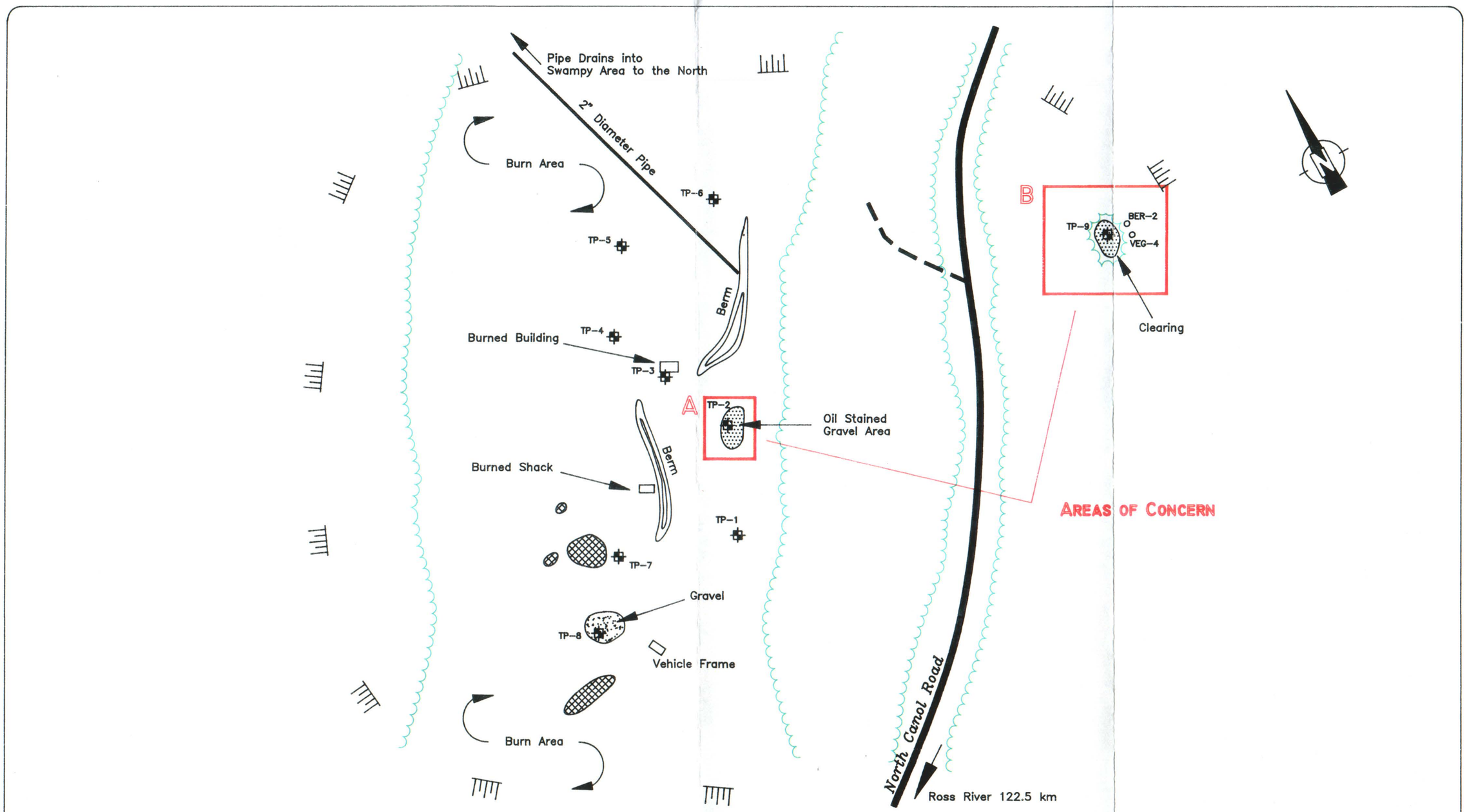
Drawn By: B. Belzac	Project No. 96769
Site Name: North Canol Road	File Name: D:\96769\769-15

MILE POST 213 SITE LOCATION

Canol Road
Site Assessments

Gartner Lee

Figure No. 15



LEGEND

- Canol Road
- Secondary Road
- Abandoned Road
- Oil Staining
- Metal Debris
- Drainage Course
- Surface Water Flow
- Ponded Water
- Swamp/Bog
- Slope
- Tree Line
- Bedrock Outcrop
- SS-1 — Soil Sampling Location
- TP-1 — Test Pit Location
- 73-1 — Water Sampling Location
- BER-1 / VEG-1 — Vegetation Sampling Location

Scale 1:2000 (approximate)

0 10 20 40 60 metres

Drawn By: B. Belzac | Project No. 96769
Site Name: North Canol Road | File Name: D:\96769\769-213

SKETCH MAP MILE POST 213

Canol Road
Site Assessments

Gartner Lee

Figure No. 16

Terrain analysis which was conducted for this area supports the work by Jackson (1993) which describes the surface soil as a till blanket. Also similar to MP 212, there are gullies and spillways which provide potential "pathways" for the migration of contaminants and are also associated with the occurrence of "sorted" fluvial sediments which mantle the till blanket in this area. Test pits excavated on the site during the soil sampling program also confirmed the regional mapping, however, the silt till was mantled with coarse sands and gravels to a depth of between 0.6 to 1.05 m. The coarse sand and gravel was overlain by silty sand and gravel, which in turn was overlain by a layer of white volcanic ash.

Hydrogeology

Ground water was encountered as seepage in 7 of the 8 test pits excavated on the west side of the road at depths of between 0.45 to 0.90 m. This is a result of a perched water table on top of the dense glacial till underlying the site. A slight hydrocarbon sheen was observed on the surface of the ground water in a few of the test pits which shows that these contaminants are migrating downward into the soil profile and presumably downgradient of the site in shallow ground water flow. Ground water flow is inferred to follow the surrounding topography with nearly radially outward flow from the topographically high areas to the lower lying wetland areas with flow to the north having the greatest magnitude.

Vegetation

The area on the west side of the road was affected by the same burn as MP 212. Similarly, the former forest consisted of Black Spruce (*Picea mariana*) with some Trembling Aspen (*Populus tremuloides*) and White Birch (*Betula papyrifera*), and willows in the understory. A dense thicket of willows and alders (*Alnus sp.*) with some low shrubs and herbs remain on the east side of Canol Road. This area had been disturbed by previous activities including grading and filling.

4.8.2 Test Results

Field Testing and Observations

A total of 15 soil samples were field screened for organic vapour concentrations using the PID and 12 soil samples were field screened for the occurrence of DDT using the immunoassay field kit. The results of both field screening procedures are presented in Table 3, starting on Page 14.

Only two of the 15 soil samples field screened for organic vapours had concentrations which were considered to be above background levels. Both samples had concentrations which were only slightly above what are considered background levels (up to 10 ppm), with both samples having readings of 15 ppm.

Of the 13 samples field screened for the occurrence of DDT, only two suggested positive results. One sample was found to have a concentration ranging between 0.2 and 1 ppm and the other indicated a concentration ranging between 1.0 and 10 ppm.

Soil Chemistry

Selected soil samples were submitted to the analytical laboratory for analysis of potential contaminants of concern previously identified by K. Bisset and Associates. This section provides a summary of the analytical results with the complete results presented in Tables 4.8.1 and 4.8.2 in Appendix B.

Petroleum hydrocarbons were detected in six of the eleven soil samples analyzed.

In Area A, a surficial soil sample had a concentration of oil and grease which exceeded the Industrial criterion. At the same location but at a depth of 0.64 m the concentration had decreased to below the Parkland criterion.

Total oil and grease concentration in a surficial soil sample from Area B exceeded the Industrial criterion, while a second sample from the same location but at a depth of 0.16 m exceeded the B.C. Special Waste criterion, also for oil and grease. The second sample also exceeded the Parkland criterion for LEPH and exceeded the Industrial criterion for HEPH.

Three other samples from around the site had detectable concentrations of oil and grease, but at levels below the Parkland criterion.

Of the ten samples submitted for metals analysis, only one sample showed a concentration of barium which exceeded the Parkland criterion. This sample was collected from the surface of the oil spill in Area B.

Surface Water Chemistry

No permanent water courses were observed on the site. The permeable nature of the site soils precludes the formation of any bodies of surface water, but rather allows precipitation and snow melt to readily infiltrate into the subsoils. As a result, no water samples were collected at this site.

Vegetation Sampling

Vegetation samples were taken from on the east side of Canol Road near an oil stained area (Area B). Although most of the site occurs on the west side, samples could not be collected because of the earlier fire. Both samples analyzed showed similar parameter concentrations to the background samples. Complete analytical results are presented in Table 4.8.3 in Appendix B.

4.8.3 Discussion

Two Areas of Concern were identified at this site and are highlighted on the Site Plan (Figure 16) as Areas A, and B. These two areas consist of heavily oil-stained surficial soils each located in a small gravel covered clearing.

Area A has concentrations of oil and grease at the surface which exceeds the Industrial criterion. With depth, the concentration decreases to levels within the Parkland criterion.

In Area B, the surficial soils have concentrations of oil and grease which exceed the Industrial criterion, and at shallow depths the concentrations exceed the B.C. Special Waste criterion. The concentration of barium in the surficial soil sample was found to exceed the Parkland criterion, but this value is likely attributable to the regional geochemistry.

Both of these areas are isolated and appear not to be impacting the surrounding environment, except for perhaps the vegetation. There is no vegetation growing within the two oil saturated areas, however this may be a result of the gravelly soils.

4.8.4 Conclusions

Based on the findings of the site investigation, the following conclusions can be made:

a) **hydrocarbon contamination of the shallow soils exceeding the B.C. Special Waste** criterion has been identified in two areas, Area A and Area B;
b) both areas are isolated and the contamination appears to be the result of spills.

4.8.5 Recommendations

The following recommendation is made based on the conclusions outlined above:

a) The shallow soils affected by the petroleum hydrocarbon contamination do not appear to having significant impacts on the surrounding environment. However, should these occurrences be a concern to the Ross River people the shallow soils should be excavated and removed from the site to a treatment or storage facility. This work could be carried out in conjunction with remediation activities at the sites further to the north.

Vegetation Sampling

Vegetation samples were taken from on the east side of Canol Road near an oil stained area (Area B). Although most of the site occurs on the west side, samples could not be collected because of the earlier fire. Both samples analyzed showed similar parameter concentrations to the background samples. Complete analytical results are presented in Table 4.8.3 in Appendix B.

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TABLE 4.8.1: SOIL CHEMISTRY - HYDROCARBON RESULTS

Parameter	CCME/ CMCS Parkland Criteria	CCME/ CMCS Industrial Criteria	B.C. Special Waste	Zenon ID : Sample ID : MDC	MP213 96025226 TP2 SURFACE	MP213 96025228 TP5 0.29m	96025214 TP2 0.64m	96025215 TP4 0.23m	96025216 TP5 0.84m	96025217 TP3 0.19m	96025218 TP3 0.73m	96025220 SS1 E.SIDE	96025221 TP6 0.75m	96025222 TP8 0.17m	96025223 TP1 E.S. 0 .16m(.26m)
HYDROCARBONS															
TEH (C10 - C30)				5	—	—	65	—	—	—	—	—	< 5	—	8200
TEH Heavy Oil (>C30)				5	—	—	41	—	—	—	—	—	< 5	—	7300
EPH (C10 - <C19)	1000	2000		5	—	—	< 5	—	—	—	—	—	< 5	—	1800
EPH (C19 - C32)	1000	5000		5	—	—	73	—	—	—	—	—	< 5	—	8000
Oil & Grease Total	100	5000	30000	100	15000	< 100	190	130	< 100	240	< 100	26000	< 100	< 100	42000
POLYAROMATIC HYDROCARBONS															
Benz(a)anthracene	1	10		0.01	—	—	< 0.01	—	—	—	—	—	—	—	< 0.01
Dibenz(a,h)anthracene	1	10		0.02	—	—	< 0.02	—	—	—	—	—	—	—	< 0.02
Chrysene				0.01	—	—	< 0.01	—	—	—	—	—	—	—	0.67
Benzo(b)Fluoranthene	1	10		0.01	—	—	< 0.01	—	—	—	—	—	—	—	< 0.03
Benzo(k)fluoranthene	1	10		0.01	—	—	< 0.01	—	—	—	—	—	—	—	< 0.01
Benzo(j)fluoranthene				0.01	—	—	< 0.01	—	—	—	—	—	—	—	< 0.01
Benzo(g,h,i)perylene				0.02	—	—	< 0.02	—	—	—	—	—	—	—	< 0.02
Pyrene	10	100		0.01	—	—	< 0.01	—	—	—	—	—	—	—	0.09
Benzo(a)pyrene	1	10		0.01	—	—	< 0.01	—	—	—	—	—	—	—	< 0.01
Indeno(1,2,3-c,d)pyrene	1	10		0.02	—	—	< 0.02	—	—	—	—	—	—	—	< 0.02
Acenaphthene				0.01	—	—	< 0.01	—	—	—	—	—	—	—	< 0.01
Acenaphthylene				0.01	—	—	< 0.01	—	—	—	—	—	—	—	< 0.06
Anthracene				0.01	—	—	< 0.01	—	—	—	—	—	—	—	< 0.03
Fluoranthene				0.01	—	—	< 0.01	—	—	—	—	—	—	—	< 0.01
Fluorene				0.01	—	—	< 0.01	—	—	—	—	—	—	—	< 0.01
Naphthalene	5	50		0.01	—	—	< 0.01	—	—	—	—	—	—	—	< 0.01
Phenanthrene	5	50		0.01	—	—	< 0.01	—	—	—	—	—	—	—	< 0.01
Total PAH's					—	—	< 0.20	—	—	—	—	—	—	—	0.76
Total Low MW PAH's					—	—	< 0.060	—	—	—	—	—	—	—	< 0.13
Total High MW PAH's					—	—	< 0.14	—	—	—	—	—	—	—	0.76

Notes:

1. All concentrations in mg/kg (ppm).
2. MDC - Method Detection Concentration.
3. 1000 Concentration exceeds Parkland criteria.
4. 5000 Concentration exceeds Industrial criteria.
5. 30000 Concentration exceeds B.C. Special Waste criteria.
6. — Parameter not determined.

(96769-1/15/97-MP213.XLS)

TABLE 4.8.2: SOIL CHEMISTRY - METAL RESULTS

Parameter	CCME/ CMCS Parkland Criteria	CCME/ CMCS Industrial Criteria	Zenon ID : Sample ID : MDC	MP213 96025214 TP2 0.64m	MP213 96025217 TP3 0.19m	MP213 96025218 TP3 0.73m	MP213 96025220 SS1 E.SIDE	MP213 96025222 TP8 0.17m	MP213 96025225 TP7 0.17m	MP213 96025226 TP2 surface	MP213 96025227 TP8 0.39m	MP213 96025229 TP1 0.52m	MP213 96025230 TP1 0.16m
METALS TOTAL													
Aluminum			2	7450	13300	4400	5120	7450	3000	3720	4660	4460	9010
Antimony	20	40	2	2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Arsenic	30	50	8	21	20	14	18	16	9	< 8	16	19	18
Barium	500	2000	0.1	406	170	240	619	215	144	121	342	374	148
Beryllium	4	8	0.1	0.5	0.5	0.3	0.3	0.5	< 0.1	0.1	0.4	0.4	0.5
Bismuth			2	2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Cadmium	5	20	0.2	0.4	< 0.2	0.2	0.5	0.2	< 0.2	0.2	< 0.2	1.1	0.3
Calcium			1	1900	703	1660	1840	948	278	410	1540	2030	1320
Chromium	250	800	0.2	11.9	14.4	8.5	9.2	11.6	5.5	2.2	8.7	8.3	13.3
Cobalt	50	300	0.3	9.1	4	7.5	4.5	7.2	1.6	0.6	6.8	10.1	5
Copper	100	500	0.1	46.7	20.6	37.6	32.2	34.4	10.5	10	39.6	46.8	27
Iron			0.3	21700	23800	17000	17400	19900	10100	2490	16300	18700	21100
Lead	500	1000	2	13	10	10	42	10	9	8	9	11	11
Magnesium			2	2040	1650	1670	1530	1770	601	201	1610	1530	1640
Manganese			0.2	481	174	333	219	295	84.2	41.5	347	667	177
Mercury	2	10	0.05	0.17	0.14	0.17	0.14	0.18	0.05	< 0.05	0.21	0.16	0.1
Molybdenum	10	40	0.4	2.7	2.4	2.1	2.1	2.4	1.7	< 0.4	1.8	2.5	2.2
Nickel	100	500	0.8	31.2	17.6	27.7	19.3	21.8	5.6	2	24.7	33.8	23.8
Phosphorus			4	1080	1010	893	1170	812	443	336	833	1100	972
Potassium			40	441	359	284	474	263	383	284	287	355	358
Selenium	3	10	5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Silver	20	40	1	1	2	< 1	< 1	1	< 1	< 1	< 1	< 1	1
Sodium			1	33	22	23	24	18	20	63	20	22	21
Strontium			0.1	24.4	11.1	19.5	22.2	12.6	7.6	5.3	19.2	26.4	17.2
Sulphur			3	172	177	71	336	70	96	133	46	127	108
Tellurium			2	4	4	3	4	4	3	< 2	3	2	3
Thallium			1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Tin	50	300	2	< 2	2	< 2	5	< 2	< 2	< 2	< 2	2	2
Titanium			0.3	54.9	72.8	59.2	76.1	27.5	59	102	33.6	30	36.9
Vanadium	200		0.3	35.9	38.5	25	27.4	31.2	29.8	5.9	26.1	26	31.7
Zinc	500	1500	0.2	158	107	110	103	107	38.9	13	110	136	123
Zirconium			0.3	1	1.1	1	0.4	0.8	0.5	0.4	1.1	0.9	1.5

Notes:

1. All concentrations in mg/kg (ppm).
2. MDC - Method Detection Concentration.
3. 500 Concentration exceeds Parkland criteria.
4. 1000 Concentration exceeds Industrial criteria.

(96769-1/15/97-MP213.XLS)

TABLE 4.8.3: VEGETATION CHEMISTRY - METAL RESULTS

Parameter	Zenon ID : Sample ID : MDC	MP213 96025337 BERRY 2 LBC	MP213 96025338 VEG 4 LT
METALS TOTAL			
Aluminum	2	29	25
Antimony	2	< 2	< 2
Arsenic	8	< 8	< 8
Barium	0.1	16.6	119
Beryllium	0.1	< 0.1	< 0.1
Bismuth	2	< 2	< 2
Cadmium	0.2	< 0.2	< 0.2
Calcium	1	1110	4740
Chromium	0.2	0.2	1
Cobalt	0.3	< 0.3	0.6
Copper	0.1	3.2	5.9
Iron	0.3	19.6	50.7
Lead	2	< 2	< 2
Magnesium	2	607	820
Manganese	0.2	399	1130
Mercury	0.05	< 0.05	< 0.05
Molybdenum	0.4	< 0.4	< 0.4
Nickel	0.8	1.6	3.3
Phosphorus	4	1240	1280
Potassium	40	7490	3800
Selenium	5	< 5	< 5
Silver	1	< 1	< 1
Sodium	1	33	24
Strontium	0.1	3.5	16.7
Sulphur	3	646	769
Tellurium	2	< 2	< 2
Thallium	1	2	< 1
Tin	2	< 2	< 2
Titanium	0.3	< 0.3	0.4
Vanadium	0.3	< 0.3	< 0.3
Zinc	0.2	12.4	38.8
Zirconium	0.3	< 0.3	< 0.3

Notes:

1. All concentrations in mg/kg (ppm).
2. MDC - Method Detection Concentration.
3. LT - Labrador Tea.
4. LBC - Low Brush Cranberry.

4.9 SITE NO. 8 - MP 233

4.9.1 Physical Setting

General Description

MP 233 is located 154 km north of Ross River, 4 km past Moose Creek, on both sides of the North Canol Road (Figure 17). The site is located on a bedrock bench at the base of a north-facing mountain slope. The site consists of a rounded bedrock knob and face exposed on the north side of the road and a low lying swampy area on the south side (see Photographs 40, 41 and 42). The surrounding topography slopes steeply to the east and north and less steeply to the west.

The swampy area on the south side of the road appears to be a discharge zone at the base of the slope. There are areas of ponded water which outlet to a small creek which flows down the hillside at the east end of the site, and then downslope to the east. Surface runoff on the north side of the road is channeled to a small depression on the north side of the bedrock knob and then down the slope to the north.

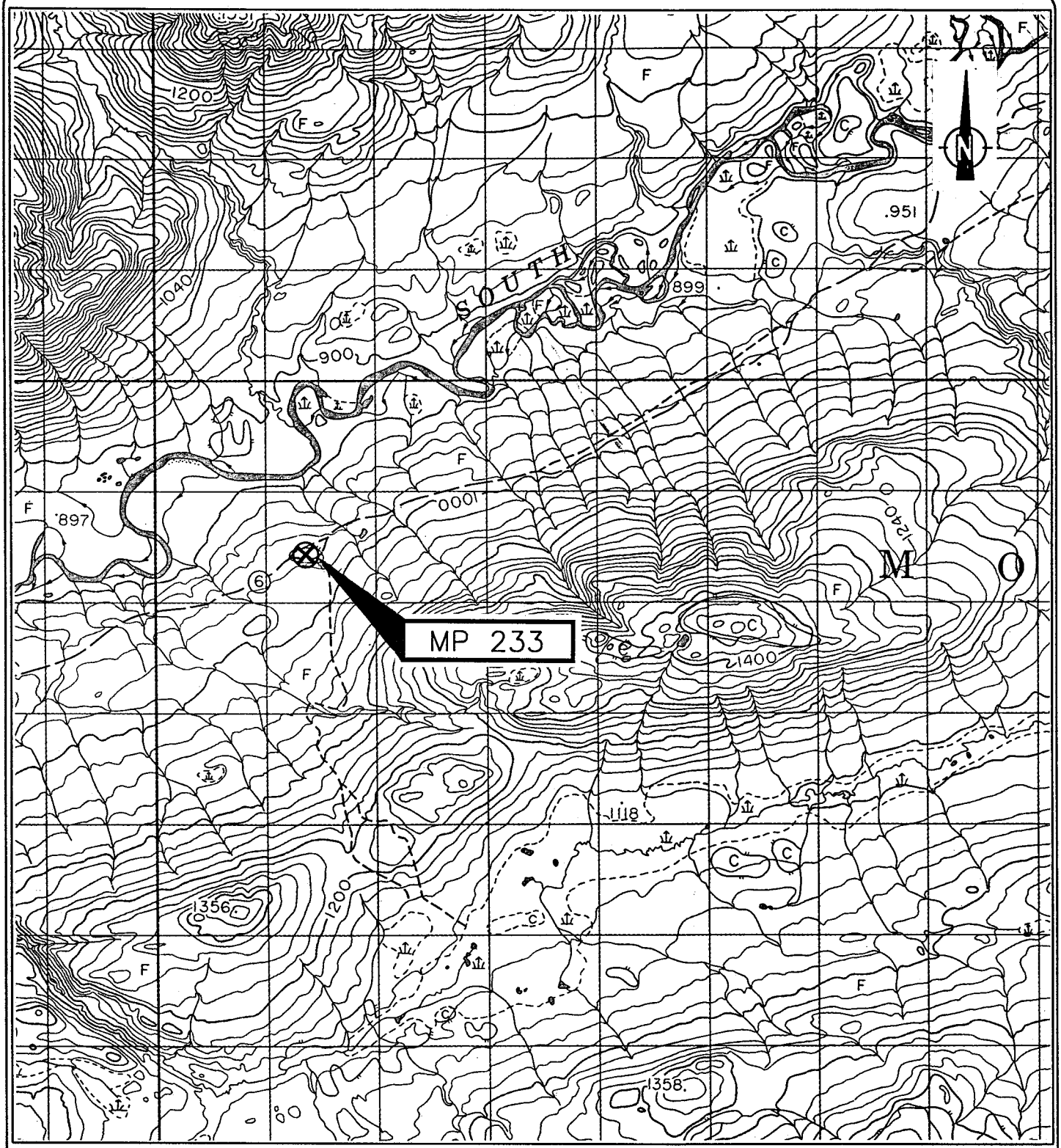
The site was formerly occupied by a pumping station, the remnants of which were observed in the form of three concrete foundations still standing on the site (Figure 18). Several wooden buildings also once stood on the site, but all traces of these have since disappeared, except for a wooden "skidder" shack located on the south side of the road near the west end of the site.

Numerous vehicle hulks are lined up along the road(see Photograph 44), on the north side, and several metal drums were observed in the standing water on the south side. In front of the rock face, there were several small areas of surficial oil staining, the Synergy report stated that this may have been a storage area for oil drums.

Beyond the north boundary of the site, into the bush, there were numerous small piles of half buried wooden and metal debris.

Geology

The regional geological mapping of this area as shown in GSC Surficial Geology Map 1833A (Jackson, 1993) indicates that the surface geology in this area is comprised of a till blanket with a silty sand matrix, pebbles, cobbles and occasional boulders, more than 1m in thickness. These sediments were deposited either directly by glacial ice or by gravity flows from glacier ice.



LEGEND

⊗ MP 233 Mile Post Location

Source:
NTS 105 J/15 EDITION 1

SCALE 1:50,000

0 500 1000 1500 Metres

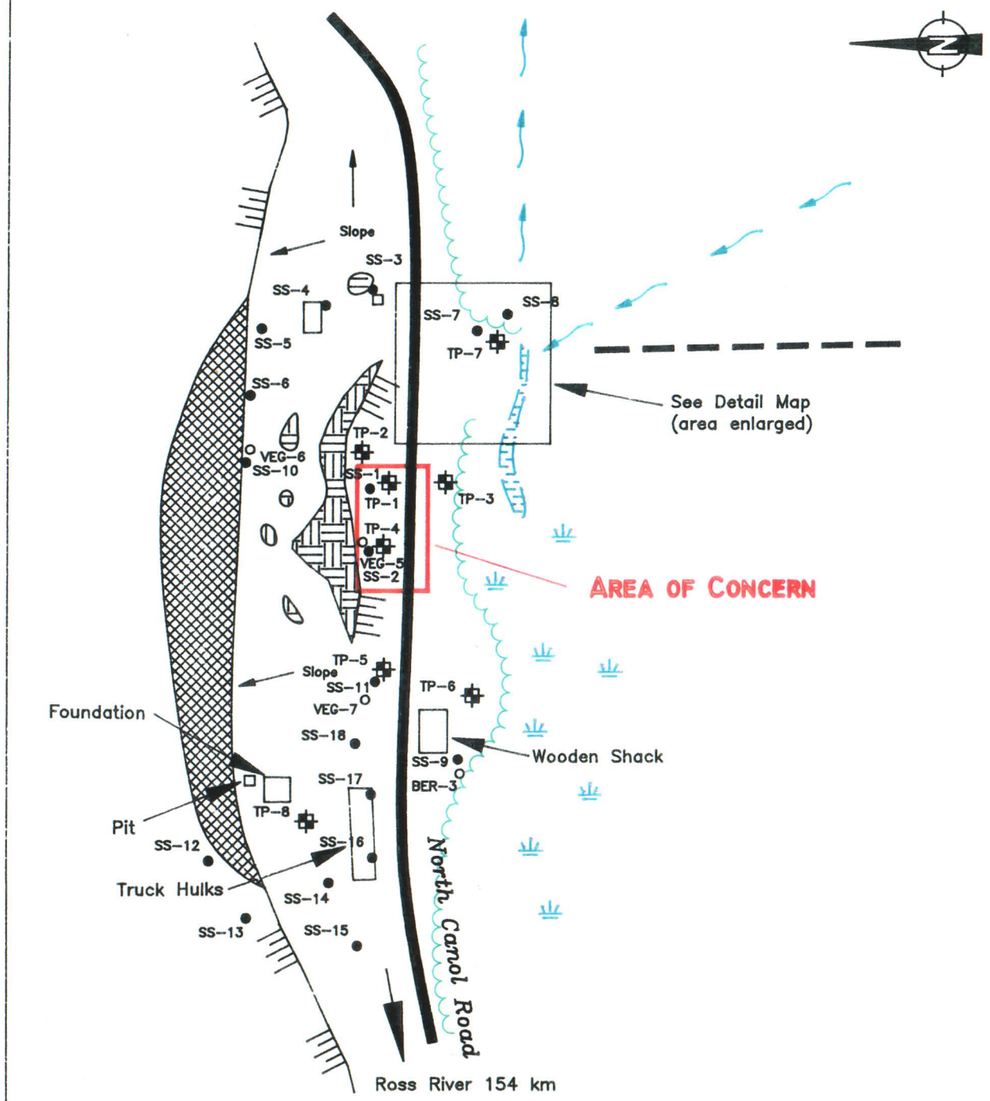
Drawn By: B. Belzac	Project No. 96769
Site Name: North Canol Road	File Name: D:\96769\769-17

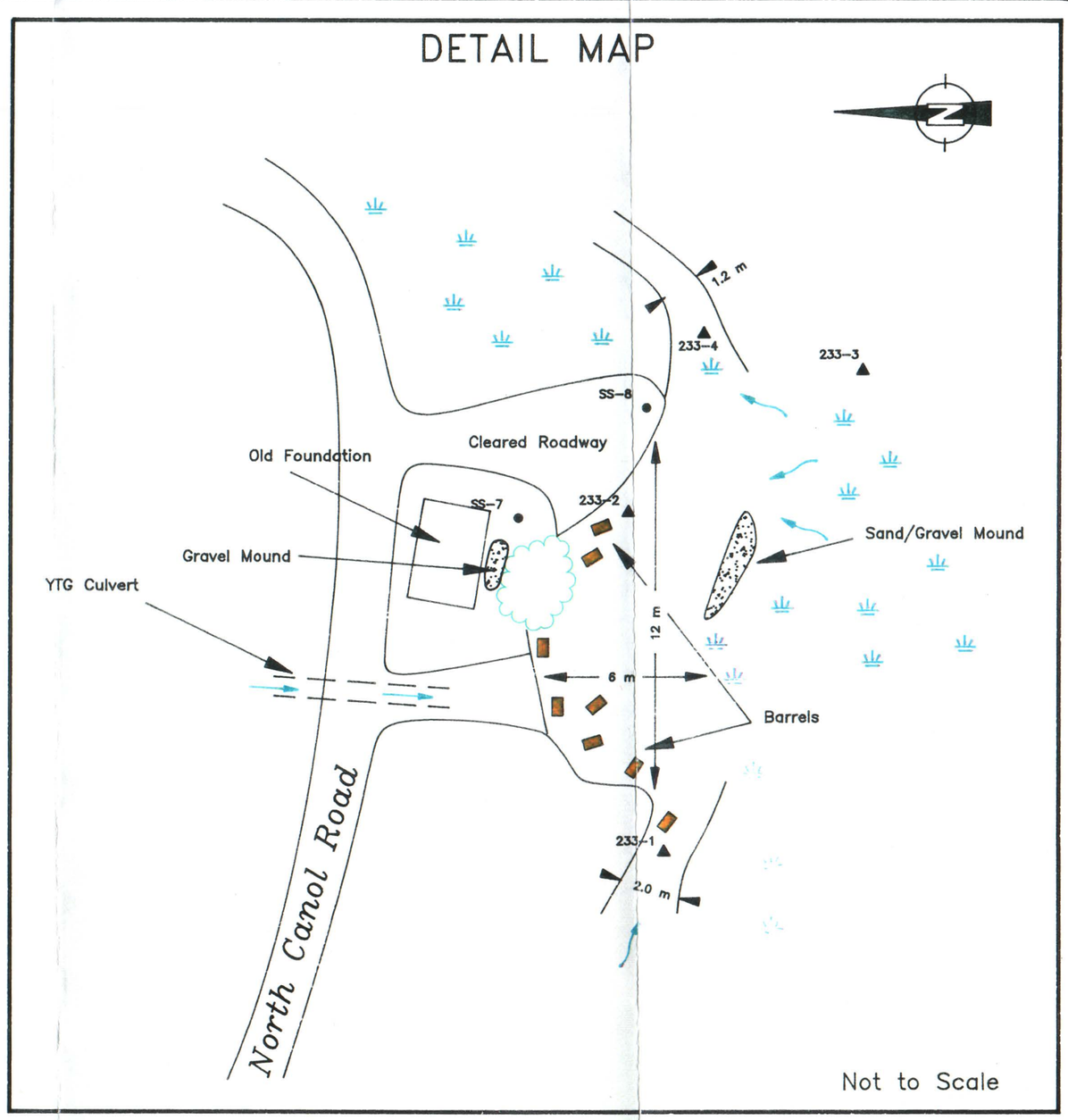
MILE POST 233 SITE LOCATION

Canol Road
Site Assessments

Gartner Lee

Figure No. 17





LEGEND

- Canol Road
- Secondary Road
- Abandoned Road
- Oil Staining
- Metal Debris
- Drainage Course
- Surface Water Flow
- Ponded Water
- Swamp/Bog
- Slope
- Tree Line
- Bedrock Outcrop
- SS-1 Soil Sampling Location
- TP-1 Test Pit Location
- 73-1 Water Sampling Location
- BER-1 / VEG-1 Vegetation Sampling Location

Scale 1:2000 (approximate)

0 10 20 40 60 metres

Drawn By: B. Belzac | Project No. 96789
Site Name: North Canol Road | File Name: D:\96789\789-233Z

SKETCH MAP MILE POST 233

Canol Road
Site Assessments

Gartner Lee

Figure No. 18

The terrain analysis conducted for this site supports the regional interpretation by Jackson (1993). There is also active gullying at this site with shallow subsurface water (e.g. seepage) moving downgradient into the South MacMillan River. There is also evidence of permafrost and poorly drained soils around this site. As a result of this, the potential to move contaminants via active "pathways" at this site is high. The test pits dug at this site found that the sediments tend to be gravelly and sandy with numerous bedrock exposures. In places up to 0.70 m of gravelly sand was found overlying dense silty till.

Hydrogeology

The south area of the site, at the base of the mountain slope, appears to be located in a ground water discharge zone resulting in ponded surface water and saturated soils. The direction of ground water flow for the south part of the site is inferred to be to the east, downslope following the local topography. No indications of ground water were observed north of the bedrock knob, although the inferred flow direction would follow the topography to the north.

Vegetation

This area was cleared of vegetation and then covered with coarse gravel and stone. Regeneration of this area is poor with only immature poplars, aspens and willow species making up the dominant plant community. The ground cover consists primarily of mosses, lichens and Fireweed (*Epilobium angustifolium*). The coarse grained soils with little water retention probably account for the slow rate of regeneration here. The area off-site is a mixed forest of Trembling Aspen (*Populus tremuloides*), White Spruce (*Picea glauca*) and Black Spruce (*Picea mariana*). A Black Spruce bog with a dense lower understory of Labrador Tea (*Ledum groenlandicum*) and Sphagnum moss occurs immediately east of Canol Road.

Surface Water

As discussed above, there are ponded areas at this site with the water originating from seepage areas at the base of the slope as well as from areas upslope and to the east of the ponded area (see Figure 18). The bottom substrates in the ponded area are mainly muddy sediments with a high percentage of organic detritus which is covered with algae. The margins of the ponded areas are vegetated with grasses and sedges. The bottom substrate in the creek area is sand and gravel with some silt. Approximately seven barrels were observed at the bottom and sides of the ponded area. Orange staining was observed in areas around the barrels and from some sections along the margins of the pond and creek.

4.9.2 Test Results

Field Testing and Observations

A total of 30 soil samples were field screened for organic vapour concentrations using the PID and 14 soil samples were field screened for the occurrence of DDT using the immunoassay field kit. The results from both field screening procedures are presented in Table 3, starting on Page 14.

Eight of the 30 soil samples screened for organic vapours had readings which were considered to be above background with values ranging from 11 to 1,323 ppm.

Six of the 14 soil samples screened for the occurrence of DDT suggested positive results. Of the six positive samples, five had concentrations ranging between 0.2 and 1.0 ppm, and one sample had a concentration ranging between 1.0 and 10.0 ppm.

Subsequent step-out samples were collected around the sample with the highest field concentration of DDT. Each of these samples revealed a negative result with suggested concentrations of 0.0 ppm.

Soil Chemistry

Selected soil samples were submitted to the analytical laboratory for analysis of potential contaminants of concern previously identified by K. Bisset and Associates. This section provides a summary of the analytical results with the complete results presented in Tables 4.9.1, 4.9.2 and 4.9.3 in Appendix B.

Total oil and grease concentrations exceeding the Industrial criterion were detected in one sample while three other samples had concentrations which exceeded the Parkland criterion. LEPH/HEPH were detected in one sample with a concentration of LEPH which exceeded the Parkland criterion.

Metals whose concentration exceeded the Parkland criterion were detected in several of the samples. Barium concentrations in six samples exceed the criterion, while arsenic, cadmium and copper concentrations in three samples were found to exceed the criterion. Molybdenum concentrations exceeded the criterion in two samples and the zinc concentration in one sample exceeded the criterion.

The pesticides DDT, Endrin and Hexachlorobenzene were detected only in trace amounts in one surficial soil sample. This was the same sample that suggested a concentration of between 1 and 10 ppm in the field screening.

Surface Water Chemistry

General field measurements including pH, conductivity and dissolved oxygen were taken from four locations : upstream of the ponded area, from the seepage area , the pond itself and downstream in the creek. Four water samples 233 - 1, 233 - 2, 233 - 3, and 233 - 4 were also collected from these locations and submitted to Zenon Laboratories. The field chemistry showed little variation between the areas and offered no obvious indications of obvious contamination.

Laboratory results indicate that the concentrations of several metals exceed the Freshwater Aquatic Life (FAL) criterion. Concentrations of aluminum and manganese in three samples, copper and zinc in four samples, and nickel, cadmium, mercury and barium in one sample each exceed the criteria. Complete analytical results are presented in Table 4.9.5 in Appendix B.

Vegetation Sampling

Foliage samples were collected from Fireweed and Labrador Tea while berry samples were collected from Wild Red Raspberry. Both Fireweed samples showed elevated concentrations of Barium and nickel compared to the control samples. The Labrador Tea sample showed elevated levels of iron and the Wild Red Raspberry sample indicated an elevated concentration of nickel. Complete analytical results are presented in Table 4.9.4 in Appendix B.

4.9.3 Discussion

One area of concern was identified at this site and is highlighted on the Site Plan (Figure 18). Concentrations of oil and grease in soil at depths of over 1 m were found to exceed the Parkland criterion. LEPH was also found to exceed the Parkland criterion at a depth of slightly less than 1 m. This area is located in the major ground water flow path of the site and contaminants readily travel with the local ground water flow towards discharge areas.

Several other small areas of surficial staining were sampled and found to have concentrations of oil and grease which exceeded the Parkland criterion, however, these areas are all less than 1 m in diameter and appear very minor.

Metal exceedances in the soil and surface water, as well as relatively high concentrations in the vegetation samples appear to be related to the regional geochemistry, except in one case. Concentrations of mercury and copper in one of the surface water samples which exceed the Freshwater Aquatic Life (FAL) criterion do not correlate well with the regional geochemistry and may originate from another source.

Reportedly, there may be a dump located up slope from the site that was not visited during the site investigation. Information regarding the existence of the dump was brought to the attention of the field crew after all of the site investigations had been completed. This may be the source of the anomalous mercury and copper concentrations in the surface water.

Also, within the ponded water on the south side of the road, several drums were observed to be either partially or completely submerged. One of the drums was removed while the backhoe was on-site and was discovered to be empty. The conditions and contents of the others was not determined.

4.9.4 Conclusions

Based on the findings of the site investigation, the following conclusions can be made:

a) soil contamination by petroleum hydrocarbons which exceeds the Parkland criterion has been encountered at depths of greater than 1 m;
b) several small areas of hydrocarbon contamination of soils exist about the site;
c) several submerged drums were observed in the area of ponded water and the water was found to have anomalous concentrations of mercury and copper which exceed the Freshwater Aquatic Life criterion;
d) the anomalous metal concentrations in the surface water may be the result of a dump located upslope to the south of the site.

4.9.5 Recommendations

The following recommendations are made based on the conclusions outlined above:

a) Soils in the area in front of the rock face should be excavated and removed from the site. The smaller areas of staining about the site could also be removed at this time. The materials removed from in front of the rock face should be replaced with clean fill.
b) The drums located in the ponded surface water should have their contents determined. The drums should then be removed from the site and disposed of at a scrap metal yard.
c) The existence of a dump upslope from the site should be verified. If there actually is a dump located here, an assessment of potential impacts should be considered.

TABLE 4.9.1: SOIL CHEMISTRY - HYDROCARBON RESULTS

Parameter	CCME/ CMCS Parkland Criteria	CCME/ CMCS Industrial Criteria	B.C. Special Waste	Zenon ID : Sample ID : MDC	MP233 96025258 SS8	MP233 96025259 SS7	MP233 96025262 SS11	MP233 96025267 SS1	MP233 96025245 TP7 0.31M	MP233 96025247 TP1 1.23M	MP233 96025248 TP7 0.72M	MP233 96025250 TP1 0.93M	MP233 96025251 TP5 0.91 M TP-1	MP233 96025254 SS20
HYDROCARBONS														
TEH (C10 - C30)				5	—	—	—	—	94	420	—	2300	—	—
TEH Heavy Oil (>C30)				5	—	—	—	—	78	61	—	77	—	—
EPH (C10 - <C19)	1000	2000		5	—	—	—	—	10	340	—	2100	—	—
EPH (C19 - C32)	1000	5000		5	—	—	—	—	100	89	—	220	—	—
Oil & Grease Total	100	5000	30000	100	2300	< 100	14000	1500	< 100	1100	450	810	< 100	< 100
POLYAROMATIC HYDROCARBONS														
Benz(a)anthracene	1	10		0.01	—	—	< 0.01	—	—	—	—	< 0.01	—	—
Dibenz(a,h)anthracene	1	10		0.02	—	—	< 0.02	—	—	—	—	< 0.02	—	—
Chrysene				0.01	—	—	0.55	—	—	—	—	< 0.01	—	—
Benzo(b)Fluoranthene	1	10		0.01	—	—	< 0.11	—	—	—	—	< 0.01	—	—
Benzo(k)fluoranthene	1	10		0.01	—	—	< 0.02	—	—	—	—	< 0.01	—	—
Benzo(j)fluoranthene				0.01	—	—	< 0.01	—	—	—	—	< 0.01	—	—
Benzo(g,h,i)perylene				0.02	—	—	< 0.02	—	—	—	—	< 0.02	—	—
Pyrene	10	100		0.01	—	—	0.26	—	—	—	—	< 0.01	—	—
Benzo(a)pyrene	1	10		0.01	—	—	< 0.01	—	—	—	—	< 0.01	—	—
Indeno(1,2,3-c,d)pyrene	1	10		0.02	—	—	< 0.02	—	—	—	—	< 0.02	—	—
Acenaphthene				0.01	—	—	< 0.01	—	—	—	—	< 0.11	—	—
Acenaphthylene				0.01	—	—	< 0.01	—	—	—	—	< 0.02	—	—
Anthracene				0.01	—	—	< 0.01	—	—	—	—	< 0.01	—	—
Fluoranthene				0.01	—	—	< 0.09	—	—	—	—	< 0.01	—	—
Fluorene				0.01	—	—	< 0.01	—	—	—	—	< 0.01	—	—
Naphthalene	5	50		0.01	—	—	< 0.01	—	—	—	—	< 0.22	—	—
Phenanthrene	5	50		0.01	—	—	< 0.01	—	—	—	—	0.02	—	—
Total PAH's					—	—	0.81	—	—	—	—	0.02	—	—
Total Low MW PAH's					—	—	< 0.060	—	—	—	—	0.02	—	—
Total High MW PAH's					—	—	0.81	—	—	—	—	< 0.14	—	—

Notes:

1. All concentrations in mg/kg (ppm).
2. MDC - Method Detection Concentration.
3. 1000 Concentration exceeds Parkland criteria.
4. 2000 Concentration exceeds Industrial criteria.
5. *30000* Concentration exceeds B.C. Special Waste criteria.
6. — Parameter not determined.

(96769-1/15/97-MP233.XLS)

TABLE 4.9.2: SOIL CHEMISTRY - METAL RESULTS

Parameter	CCME/ CMCS Parkland Criteria	CCME/ CMCS Industrial Criteria	Zenon ID : Sample ID : MDC	MP233 96025258 SS8	MP233 96025261 SS4	MP233 96025263 SS2	MP233 96025185 SS-13	MP233 96025264 SS14	MP233 96025266 SS12	MP233 96025267 SS1	MP233 96025249 TP4 0.060 M	MP233 96025250 TP1 0.93M
METALS TOTAL												
Aluminum			2	5420	6120	3530	8990	5440	4600	4720	6770	4430
Antimony	20	40	2	6	< 2	3	3	5	4	7	4	2
Arsenic	30	50	8	25	21	15	33	22	30	33	19	17
Barium	500	2000	0.1	413	591	332	1030	511	516	519	588	424
Beryllium	4	8	0.1	0.5	0.4	0.3	0.6	0.5	0.5	0.5	0.5	0.4
Bismuth			2	2	6	< 2	< 2	3	2	2	< 2	< 2
Cadmium	5	20	0.2	2.6	3	3.3	3.1	6	5.3	5.6	2.8	1.6
Calcium			1	3030	3170	3090	3630	6160	5280	5570	3750	1310
Chromium	250	800	0.2	19.4	18.6	11.1	22.4	18.2	14.2	16.8	15.3	11.6
Cobalt	50	300	0.3	9.6	15.3	4.7	10.8	10.2	7.4	10.4	9.3	5.4
Copper	100	500	0.1	131	155	61.7	66.8	106	96.1	99.7	58.7	44.5
Iron			0.3	27600	30800	15600	30300	21900	19800	26400	24200	14500
Lead	500	1000	2	328	16	18	19	19	11	85	15	21
Magnesium			2	2050	2700	1000	2830	1520	1150	1280	2470	1060
Manganese			0.2	532	805	217	439	554	394	623	455	174
Mercury	2	10	0.05	0.38	0.21	0.33	0.28	1.06	0.69	0.79	0.17	0.45
Molybdenum	10	40	0.4	5.2	5.4	5.4	7	10.4	8.6	11	6	4.7
Nickel	100	500	0.8	45.9	68.3	38	70.4	77.1	57.8	76.5	54.4	29.6
Phosphorus			4	1390	1290	1630	1460	2800	2510	2590	1450	791
Potassium			40	1110	458	445	1480	712	620	655	803	716
Selenium	3	10	5	< 5	< 5	< 5	< 5	5	< 5	7	< 5	< 5
Silver	20	40	1	2	2	2	2	3	2	3	2	1
Sodium			1	104	36	25	56	55	40	41	78	42
Strontium			0.1	104	43.4	55.3	53.5	109	91.6	94.3	42.6	53.2
Sulphur			3	1860	221	620	217	595	538	575	202	663
Tellurium			2	6	6	7	7	11	8	11	5	3
Thallium			1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Tin	50	300	2	4	3	< 2	< 2	3	< 2	< 2	4	< 2
Titanium			0.3	61.2	47.2	44.9	100	76.9	51.2	60	172	53.4
Vanadium	200		0.3	62.6	52.8	85.8	71.6	171	128	169	54.6	45.5
Zinc	500	1500	0.2	355	295	261	377	473	378	502	257	151
Zirconium			0.3	0.9	2.3	0.8	3.3	2.2	2.7	0.9	2.3	0.6

Notes:

1. All concentrations in mg/kg (ppm).
2. MDC - Method Detection Concentration.
3. 500 Concentration exceeds Parkland criteria.
4. 2000 Concentration exceeds Industrial criteria.

(96769-1/14/97-MP233.XLS)

TABLE 4.9.3: SOIL CHEMISTRY - PESTICIDE RESULTS

Parameter	CCME/ CMCS Parkland Criteria [1]	Zenon ID : Sample ID : MDC	MP233 96025262 SS11
ORGANOCHLORINE PESTICIDES			
Aldrin		0.0004	<0.0004
BHC, alpha-		0.0004	<0.0004
BHC, beta-		0.0004	<0.0004
BHC, delta-		0.0004	<0.0004
Chlordane, alpha-		0.002	<0.002
Chlordane, gamma-		0.002	<0.002
DDE, p,p'-		0.001	<0.001
DDT, o,p'-		0.002	0.006
DDD, p,p'-		0.002	<0.002
DDT, p,p'-		0.002	<0.002
Dieldrin		0.002	<0.002
Endosulfan I		0.002	<0.002
Endosulfan II		0.002	<0.002
Endosulfan Sulphate		0.004	<0.004
Endrin		0.002	0.009
Heptachlor		0.0004	<0.0004
Heptachlor epoxide		0.0008	<0.0008
Hexachlorobenzene		0.0002	0.0046
Lindane, BHC, gamma-		0.0004	<0.0004
Methoxychlor		0.004	<0.004
Mirex		0.004	<0.004
Nonachlor, trans-		0.002	<0.002
Oxychlordane		0.002	<0.002
POLYCHLORINATED BIPHENYLS			
PCB's - Totals		0.01	<0.01
Dibromobiphenyl			88

Notes:

1. All concentrations in mg/kg (ppm).
2. MDC - Method Detection Concentration.
3. [1] Total pesticide concentration not to exceed 2 ppm.

TABLE 4.9.4: VEGETATION CHEMISTRY - METAL RESULTS

Parameter	Zenon ID : Sample ID : MDC	MP233 96025339 VEG 5 Fw	MP233 96025340 VEG 6 LT	MP233 96025341 VEG 7 Fw	MP233 96025342 BERRY 3 R
METALS TOTAL					
Aluminum	2	58	36	100	102
Antimony	2	< 2	< 2	3	3
Arsenic	8	< 8	< 8	< 8	< 8
Barium	0.1	1270	251	1110	20.8
Beryllium	0.1	< 0.1	< 0.1	< 0.1	< 0.1
Bismuth	2	< 2	< 2	< 2	< 2
Cadmium	0.2	0.6	< 0.2	0.6	0.4
Calcium	1	13300	7090	12700	1480
Chromium	0.2	1.1	0.8	1	0.8
Cobalt	0.3	< 0.3	0.4	0.4	0.6
Copper	0.1	3.8	5.2	5	6
Iron	0.3	101	686	255	33
Lead	2	< 2	< 2	< 2	4
Magnesium	2	2500	1350	3490	1550
Manganese	0.2	167	347	239	23.3
Mercury	0.05	< 0.05	< 0.05	< 0.05	< 0.05
Molybdenum	0.4	< 0.4	< 0.4	< 0.4	< 0.4
Nickel	0.8	24.4	5.7	20.9	15.3
Phosphorus	4	2300	1530	1570	2460
Potassium	40	9540	7470	6230	10800
Selenium	5	< 5	< 5	< 5	< 5
Silver	1	< 1	< 1	< 1	< 1
Sodium	1	63	18	42	5
Strontium	0.1	107	22.7	119	8.2
Sulphur	3	621	916	624	861
Tellurium	2	< 2	< 2	< 2	< 2
Thallium	1	< 1	1	< 1	1
Tin	2	< 2	< 2	3	< 2
Titanium	0.3	0.4	0.3	1.4	< 0.3
Vanadium	0.3	< 0.3	< 0.3	1.4	< 0.3
Zinc	0.2	144	52.3	114	25.7
Zirconium	0.3	< 0.3	< 0.3	< 0.3	< 0.3

Notes:

1. All concentrations in mg/kg (ppm).
2. MDC - Method Detection Concentration.
3. LT - Labrador Tea.
4. Fw - Fireweed.
5. R - Raspberry.

TABLE 4.9.5: SURFACE WATER CHEMISTRY RESULTS

Parameter	CCME/ CMCS Fresh Water Aquatic Life	Zenon ID : Client ID : MDC	96025369 233-1	96025370 233-2	96025371 233-3	96025372 233-4
METALS TOTAL						
Aluminum	0.02	0.06	0.21	21	0.46	< 0.06
Antimony		0.02	< 0.02	< 0.02	< 0.02	< 0.02
Arsenic	0.05	0.04	< 0.04	< 0.04	< 0.04	< 0.04
Barium	1	0.001	0.072	1.82	0.126	0.055
Beryllium	0.053	0.001	< 0.001	0.001	< 0.001	< 0.001
Bismuth		0.02	< 0.02	< 0.02	< 0.02	< 0.02
Boron		0.04	< 0.04	< 0.04	< 0.04	< 0.04
Cadmium	0.0008	0.002	< 0.002	0.004	< 0.002	< 0.002
Calcium		0.05	7.5	13.6	3.44	7.46
Chromium	0.002	0.002	< 0.002	0.049	0.005	< 0.002
Cobalt	0.05	0.004	< 0.004	0.01	< 0.004	< 0.004
Copper	0.004	0.002	0.004	0.102	0.01	0.098
Iron	0.300	0.05	0.69	39.6	0.7	0.51
Lead	0.006	0.03	< 0.03	< 0.03	< 0.03	< 0.03
Magnesium		0.02	4.38	8.64	1.2	4.25
Manganese	0.100	0.002	0.129	1.76	0.082	0.163
Mercury	0.0001	0.00005	< 0.00005	0.00036	< 0.00005	< 0.00005
Molybdenum	1.000	0.004	< 0.004	0.011	< 0.004	< 0.004
Nickel	0.065	0.01	< 0.01	0.09	0.01	< 0.01
Phosphorus		0.04	< 0.04	1.83	< 0.04	< 0.04
Potassium		0.4	< 0.4	3.2	< 0.4	< 0.4
Selenium	0.001	0.03	< 0.03	< 0.03	< 0.03	< 0.03
Silicon		0.8	4.6	19	5.1	4.2
Silver	0.0001	0.03	< 0.03	< 0.03	< 0.03	< 0.03
Sodium		0.4	1.1	1.5	0.8	1
Strontium		0.001	0.047	0.131	0.03	0.046
Sulphur		0.1	5.3	6.4	1.5	5.3
Tellurium		0.02	< 0.02	< 0.02	< 0.02	< 0.02
Thallium		0.03	< 0.03	< 0.03	< 0.03	< 0.03
Tin		0.02	< 0.02	< 0.02	< 0.02	< 0.02
Titanium		0.003	0.003	0.263	0.003	< 0.003
Vanadium		0.003	< 0.003	0.188	< 0.003	< 0.003
Zinc	0.03	0.01	0.06	0.46	0.1	0.1
Zirconium		0.003	< 0.003	0.005	< 0.003	< 0.003
HYDROCARBONS						
Oil & Grease Total		1	< 1	< 1	< 1	2

Notes:

1. All concentrations in mg/L (ppm).
2. MDC - Method Detection Concentration.
3. 0.02 Concentration exceeds Fresh Water Aquatic Life criteria.

4.10 SITE NO. 9 - MP 234

4.10.1 Physical Setting

General Description

MP 234 is located 155.5 km north of Ross River on the north side of the road (Figure 19). The site is located at the base of a north facing mountain slope on a gently eastward sloping bench. To the north, the bench continues for approximately 100 m and then drops off to the South MacMillan River valley.

Surface water appears to drain to the east in the immediate vicinity of the site in a ditch excavated on the south side of the road, up-gradient of the site.

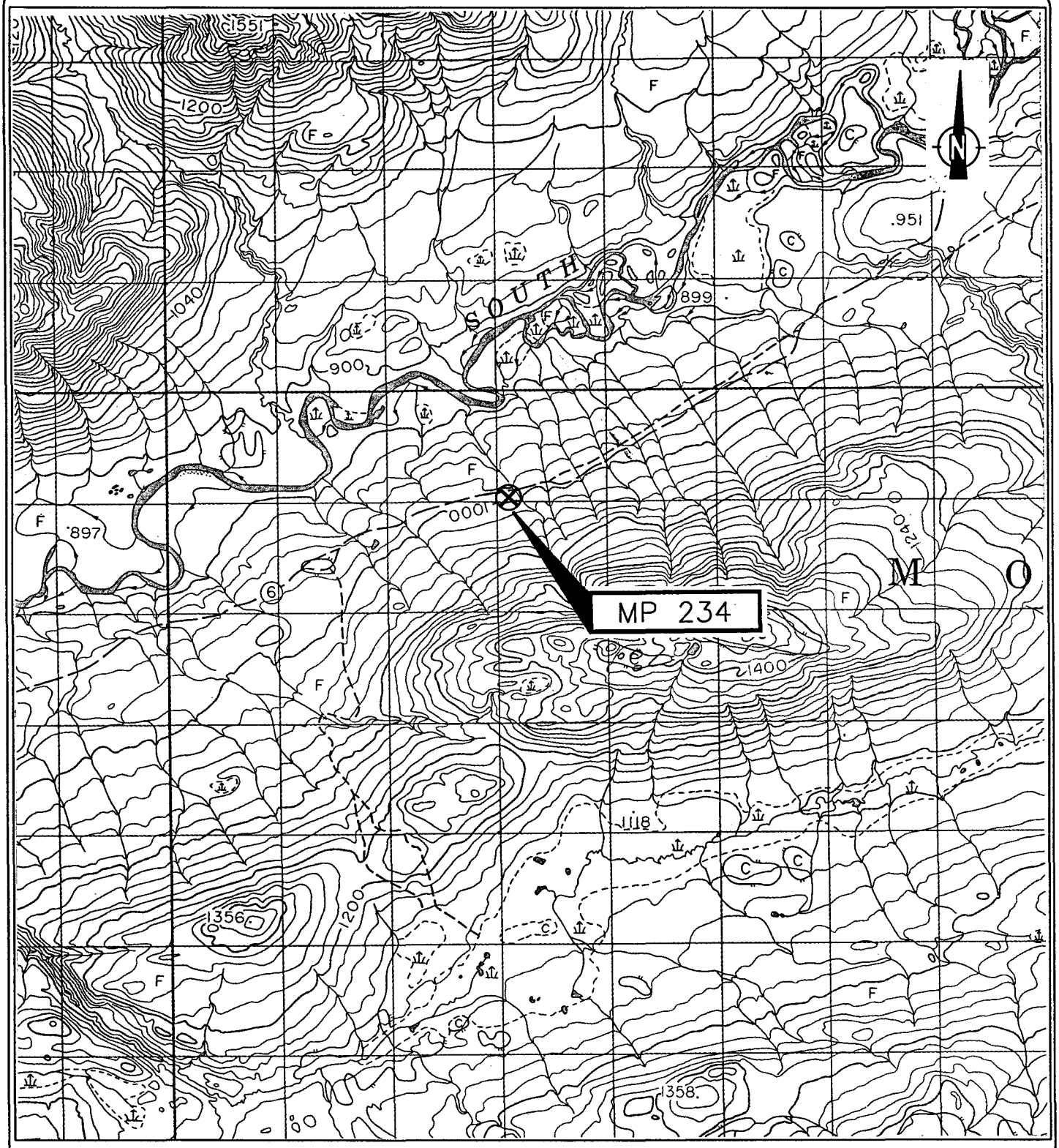
The site is easily located with a large number of vehicle hulks lining the north side of the road. Behind the three easternmost vehicle hulks, approximately 20m from the road, is a large area (30 x 10m) of staining of the surface soils with oil (Figure 20). This site apparently was used as a burial area for full drums of oil and grease by the Government of Yukon (YTG) in the early 1970's. The surface of the site consists of gravel fill and areas which resemble asphalt due to the mixture of oil and gravel.

Surface water ponded on the compacted fill was observed to have a hydrocarbon sheen, and within the water the tops of several crushed barrels were observed. There was little vegetation in the affected area.

Geology

The regional geological mapping of this area as shown on GSC Surficial Geology Map 1833A (Jackson, 1993) indicates that the surface geology in this area is comprised of a till blanket which has a silty sand matrix, with pebbles, cobbles and occasional boulders, more than 1 m in thickness. These sediments were deposited either directly by glacial ice or by gravity flows from glacier ice.

The terrain analysis conducted for this site also indicates a morainal or till blanket with active surface and shallow subsurface gullying with broad areas which contain permafrost. As described at the last site, the presence of gullying and permafrost allows the migration of surface water (e.g. slope wash) and shallow subsurface water in a downgradient direction into the receiving waters of the South MacMillan River. Test pits excavated as part of the soil sampling program confirmed the regional mapping and the terrain analysis with the exception that the native till material was covered with up to 1.80 m of sand and gravel fill in some areas likely used to bury the oil drums by YTG.



LEGEND

⊗ MP 234 Mile Post Location

Source:
NTS 105 J/15 EDITION 1

SCALE 1:50,000

0 500 1000 1500 Metres

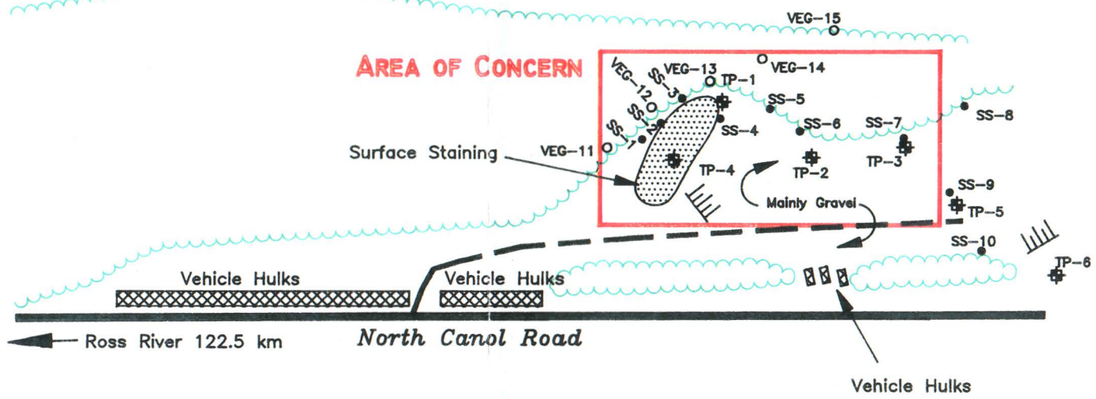
MILE POST 234 SITE LOCATION

Canol Road
Site Assessments

Gartner Lee

Figure No. 19

Drawn By: B. Belzac	Project No. 96769
Site Name: North Canol Road	File Name: D:\96769\769-19



LEGEND

- Canol Road
- Secondary Road
- Abandoned Road
- Oil Staining
- Metal Debris
- Drainage Course
- Surface Water Flow
- Ponded Water
- Swamp/Bog
- Slope
- Tree Line
- Bedrock Outcrop
- SS–1 Soil Sampling Location
- TP–1 Test Pit Location
- 73–1 Water Sampling Location
- BER–1 / VEG–1 Vegetation Sampling Location

Scale 1:1000 (approximate)

0 5 10 20 30 metres

Drawn By: B. Belzac | Project No. 96769
Site Name: North Canol Road | File Name: D:\96769\769-234

SKETCH MAP MILE POST 234

Canol Road
Site Assessments

Gartner Lee

Figure No. 20

Hydrogeology

The site appears to be in a ground water discharge zone at the base of the mountain slope. This is inferred as ground water was encountered as seepage in the test pits at depths of between 0.30 to 0.50 m. There seems to be a perched water table, on top of the silt till, in the area of the site with the ground water flow direction following the topography. The direction of ground water flow is inferred to be to the east and to the north (e.g. downgradient into the MacMillan River drainage basin).

Vegetation

Vegetation on the majority of the site showed signs of recent disturbance and clearing. Irregular clumpings of willow up to 3 m tall with some White Birch (*Betula papyrifera*) and saplings of Trembling Aspen (*Populus tremeloides*) and Balsam Poplar (*Populus balsamifera*) are interspersed among areas of bare to sparsely vegetated, gravelly ground. There is also the occasional occurrence of horsetails (*Equisetum sp.*), clover (*Trifolium sp.*), club moss (*Lycopodium sp.*) and grass tufts. The gravelly soils are probably responsible for the retarded rate of regeneration. Surface oil staining is frequent and in these areas many plants exhibited signs of stress in the form of necrosis as a result of the surface and subsurface hydrocarbon contamination.

4.10.2 Test Results

Field Testing and Observations

A total of 19 soil samples were field screened for organic vapours using the PID and 15 soil samples were field screened for the occurrence of DDT using the immunoassay kit. The results of both field screening procedures are presented in Table 3, starting on Page 14.

Of the 19 soil samples screened for organic vapours, eleven had concentrations which were considered above background with three of the eleven being significantly above background. Concentrations of these samples ranged from 11 to 2,660 ppm.

Six of the 15 soil samples screened for the occurrence of DDT suggested a positive result. Four samples indicated concentrations ranging between 0.2 and 1.0 ppm, one sample had a suggested concentration of between 1.0 and 10.0 ppm, and one sample had a suggested concentration of greater than 10 ppm.

Soil Chemistry

Selected soil samples were submitted to the analytical laboratory for analysis of potential contaminants of concern previously identified by K. Bisset and Associates. This section provides a summary of the analytical results with the complete results presented in Tables 4.10.1, 4.10.2 and 4.10.3 in Appendix B.

Petroleum hydrocarbons were detected in all ten samples analyzed. Total oil and grease was detected in all ten of the samples with two samples having concentrations which exceeded the Special Waste criterion, three samples exceeded the Industrial criterion and one sample exceeded the Parkland criterion. LEPH/HEPH were detected in all three samples analyzed, with two samples having concentrations which exceed the Parkland criterion.

Metals concentrations which exceeded the Parkland criterion were detected in several samples. Concentrations of barium exceeded the criterion in five samples, arsenic concentrations exceeded the criterion in two samples, and molybdenum concentrations exceeded the criterion in one sample.

Endosulfan Sulphate, a metabolite of the pesticides Endosulfan I and II, was detected in trace amounts in one of the samples. No DDT was detected in any of the samples.

Surface Water Chemistry

No surface water bodies were observed in the vicinity of the site except for a small area of water ponded on compacted fills. No water samples were collected.

Vegetation Sampling

A total of five foliage samples were collected for Labrador Tea and Fireweed. All samples were taken downgradient of stained areas. One of the Labrador Tea samples showed elevated levels of sulphur compared to the background samples and the Fireweed samples showed elevated concentrations of barium and nickel. Complete analytical results are presented in Table 4.10.4 in Appendix B.

4.10.3 Discussion

The surface of this site is heavily stained with petroleum hydrocarbons and several of the soil samples indicate contaminant concentrations which not only exceed the Parkland criteria, but the Industrial and Special Waste criterion as well.

Numerous barrels of oil and grease were reportedly buried at this site in the 1970's and this was confirmed during the test pitting phase of the site investigation. Several crushed barrels with holes in them were unearthed in two of the test pits. Each of the barrels still had the original bungs in place indicating that they were full at the time of burial.

The exact number of barrels buried and the full extent of the burial area was not determined during this investigation. A local resident brought forth information that the burial area may continue to the west.

Immediate impacts from the contamination were observed in the lack of vegetation in the area. Not so readily apparent impacts are those on the ground water. The contamination was observed to continue at depth and heavy ground water seepage was observed in the test pits.

Elevated concentrations of metals were determined for several soil samples as well as vegetation samples. Each of the exceedances in the soils and the elevated concentrations in the vegetation are likely attributable to the regional geochemistry. The further north along the Canol Road and closer to the MacMillan Pass area the sites are, the greater the influence the regional geochemistry becomes on the concentrations of individual elements in the soils.

4.10.4 Conclusions

Based on the findings of the site investigation, the following conclusions can be made:

a) the site was used as a burial area for drums full of oil and grease in the 1970's;
b) the site is heavily impacted by petroleum hydrocarbons at levels which exceed the B.C. Special Waste criterion;
c) elevated metal concentrations in the soils and vegetation are likely related to the regional geochemistry.

4.10.5 Recommendations

The following recommendations are made based on the conclusions outlined above:

a) The full extent of the area which contains the buried drums should be determined by excavating additional test pits.
b) The contaminated soils should be removed and transported to a storage or treatment facility.

TABLE 4.10.1: SOIL CHEMISTRY - HYDROCARBON RESULTS

Parameter	CCME/ CMCS Parkland Criteria	CCME/ CMCS Industrial Criteria	B.C. Special Waste	Zenon ID : Sample ID : MDC	MP234 96025274 TP1 0.21m	MP234 96025275 TP2 0.61m	MP234 96025276 SS2	MP234 96025277 SS10	MP234 96025278 SS5	MP234 96025279 SS7	MP234 96025281 SS3	MP234 96025268 TP2 1.2M	MP234 96025270 TP3 0.56M	MP234 96025272 TP4 0.25M
HYDROCARBONS														
TEH (C10 - C30)				5	—	26000	—	—	—	—	—	44	5500	—
TEH Heavy Oil (>C30)				5	—	370	—	—	—	—	—	8	290	—
EPH (C10 - <C19)	1000	2000		5	—	16000	—	—	—	—	—	18	2400	—
EPH (C19 - C32)	1000	5000		5	—	8000	—	—	—	—	—	28	1200	—
Oil & Grease Total	100	5000	30000	100	280	19000	*120000*	410	1900	800	15000	270	8300	*40000*
POLYAROMATIC HYDROCARBONS														
Benz(a)anthracene	1	10		0.01	—	< 0.01	—	—	—	—	—	—	< 0.01	—
Dibenz(a,h)anthracene	1	10		0.02	—	< 0.02	—	—	—	—	—	—	< 0.02	—
Chrysene				0.01	—	< 0.01	—	—	—	—	—	—	< 0.02	—
Benzo(b)Fluoranthene	1	10		0.01	—	< 0.04	—	—	—	—	—	—	< 0.01	—
Benzo(k)fluoranthene	1	10		0.01	—	< 0.01	—	—	—	—	—	—	< 0.01	—
Benzo(j)fluoranthene				0.01	—	< 0.01	—	—	—	—	—	—	< 0.01	—
Benzo(g,h,i)perylene				0.02	—	< 0.02	—	—	—	—	—	—	< 0.02	—
Pyrene	10	100		0.01	—	< 0.03	—	—	—	—	—	—	0.04	—
Benzo(a)pyrene	1	10		0.01	—	< 0.01	—	—	—	—	—	—	< 0.01	—
Indeno(1,2,3-c,d)pyrene	1	10		0.02	—	< 0.02	—	—	—	—	—	—	< 0.02	—
Acenaphthene				0.01	—	< 1.1	—	—	—	—	—	—	< 0.31	—
Acenaphthylene				0.01	—	< 0.39	—	—	—	—	—	—	< 0.01	—
Anthracene				0.01	—	< 0.01	—	—	—	—	—	—	< 0.01	—
Fluoranthene				0.01	—	< 0.01	—	—	—	—	—	—	< 0.01	—
Fluorene				0.01	—	1.2	—	—	—	—	—	—	< 0.01	—
Naphthalene	5	50		0.01	—	< 1.1	—	—	—	—	—	—	0.03	—
Phenanthrene	5	50		0.01	—	0.37	—	—	—	—	—	—	< 0.01	—
Total PAH's					—	1.6	—	—	—	—	—	—	0.07	—
Total Low MW PAH's					—	1.6	—	—	—	—	—	—	0.03	—
Total High MW PAH's					—	< 0.19	—	—	—	—	—	—	0.04	—

Notes:

1. All concentrations in mg/kg (ppm).
2. MDC - Method Detection Concentration.
3. 1000 Concentration exceeds Parkland criteria.
4. 2000 Concentration exceeds Industrial criteria.
5. *30000* Concentration exceeds B.C. Special Waste criteria.
6. — Parameter not determined.

(96769-1/15/97-MP234.XLS)

TABLE 4.10.2: SOIL CHEMISTRY - METAL RESULTS

Parameter	CCME/ CMCS Parkland Criteria	CCME/ CMCS Industrial Criteria	Zenon ID : Sample ID : MDC	MP234 96025275 TP2 0.61m	MP234 96025276 SS2	MP234 96025279 SS7	MP234 96025281 SS3	MP234 96025283 SS4	MP234 96025270 TP3 0.56M	MP234 96025272 TP4 0.25M	MP234 96025170 SS-1 0.04 M	MP234 96025173 SS-6 0.02M
METALS TOTAL												
Aluminum			2	7720	5910	8140	6360	8280	6550	5250	4950	6120
Antimony	20	40	2	2	2	3	3	3	4	2	2	5
Arsenic	30	50	8	12	19	38	10	13	15	12	13	39
Barium	500	2000	0.1	588	688	542	256	309	685	497	408	582
Beryllium	4	8	0.1	0.5	0.3	0.7	0.3	0.5	0.4	0.4	0.3	0.5
Bismuth			2	< 2	< 2	9	< 2	< 2	< 2	< 2	< 2	< 2
Cadmium	5	20	0.2	2.2	1.1	2.8	0.6	0.9	2.8	1.6	0.8	3.3
Calcium			1	3830	2090	3200	1730	1190	3080	3100	1790	4480
Chromium	250	800	0.2	16.2	12.5	30.3	12.3	14.9	14.4	12.2	10.2	15.7
Cobalt	50	300	0.3	6.2	2.9	21.3	3.7	8.1	5.5	5.5	3.4	9.8
Copper	100	500	0.1	57.9	34.7	311	24.9	40.5	55.7	45.1	40.4	65.7
Iron			0.3	16600	22300	36600	19900	22100	15300	17600	16000	31900
Lead	500	1000	2	23	41	260	19	13	81	14	33	53
Magnesium			2	1770	1250	2800	1600	1840	1800	1900	944	1720
Manganese			0.2	306	162	2030	178	412	252	162	134	1650
Mercury	2	10	0.05	0.24	0.14	0.28	0.16	0.17	0.28	0.12	0.12	0.18
Molybdenum	10	40	0.4	5.9	4.4	6.6	5.3	5.6	5.2	5.7	3.5	37
Nickel	100	500	0.8	30.1	17.6	69.8	17.8	24.8	37.8	30.3	21	61.9
Phosphorus			4	1300	1250	1510	1060	962	1360	1360	942	1880
Potassium			40	658	630	1070	483	698	693	541	557	1080
Selenium	3	10	5	< 5	< 5	< 5	< 5	< 5	15	< 5	< 5	< 5
Silver	20	40	1	2	2	2	1	< 1	2	1	1	2
Sodium			1	32	29	61	52	54	45	30	38	67
Strontium			0.1	46.3	32.5	141	26.8	20.5	44.1	38.9	31.4	84.2
Sulphur			3	589	613	1020	317	210	442	294	880	963
Tellurium			2	4	4	7	4	4	4	5	4	7
Thallium			1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Tin	50	300	2	< 2	3	9	< 2	< 2	3	< 2	< 2	2
Titanium			0.3	80.9	82.3	63.7	96.9	104	93.4	123	66.7	90.4
Vanadium	200		0.3	62.1	52.9	65.5	50.4	59.1	57.3	44.1	35.8	75
Zinc	500	1500	0.2	146	113	368	108	152	192	169	99.6	277
Zirconium			0.3	0.4	0.5	0.9	< 0.3	< 0.3	0.4	0.8	< 0.3	0.6

Notes:

1. All concentrations in mg/kg (ppm).
2. MDC - Method Detection Concentration.
3. 500 Concentration exceeds Parkland criteria.
4. 2000 Concentration exceeds Industrial criteria.

(96769-1/14/97-MP234.XLS)

TABLE 4.10.3: SOIL CHEMISTRY - PESTICIDE RESULTS

Parameter	CCME/ CMCS Parkland Criteria [1]	Zenon ID : Sample ID : MDC	MP234 96025170 SS-1 0.04 M
ORGANOCHLORINE PESTICIDES			
Aldrin		0.0004	<0.0004
BHC, alpha-		0.0004	<0.0004
BHC, beta-		0.0004	<0.0004
BHC, delta-		0.0004	<0.0004
Chlordane, alpha-		0.002	<0.002
Chlordane, gamma-		0.002	<0.002
DDE, p,p'-		0.001	<0.001
DDT, o,p'-		0.002	<0.002
DDD, p,p'-		0.002	<0.002
DDT, p,p'-		0.002	<0.002
Dieldrin		0.002	<0.002
Endosulfan I		0.002	<0.002
Endosulfan II		0.002	<0.002
Endosulfan Sulphate		0.004	0.099
Endrin		0.002	<0.002
Heptachlor		0.0004	<0.0004
Heptachlor epoxide		0.0008	<0.0008
Hexachlorobenzene		0.0002	<0.0002
Lindane, BHC, gamma-		0.0004	<0.0004
Methoxychlor		0.004	<0.004
Mirex		0.004	<0.004
Nonachlor, trans-		0.002	<0.002
Oxychlordane		0.002	<0.002
POLYCHLORINATED BIPHENYLS			
PCB's - Totals		0.01	<0.01
Dibromobiphenyl			84

Notes:

1. All concentrations in mg/kg (ppm).
2. MDC - Method Detection Concentration.
3. [1] Total pesticide concentration not to exceed 2 ppm.

TABLE 4.10.4: VEGETATION CHEMISTRY - METAL RESULTS

Parameter	Zenon ID : Sample ID : MDC	MP234 96025347 VEG 11 LT	MP234 96025348 VEG 12 Fw	MP234 96025349 VEG 13 LT	MP234 96025350 VEG 14 Fw	MP234 96025351 VEG 15 Fw
METALS TOTAL						
Aluminum	2	32	139	30	52	41
Antimony	2	2	< 2	< 2	< 2	< 2
Arsenic	8	< 8	< 8	< 8	< 8	< 8
Barium	0.1	97.5	1240	121	423	273
Beryllium	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Bismuth	2	< 2	< 2	< 2	< 2	< 2
Cadmium	0.2	< 0.2	0.7	< 0.2	< 0.2	< 0.2
Calcium	1	4910	14500	5030	14200	15000
Chromium	0.2	0.7	1	0.6	0.9	0.8
Cobalt	0.3	0.4	0.6	< 0.3	1	0.3
Copper	0.1	5.8	16.1	6.2	51.7	9.7
Iron	0.3	54	85.9	71.3	66.2	83.8
Lead	2	< 2	4	< 2	6	< 2
Magnesium	2	917	3330	944	3750	3490
Manganese	0.2	469	564	509	222	121
Mercury	0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Molybdenum	0.4	< 0.4	< 0.4	< 0.4	3.6	< 0.4
Nickel	0.8	3	14.3	3.8	10.2	7.5
Phosphorus	4	1380	2810	1230	1940	3400
Potassium	40	8770	13100	4040	6770	11400
Selenium	5	< 5	< 5	< 5	< 5	< 5
Silver	1	< 1	< 1	< 1	< 1	< 1
Sodium	1	28	78	31	40	51
Strontium	0.1	13.6	156	17.7	134	108
Sulphur	3	4000	2990	887	419	782
Tellurium	2	< 2	< 2	< 2	< 2	< 2
Thallium	1	< 1	2	3	< 1	< 1
Tin	2	< 2	< 2	< 2	2	< 2
Titanium	0.3	0.3	< 0.3	0.4	< 0.3	< 0.3
Vanadium	0.3	0.3	< 0.3	0.3	< 0.3	0.4
Zinc	0.2	200	555	68.8	107	74.9
Zirconium	0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3

Notes:

1. All concentrations in mg/kg (ppm).
2. MDC - Method Detection Concentration.
3. LT - Labrador Tea.
4. Fw - Fireweed.

4.11 SITE NO. 10 - MP 268

4.11.1 Physical Setting

General Description

MP 268 is located just across the MacMillan River # 2 crossing 210 km north of Ross River (Figure 21). The site is situated on top of a fluvial terrace 10 to 15 m above the river. The site is mainly flat lying and slopes gently to the south, with a steep embankment along the west side which leads down to the river. Along the east and south boundaries of the site are a number of YTG borrow pits.

The coarse nature of the soil and underlying sediments at this site precludes any surface drainage courses in the area as surface water readily infiltrates into the subsurfaces.

The site consists of gravel covered clearings and scrub brush (Figure 22). Along the east side of the road are two sets of numerous vehicle hulks neatly lined up (see Photographs 51 and 52). The area surrounding them has been cleared of vegetation. Across the road there are two graders located near the south end of the site in a partially cleared area and two empty barrels located near the mid part of the site.

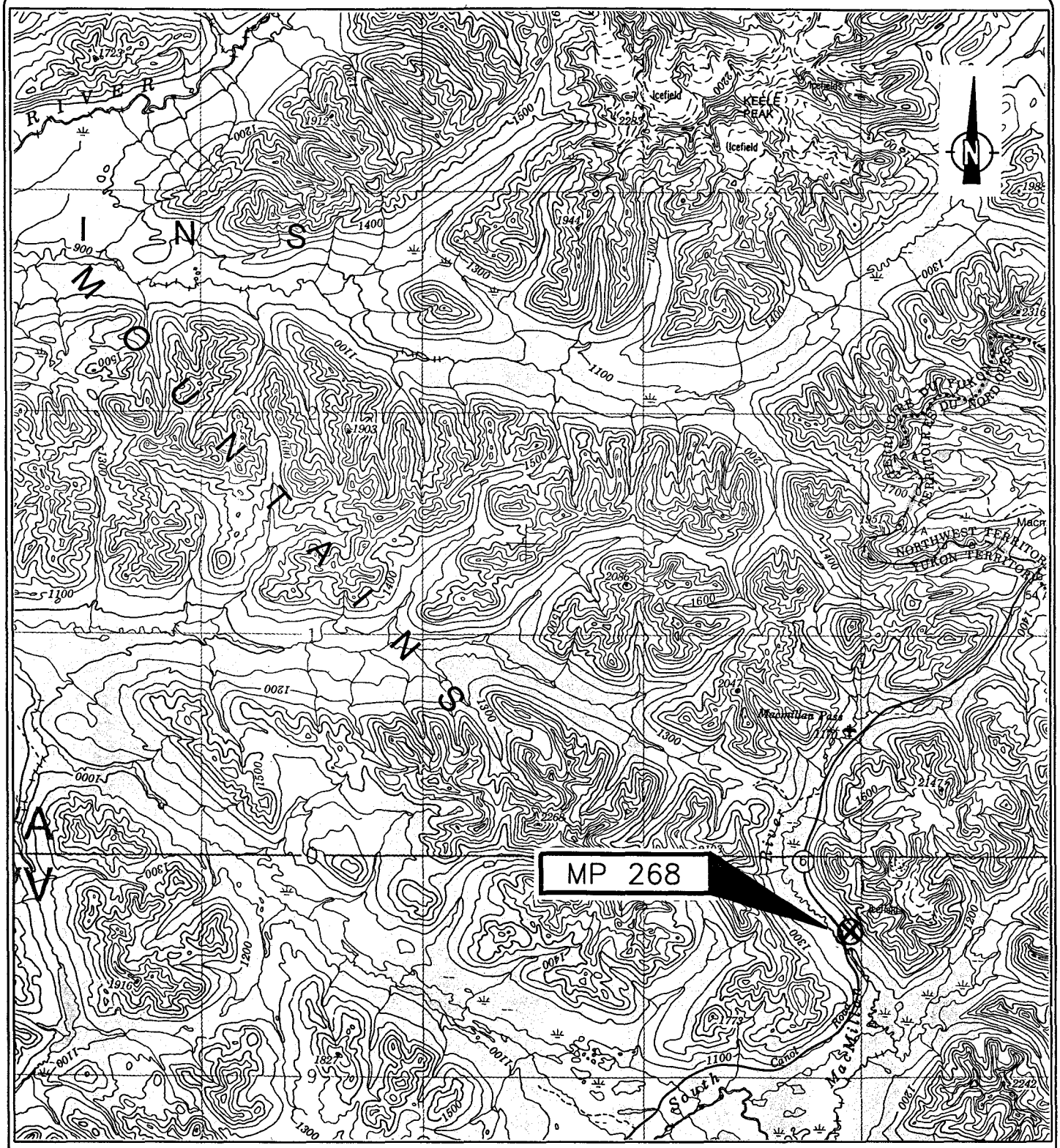
Geology

The terrain analysis conducted for this site shows that the area is dominantly ice stagnant or hummocky ice contact terrain which is typically sand and gravel. This area also appears to be well drained with no surficial evidence of permafrost. A visual field reconnaissance of the site and surrounding area confirms the above mentioned geology. Inspections of the borrow pits surrounding the site and the embankment leading down to the river revealed a thick (> 10 m) sequence of coarse sands and gravels with cobbles and occasional boulders.

Hydrogeology

No zones of ground water seepage were observed in the area of the site or in any of the nearby borrow pits. This indicates that the depth to ground water in the area of the site is greater than 10 m. Ground water likely occurs at depths slightly above the level of the adjacent South MacMillan River in which the water level occurs approximately 15 m below the elevation of the site.

The inferred ground water flow direction is to the west towards the South MacMillan River.



LEGEND

⊗ MP 268 Mile Post Location

Source:
NTS 105 O EDITION 2 ✓ 10501

10501
630527

SCALE 1:250,000

0 2.5 5 7.5 KM

Drawn By: B. Belzoc	Project No. 96769
Site Name: North Canol Road	File Name: D:\96769\769-21

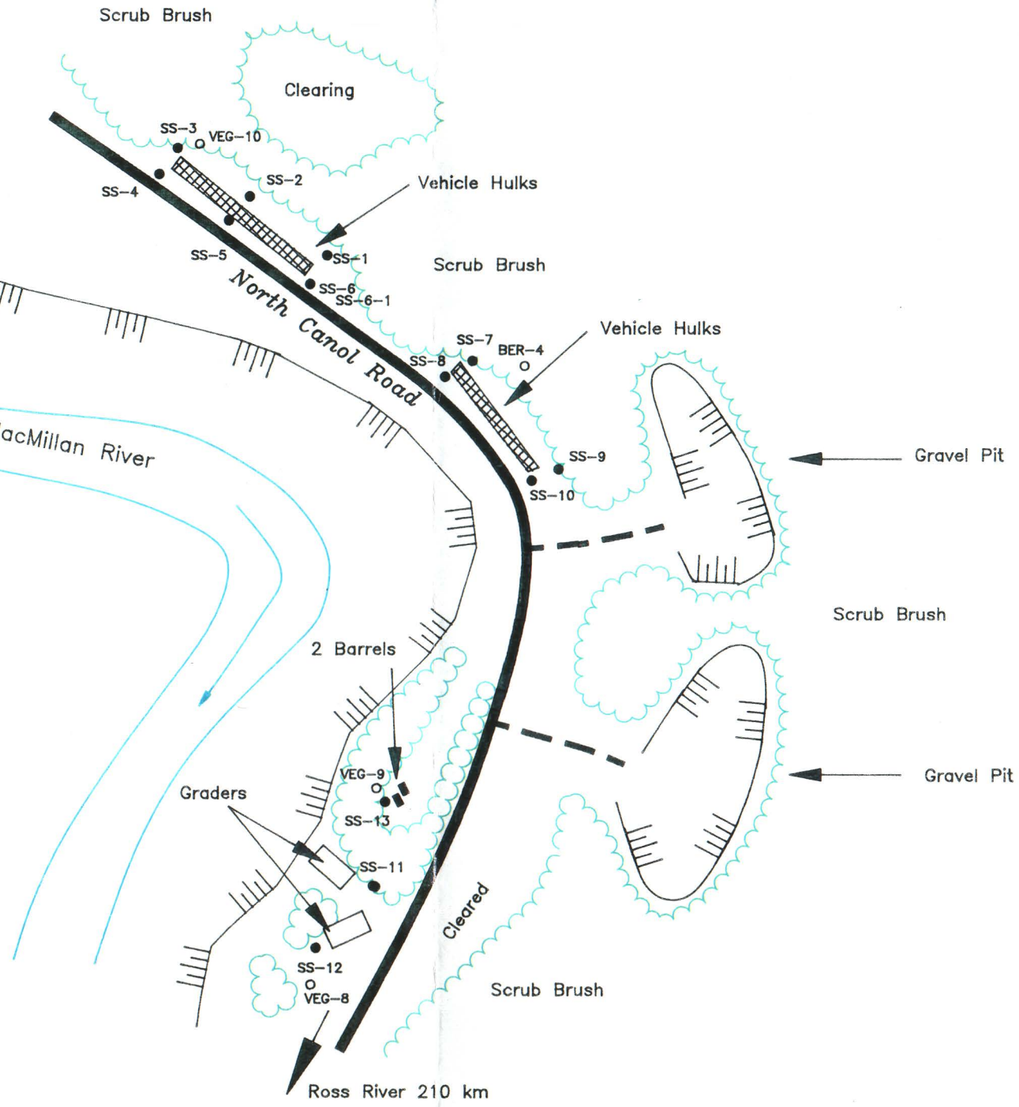
MILE POST 268 SITE LOCATION

Canol Road
Site Assessments

Gartner Lee

Figure No. 21

130 11 56



N

LEGEND

- Canol Road
- Secondary Road
- Abandoned Road
- Oil Staining
- Metal Debris
- Drainage Course
- Surface Water Flow
- Ponded Water
- Swamp/Bog
- Slope
- Tree Line
- Bedrock Outcrop
- SS-1 — Soil Sampling Location
- TP-1 — Test Pit Location
- 73-1 — Water Sampling Location
- BER-1 / VEG-1 — Vegetation Sampling Location

Scale 1:2000 (approximate)

0 10 20 40 60 metres

Drawn By: B. Belzac | Project No. 96769
Site Name: North Canol Road | File Name: D:\96769\769-268

SKETCH MAP MILE POST 268

Canol Road Site Assessments

Gartner Lee

Figure No. 22

Vegetation

The site itself has been cleared and much of the ground contains an irregular or sparse cover of ground cover such as Fireweed (*Epilobium angustifolium*), Dwarf Blueberry (*Vaccinium caespitosum*) and Club Moss (*Lycopodium annotinum*). Much of this area is un-vegetated due to the combination of surface disturbances and soil conditions which do not promote growth due to poor water retention capability. No evidence of vegetation stress was observed as dense thickets dominated by willows 2 to 5 m high, surrounded the site.

4.11. 2 Test Results

Field Testing and Observations

A total of 15 soil samples were field screened for organic vapours using the PID and 15 samples were also field screened for the occurrence of DDT using the immunoassay field kit. The results of both field screening procedures are presented in Table 3, starting on page 14.

Five of the 15 soil samples screened for organic vapours had concentrations slightly above background with concentrations ranging from 11 to 17 ppm.

Three of the 15 soil samples screened for the occurrence of DDT suggested positive results. The three samples had suggested concentrations of between 0.2 and 1.0 ppm.

Soil Chemistry

Selected soil samples were submitted to the analytical laboratory for analysis of potential contaminants of concern previously identified by K. Bisset and Associates. This section provides a summary of the analytical results with the complete results presented in Tables 4.11.1 and 4.11.2 in Appendix B.

Petroleum hydrocarbons were detected in five of the ten soil samples analyzed. Total oil and grease was detected in five of the samples, but at concentrations well below the Parkland criterion. HEPH were detected in two of the three samples analyzed at concentrations below the Parkland criterion.

Concentrations of metals detected in several of the soil samples exceeded the Parkland criterion. Arsenic concentrations in eight samples exceeded the criterion as did barium concentrations in five samples. Concentrations of cadmium, lead and zinc each exceeded the criterion in one sample.

Surface Water Chemistry

The site is located on a fluvial terrace approximately 15m above the South MacMillan River. The river is approximately 10 to 12m in width in the area of the site and is a fast flowing high gradient stream. Substrates were mainly boulders and cobbles with some finer gravels making up the sub-pavement. A reddish-brown staining was observed on many of the rocks in the river owing to the high dissolved mineral content of the water.

Vegetation Sampling

Three foliage samples of Fireweed and one fruit sample of Dwarf Blueberry were collected from this site. All three Fireweed samples showed elevated levels of barium and strontium compared to control samples. Complete analytical results are presented in Table 4.11.3 in Appendix B.

4.11.3 Discussion

Minor occurrences of hydrocarbons were detected in the soils of the site. The concentrations were all below the Parkland criterion.

Concentrations of metals, mainly barium and arsenic, were detected in several of the samples. These concentrations as well as elevated metal concentrations in the vegetation samples are likely attributable to the regional geochemistry.

4.11.4 Conclusions

Based on the findings of the site investigation, the following conclusions can be made:

a) minor occurrences of petroleum hydrocarbons were detected in the soils, however these concentrations are well within the Parkland criterion;
b) concentrations of several metals exceed the Parkland criterion which appear to be related to the naturally occurring levels of trace metals as shown by the regional geochemistry of this area.

4.11.5 Recommendations

The following recommendation is made based on the conclusions outlined above:

a) Based on the field observations and the analytical results, no further action is warranted at this site.

TABLE 4.11.1: SOIL CHEMISTRY - HYDROCARBON RESULTS

Parameter	CCME/ CMCS Parkland Criteria	CCME/ CMCS Industrial Criteria	B.C. Special Waste	Zenon ID : Sample ID : MDC	MP268 96025319 SS12	MP268 96025320 SS13	MP268 96025322 SS8	MP268 96025323 SS9	MP268 96025324 SS7	MP268 96025325 SS11	MP268 96025326 SS6-1	MP268 96025328 SS4	MP268 96025329 SS5	MP268 96025330 SS2
HYDROCARBONS														
TEH (C10 - C30)				5	19	11	—	—	—	—	—	—	—	—
TEH Heavy Oil (>C30)				5	34	28	—	—	—	—	—	—	—	—
EPH (C10 - <C19)	1000	2000		5	< 5	< 5	—	—	—	—	—	—	—	—
EPH (C19 - C32)	1000	5000		5	27	16	—	—	—	—	—	—	—	—
Oil & Grease Total	100	5000	30000	100	120	210	< 100	< 100	< 100	< 100	< 100	260	180	170

Notes:

1. All concentrations in mg/kg (ppm).
2. MDC - Method Detection Concentration.
3. 1000 Concentration exceeds Parkland criteria.
4. 5000 Concentration exceeds Industrial criteria.
5. 30000 Concentration exceeds B.C. Special Waste criteria.
6. — Parameter not determined.

TABLE 4.11.2: SOIL CHEMISTRY - METAL RESULTS

Parameter	CCME/ CMCS Parkland Criteria	CCME/ CMCS Industrial Criteria	Zenon ID : Sample ID : MDC	MP268 96025318 SS14	MP268 96025320 SS13	MP268 96025321 SS10	MP268 96025322 SS8	MP268 96025323 SS9	MP268 96025326 SS6-1	MP268 96025327 SS6	MP268 96025329 SS5	MP268 96025330 SS2	MP268 96025332 SS1
METALS TOTAL													
Aluminum			2	11400	3070	7730	8700	8390	10100	13100	9600	11500	10500
Antimony	20	40	2	2	2	2	< 2	3	3	3	3	16	3
Arsenic	30	50	8	28	32	30	37	34	33	27	30	35	37
Barium	500	2000	0.1	1310	64	754	103	257	280	1200	442	602	568
Beryllium	4	8	0.1	0.6	0.2	0.4	0.3	0.4	0.5	0.4	0.5	0.5	0.5
Bismuth			2	< 2	< 2	< 2	< 2	< 2	< 2	22	< 2	< 2	2
Cadmium	5	20	0.2	0.8	< 0.2	0.7	< 0.2	0.2	0.3	25.4	0.3	0.6	1.2
Calcium			1	767	60	1340	1110	1420	955	15900	668	809	709
Chromium	250	800	0.2	16.7	9.6	13.5	17.4	12.7	13.9	17.4	14.1	19	15.8
Cobalt	50	300	0.3	12.2	4.1	11.2	4.5	9.5	15.9	5.1	9.5	10.3	9.9
Copper	100	500	0.1	51.1	26.4	42.7	26.2	32.9	43.4	1080	41.6	47.9	47
Iron			0.3	29500	25300	23600	33600	22800	26200	23900	24400	29000	27500
Lead	500	1000	2	30	27	25	27	22	22	500	23	45	44
Magnesium			2	2660	440	1940	1790	1520	2140	1590	1990	2370	2070
Manganese			0.2	224	110	171	114	138	280	102	154	156	170
Mercury	2	10	0.05	0.09	< 0.05	0.08	< 0.05	< 0.05	0.06	0.05	0.08	0.08	0.13
Molybdenum	10	40	0.4	5.6	6.3	5	4.5	4.2	4.9	4.3	4.6	5.2	5.3
Nickel	100	500	0.8	37.8	19.9	32.7	22	27.8	45.6	24.5	35	40.3	37.6
Phosphorus			4	956	740	1100	1680	1320	1100	911	947	1110	1060
Potassium			40	924	345	682	451	404	537	400	529	722	580
Selenium	3	10	5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Silver	20	40	1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Sodium			1	28	12	28	13	17	15	98	20	25	23
Strontium			0.1	19.7	10.2	18.7	14.7	16.6	19	32.1	13.6	15.7	14.3
Sulphur			3	339	257	267	198	208	178	652	179	280	242
Tellurium			2	5	4	4	4	2	4	11	2	3	5
Thallium			1	3	2	1	< 1	< 1	< 1	2	< 1	< 1	< 1
Tin	50	300	2	< 2	< 2	< 2	< 2	< 2	< 2	15	< 2	< 2	< 2
Titanium			0.3	254	99.7	132	179	110	96.3	149	132	168	143
Vanadium	200		0.3	38.9	38.2	30.2	40.1	23	27	44.2	29.2	36.4	35
Zinc	500	1500	0.2	179	108	147	104	117	199	9960	158	173	201
Zirconium			0.3	0.8	< 0.3	0.6	1	1.8	1	< 0.3	0.5	0.3	0.9

Notes:

1. All concentrations in mg/kg (ppm).
2. MDC - Method Detection Concentration.
3. 500 Concentration exceeds Parkland criteria.
4. 2000 Concentration exceeds Industrial criteria.

(96769-1/14/97-MP268.XLS)

TABLE 4.11.3: VEGETATION CHEMISTRY - METAL RESULTS

Parameter	Zenon ID : Sample ID : MDC	MP268 96025343 VEG 8 Fw	MP268 96025344 VEG 9 Fw	MP268 96025345 VEG 10 Fw	MP268 96025346 BERRY 4 DB
METALS TOTAL					
Aluminum	2	179	216	120	222
Antimony	2	< 2	< 2	2	< 2
Arsenic	8	< 8	< 8	< 8	< 8
Barium	0.1	2050	976	994	64.2
Beryllium	0.1	< 0.1	< 0.1	< 0.1	< 0.1
Bismuth	2	< 2	< 2	< 2	< 2
Cadmium	0.2	< 0.2	< 0.2	< 0.2	0.3
Calcium	1	10300	12700	12000	1300
Chromium	0.2	1	0.9	0.8	0.8
Cobalt	0.3	< 0.3	0.4	< 0.3	< 0.3
Copper	0.1	11.3	6.5	5.8	4
Iron	0.3	507	149	106	19
Lead	2	< 2	2	< 2	< 2
Magnesium	2	3100	2180	3720	558
Manganese	0.2	72.7	171	164	115
Mercury	0.05	< 0.05	< 0.05	< 0.05	< 0.05
Molybdenum	0.4	< 0.4	< 0.4	< 0.4	< 0.4
Nickel	0.8	5.1	3.8	2.4	2.9
Phosphorus	4	935	1600	1430	1740
Potassium	40	3940	8150	10100	8630
Selenium	5	< 5	< 5	< 5	< 5
Silver	1	< 1	< 1	< 1	< 1
Sodium	1	58	63	63	19
Strontium	0.1	115	168	158	4.5
Sulphur	3	484	587	521	917
Tellurium	2	< 2	< 2	< 2	< 2
Thallium	1	< 1	2	4	4
Tin	2	< 2	3	< 2	< 2
Titanium	0.3	1.7	0.9	0.4	< 0.3
Vanadium	0.3	2.7	< 0.3	< 0.3	<
Zinc	0.2	65.4	67.5	106	24
Zirconium	0.3	< 0.3	< 0.3	< 0.3	< 0.3

Notes:

1. All concentrations in mg/kg (ppm).
2. MDC - Method Detection Concentration.
3. Fw - Fireweed.
4. DB - Dwarf Blueberry.

5.0 ADDITIONAL SITES

Two additional sites were visited during the site investigation phase of the program. One of these, MP 247, had initially been included in the original list of ten sites, and the second, located 0.5 km east of MP 124.5, was visited briefly after it was brought to the attention of the field crew by the local forestry fire crew. Each of these sites was observed to have minor issues associated with metal debris and refuse.

Anecdotal information provided by local residents indicated that there may be numerous other sites associated with the Canol Road project which have never been investigated. These sites reportedly include drum burial areas, dumps and old sawmills. The individuals who provided this information also stated that there may be up to 20 of these sites between Sheldon Lake and MacMillan Pass alone.

6.0 SUMMARY OF RECOMMENDATIONS

Complete recommendations on a site by site basis have been included in the subsections for each individual site in the main body of this report. The following table provides a summary of findings and recommendations for individual sites listed in order of priority for future action:

SITE	FINDINGS	RECOMMENDED ACTION
MP 234	A large area of surficial hydrocarbon staining as well as several buried full drums of oil were discovered.	Define burial area and remove affected soils.
MP 73	Several areas of surficial soil staining and occurrences of contamination at depth were discovered at this site as was an old camp dump.	Removal of affected soils and define dump area.
MP 124.5	Issues at this site include a UST with product and heavily contaminated shallow soils.	Pump out and remove UST, remove metal debris and affected soils.
MP 233	Isolated areas of shallow hydrocarbon contamination as well as surface water metals contamination were found at this site.	Removal of affected soils and investigate possiblity of dump site up slope.
MP 174	Contamination with hydrocarbons has affected the surficial and shallow soils at this site.	Remove affected shallow soils.
OLD ROSS	Two areas of metal and wooden debris were found at this site. Concentrations of two metals were found to exceed the Parkland criteria and one of the elements, arsenic, appears to be associated with the refuse.	Remove refuse to Ross River Landfill.
MP 213	A large camp formerly occupied this site and two isloated areas of shallow hydrocarbon contamination were found to exceed the the criteria. Immediate impacts are not predicted.	Remove affected shallow soils.
MP 212	A former dump site littered with a large amount of metal debris was found at this site. There are no indications of contamination.	Bury or remove metal debris.
MP 99.5	Very little evidence remains of a small camp once located on this site. Concentrations of contaminants did not exceed the Parkland criteria and no remedial action is required.	No action recommended.
MP 268	Several old vehicle hulks were found at this site. There appear to be no impacts on the site from past activities.	No action recommended.

Anecdotal information provided by local residents suggests that there may be several other waste sites located in Ross River Dena people's traditional territory. These sites should be investigated to confirm or refute this anecdotal information. The investigations could be performed concurrently with follow-up work on the 10 original sites.

Gartner Lee Limited recognizes that the conclusions and recommendations for each site should be assessed from the perspective of traditional lifestyles and knowledge of the Ross River Dena people.

Report prepared by:

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Hydrogeologist

7.0 REFERENCES

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APPENDICES

APPENDIX A

METHODOLOGIES

CANOL ROAD PROJECT FIELD METHODOLOGIES

Site Mapping

After a site walkover was completed, the extents of the site were defined and a baseline was laid out along the road using a compass and hip-chain. A grid perpendicular to the road was constructed (50 m spacing) and the grid lines were walked to accurrately locate site features. A 90 degree angle to the road was maintained using a compass and the distances to pertinent site features were read from the hip-chain. This information was recorded in field books in the form of sketches and after returning to camp in the evening proper maps of the day's activities were constructed.

Sampling

Soils

Soil samples were collected as both shallow surficial and deeper samples from test pits. The surficial samples were collected with small metal trowels and placed in sterile 250 mL glass jars with teflon lined lids. The samples were collected from near the surface by scraping away any organic matter to expose the mineral soils.

Test pits were excavated using a track-mounted backhoe. Depths varied up to 3 m. The test pits were logged in the field by a GLL hydrogeologist and observations pertaining to soil types and depths, ground water occurrences and indications of contaminants were recorded. Soil samples were collected from the walls and base of the test pits using a small metal trowel and were also placed in sterile 250 mL glass jars with teflon lined lids.

Each test pit was then backfilled with the excavated material and compacted as much as possible. Test pit and surface sampling locations were marked with flagging tape.
The sampling trowels were scrubbed clean and rinsed with distilled water between sampling points to prevent cross contamination of samples. The samples were stored in electric coolers while in the field and then transferred to coolers with ice for delivery to the analytical laboratory.

Vegetation

Selected vegetation samples (mainly low bush cranberry and Labrador tea) were collected and analyzed for metal concentrations to detect anomalous uptake levels. The samples were collected either by removing berries by hand or cutting off small areas of foliage with pruning shears. The shears were scrubbed clean with a soap solution and rinsed with distilled water between samples to prevent cross contamination. The samples were

placed in small, individual plastic bags, sealed and labelled. Sample locations were marked with flagging tape and then tied into the mapping grid.

The samples were then stored in electric coolers and then transferred to collers with ice for delivery to the analytical laboratory.

Surface Water

Surface water samples were collected at sites where surface water bodies (ponds, creeks) were found eother on the site or immediately bordering the site. Samples were collected in one litre amber glass sampling bottles and 250 mL plastic bottles. The glass bottles were used to collect samples to be analyzed for oil and grease and the plastic bottles were used in sampling for metals. The metals samples were preserved in the field with 1 mL of a nitric acid solution.Samples were collected by facing upstream and immersing the container in the water until full. Care was taken to avoid sampling in areas of turbidity.

Field Screening and Testing

Soils

Photoionization Detector

Soil samples collected at each site were screened in the field for organic vapour concentrations using a photoionization detector (PID). The jars were half filled with soil, shaken and allowed to stand for five minutes. The headspace above the soil was then analyzed with the pid. This methodology is consistent with the Jar Headspace Procedure outlined in Environment Canada's Technical Assistance Bulletin (TAB) No.1.

DDT Immuno-Assay Field Kits

Selected soil samples from each site (up to 16 per site) were screened in the field for the occurrence of the pesticide DDT. The screening kits used were manufatured by EnviroGard and allowed for semi-quantitative measurements of DDT concentrations in soil samples.

The process involved producing a soil extract with methanol and combining this with various reagents and substrates in test tubes, as directed by the instructions included in each kit. The final product was then analyzed with a portable photospectrometer to give relative concentrations as compared to calibrants provided with the kits.

APPENDIX B

PHOTOGRAPHS

PHOTOGRAPHS - CANOL ROAD SITE ASSESSMENTS
MP 73

PHOTOGRAPH 1

South Canol Road looking north. Km 120 post near centre of photograph.

PHOTOGRAPH 2

Gravel Creek flowing northwards along east boundary of site.

PHOTOGRAPHS - CANOL ROAD SITE ASSESSMENTS
MP 73

PHOTOGRAPH 3

Old foundation which was formerly occupied by pumping station.

PHOTOGRAPH 4

Rectangular berms located at north end of site.

PHOTOGRAPHS - CANOL ROAD SITE ASSESSMENTS
MP 73

PHOTOGRAPH 5

Underground storage tank located on west side of large foundation.

PHOTOGRAPH 6

Test pitting of soils in cleared area with surficial staining.

PHOTOGRAPHS - CANOL ROAD SITE ASSESSMENTS
MP 73

PHOTOGRAPH 7

Close-up of stained soils in cleared area. Note granular texture.

PHOTOGRAPH 8

Materials excavated from dump area on west side of Canol Road.

PHOTOGRAPHS - CANOL ROAD SITE ASSESSMENTS

MP 99.5 Lapie Lake

PHOTOGRAPH 9

Looking west at south half of site. Note heavy re-growth of vegetation.

PHOTOGRAPH 10

Looking west at north half of site.

PHOTOGRAPHS - CANOL ROAD SITE ASSESSMENTS
MP 124.5 Lapie River

PHOTOGRAPH 11

Canol Road looking north in area of site.

PHOTOGRAPH 12

Demonstration of benthic community sampling in Lapie River by Gartner Lee's David Green.

PHOTOGRAPHS - CANOL ROAD SITE ASSESSMENTS
MP 124.5 Lapie River

PHOTOGRAPH 13

Old foundation near east end of site.

PHOTOGRAPH 14

Large foundation near east end of site.

PHOTOGRAPHS - CANOL ROAD SITE ASSESSMENTS
MP 124.5 Lapie River

PHOTOGRAPH 15

Concrete pads from former above ground storage tank location.

PHOTOGRAPH 16

Old antifreeze can found in dump area, north of the road.

PHOTOGRAPHS - CANOL ROAD SITE ASSESSMENTS
MP 124.5 Lapie River

PHOTOGRAPH 17

Measuring tape indicating 14 inches of product remaining in underground storage tank.

PHOTOGRAPHS - CANOL ROAD SITE ASSESSMENTS
MP 124.5 Lapie River

PHOTOGRAPH 18

Underground storage tank located adjacent to large foundation.

PHOTOGRAPHS - CANOL ROAD SITE ASSESSMENTS
Old Ross Townsite

PHOTOGRAPH 19

Dump area located at base of small slope.

PHOTOGRAPH 20

Close-up of metal debris.

PHOTOGRAPHS - CANOL ROAD SITE ASSESSMENTS
Old Ross Townsite

PHOTOGRAPH 21

Close-up of metal debris in pit.

PHOTOGRAPH 22

Close-up of organic soils overlying coarse sands in TP-1.

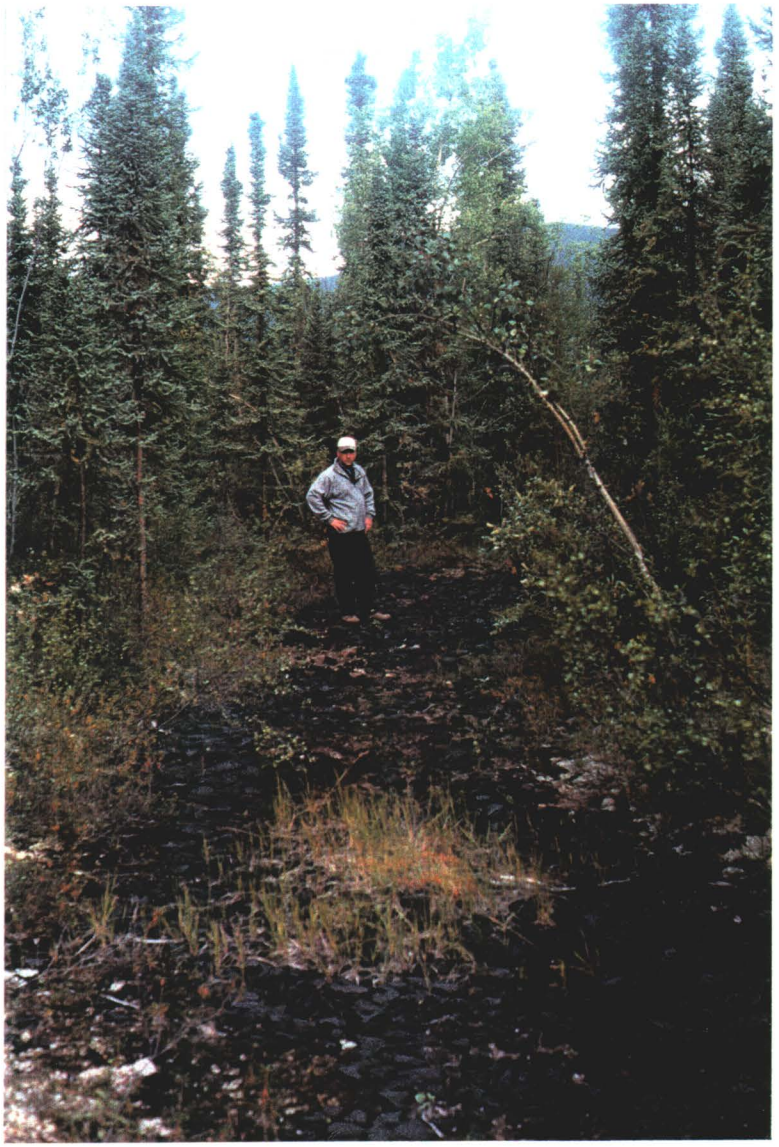
PHOTOGRAPHS - CANOL ROAD SITE ASSESSMENTS
MP 174

PHOTOGRAPH 23

Sampling of vegetation at MP 174.

PHOTOGRAPHS - CANOL ROAD SITE ASSESSMENTS
MP 174

PHOTOGRAPH 24



Area of solidified crude oil on surface.

PHOTOGRAPHS - CANOL ROAD SITE ASSESSMENTS
MP 174

PHOTOGRAPH 25

Sampling surficial soils in area of solidified oil.

PHOTOGRAPH 26

Test pitting shallow soils in area of solidified oil.

PHOTOGRAPHS - CANOL ROAD SITE ASSESSMENTS
MP 174

PHOTOGRAPH 27

Bear claw marks in piece of solidified crude oil.

PHOTOGRAPH 28

Collapsed wood frame pit on east side of road.

PHOTOGRAPHS - CANOL ROAD SITE ASSESSMENTS
MP 212

PHOTOGRAPH 29

Refuse area near centre of site.

PHOTOGRAPH 30

Close-up of metal debris.

PHOTOGRAPHS - CANOL ROAD SITE ASSESSMENTS
MP 212

PHOTOGRAPH 31

Close-up of metal debris.

PHOTOGRAPH 32

Test pit sampling of soils in refuse area.

PHOTOGRAPHS - CANOL ROAD SITE ASSESSMENTS
MP 212

PHOTOGRAPH 33

Refuse area with two large heavy equipment batteries.

PHOTOGRAPHS - CANOL ROAD SITE ASSESSMENTS
MP 213

PHOTOGRAPH 34

Gravelled areas on west side of road in burned-out area.

PHOTOGRAPH 35

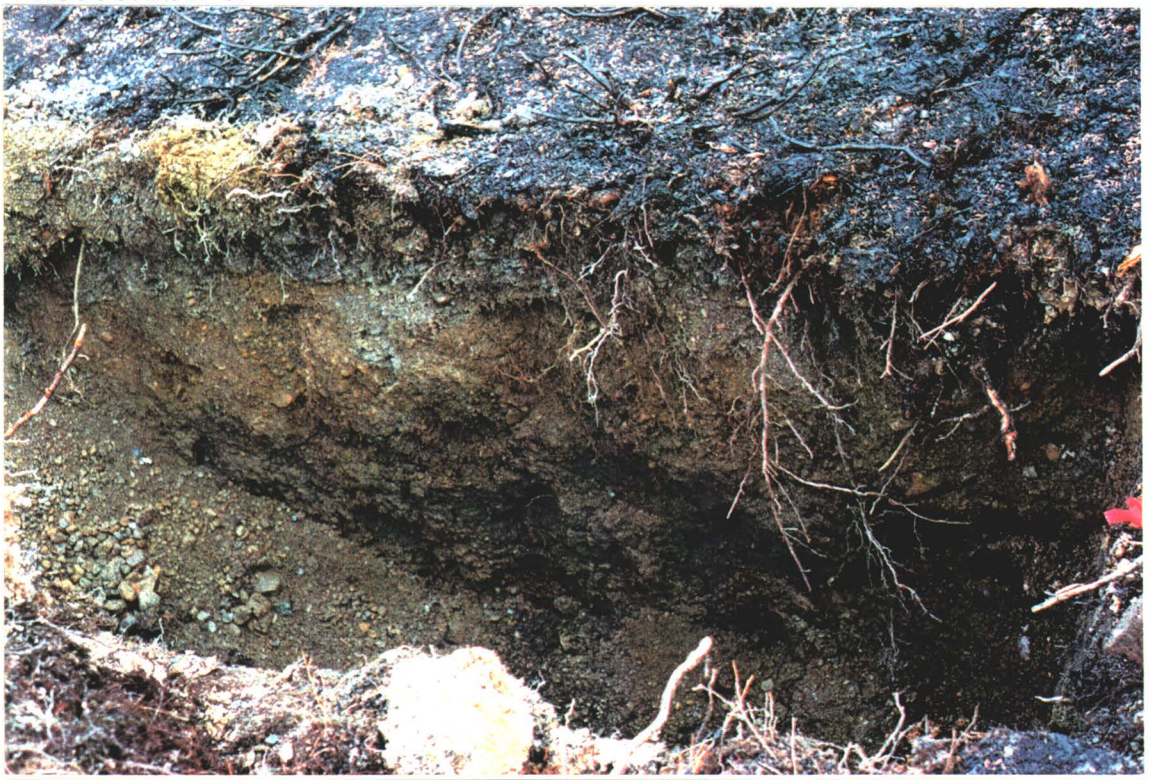
Burned-out wood frame structure.

PHOTOGRAPHS - CANOL ROAD SITE ASSESSMENTS
MP 213

PHOTOGRAPH 36

Searching for buried drums with metal detector.

PHOTOGRAPH 37



Test pit excavated during shallow soil sampling program.

PHOTOGRAPHS - CANOL ROAD SITE ASSESSMENTS
MP 213

PHOTOGRAPH 38

Logging soil types in test pit and sampling soils.

PHOTOGRAPHS - CANOL ROAD SITE ASSESSMENTS
MP 213

PHOTOGRAPH 39

Steel pipeline 2" diameter heading northwest down slope.

PHOTOGRAPHS - CANOL ROAD SITE ASSESSMENTS
MP 233

PHOTOGRAPH 40

Looking west along MP 233 site. Canol Road on right.

PHOTOGRAPH 41

Test pitting soils in front of rock face. Looking west.

PHOTOGRAPHS - CANOL ROAD SITE ASSESSMENTS
MP 233

PHOTOGRAPH 42

Test pitting soils along north side of Canol Road. Looking south from top of rock face.

PHOTOGRAPH 43

Ross River student, Rose Shorty, field testing water samples.

PHOTOGRAPHS - CANOL ROAD SITE ASSESSMENTS
MP 233

PHOTOGRAPH 44

Ross River student, Michael Dick, sampling surficial soils.

PHOTOGRAPHS - CANOL ROAD SITE ASSESSMENTS
MP 234

PHOTOGRAPH 45

Black stained surficial soils.

PHOTOGRAPH 46

Close-up of area of stained soils. Note partially buried drum in foreground.

PHOTOGRAPHS - CANOL ROAD SITE ASSESSMENTS
MP 234

PHOTOGRAPH 47

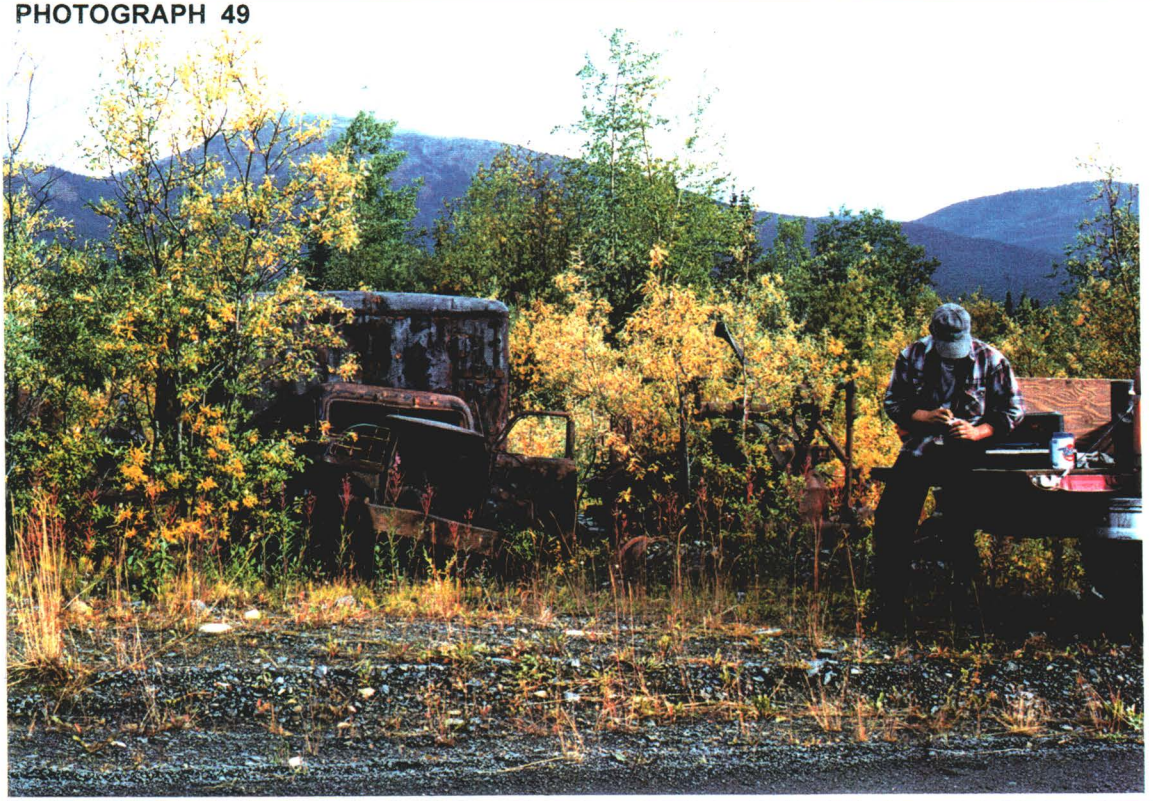
Excavating test pits in impacted areas. Note crushed drums on surface. These were encountered while digging.

PHOTOGRAPH 48

Close-up of crushed drum excavated in test pit. Note bungs still in place indicating drum may have been full at time of burial.

PHOTOGRAPHS - CANOL ROAD SITE ASSESSMENTS
MP 234

PHOTOGRAPH 49



Bruce Thomson preparing sample jars in front of vehicle hulks.

PHOTOGRAPH 50

Ross River elder collecting surficial soil sample.

PHOTOGRAPHS - CANOL ROAD SITE ASSESSMENTS
MP 268

PHOTOGRAPH 51

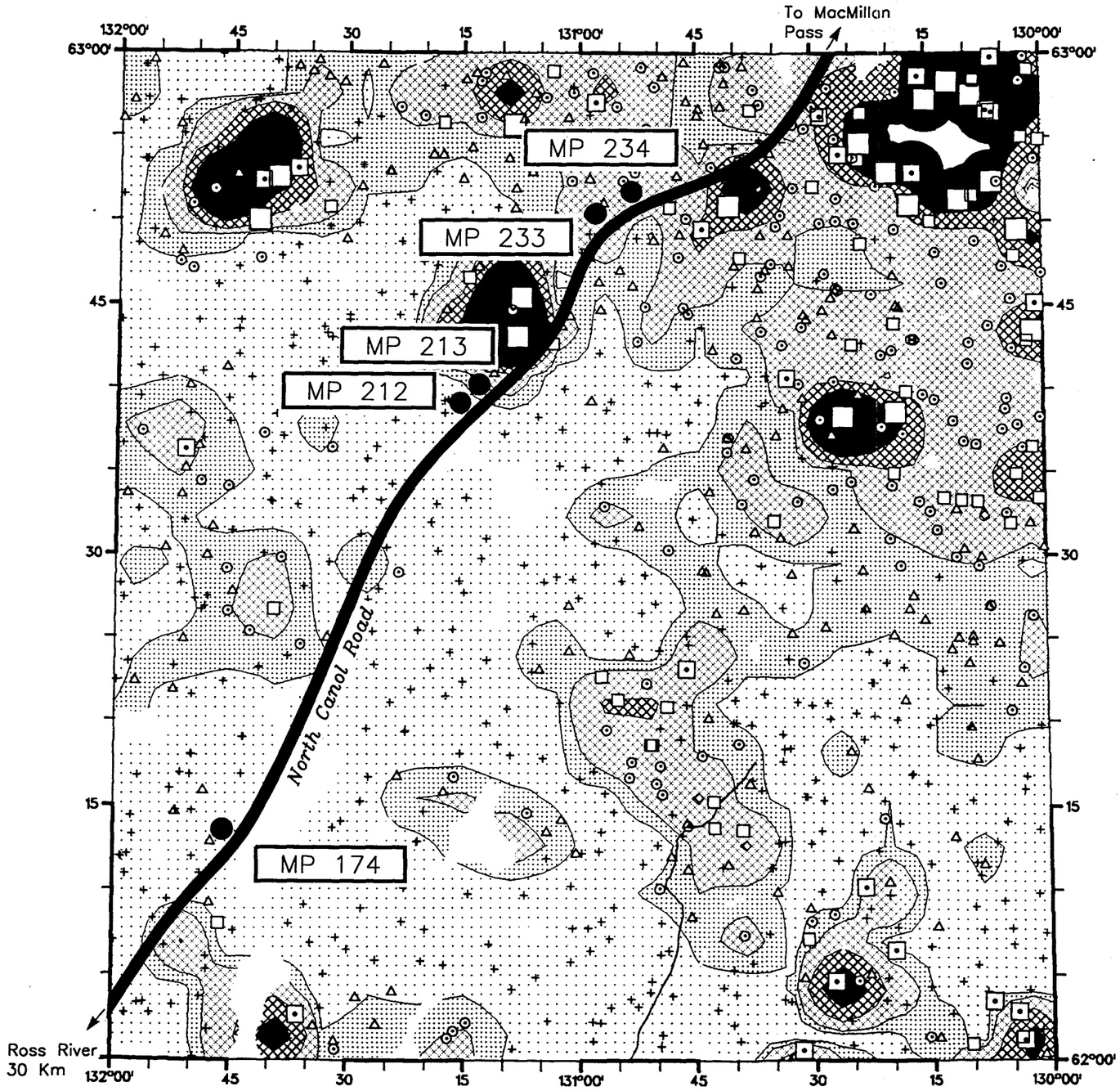
Vehicle hulks along the North Canol Road. Looking north.

PHOTOGRAPH 52

Close-up of vehicle hulk.

APPENDIX C

REGIONAL GEOCHEMISTRY OF SELECTED ELEMENTS



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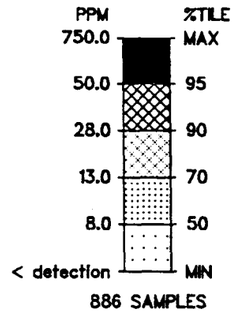
IN
STREAM SEDIMENTS

PPM		%TILE
750.0 -	□	- MAX
80.0 -	⊡	- 98
50.0 -	□	- 95
28.0 -	⊙	- 90
13.0 -	△	- 70
8.0 -	+	- 50
< detection -		- MIN

886 SAMPLES



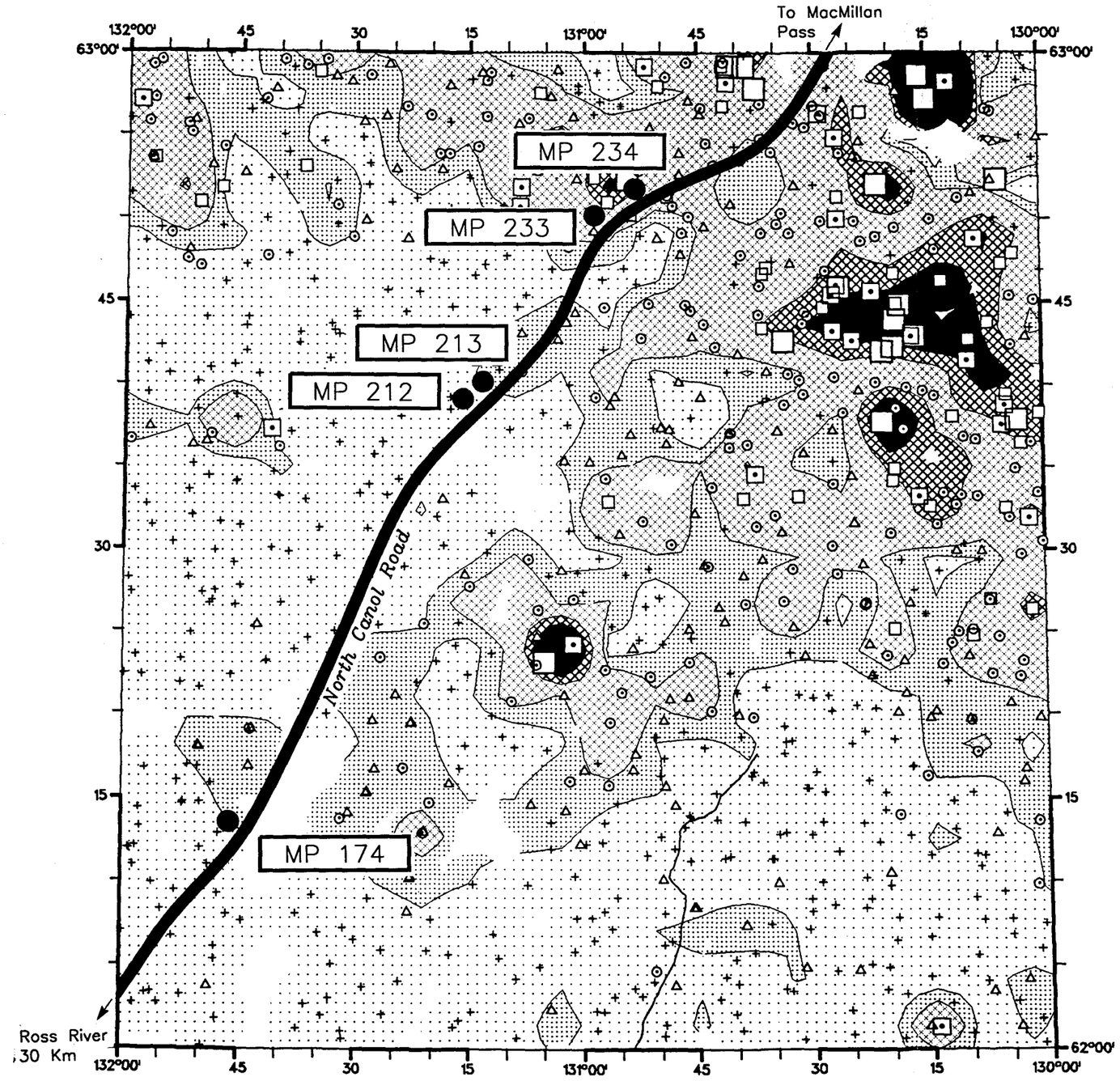
0 5 10 15 20 KM

● SITE LOCATION

Source:
GSC Open File 2173, Canada—Yukon Economic Development Program (1989—1990)

File: E:/96769/GEOCHEM.DWG

ARSENIC	
Canol Road Site Assessments Background Geochemistry	
Gartner Lee	Figure No. C—1

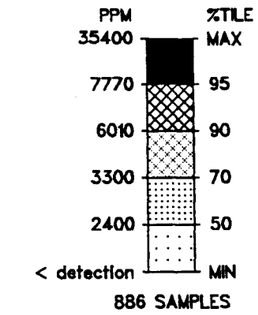


YUKON 1990
NTS 105J

BARIUM–INA
IN
STREAM SEDIMENTS

PPM		%TILE
35400 -	□	- MAX
10300 -	⊡	- 98
7770 -	□	- 95
6010 -	⊙	- 90
3300 -	△	- 70
2400 -	+	- 50
< detection -		- MIN

886 SAMPLES



0 5 10 15 20 KM

● SITE LOCATION

Source:
GSC Open File 2173, Canada–Yukon Economic Development Program (1989–1990)

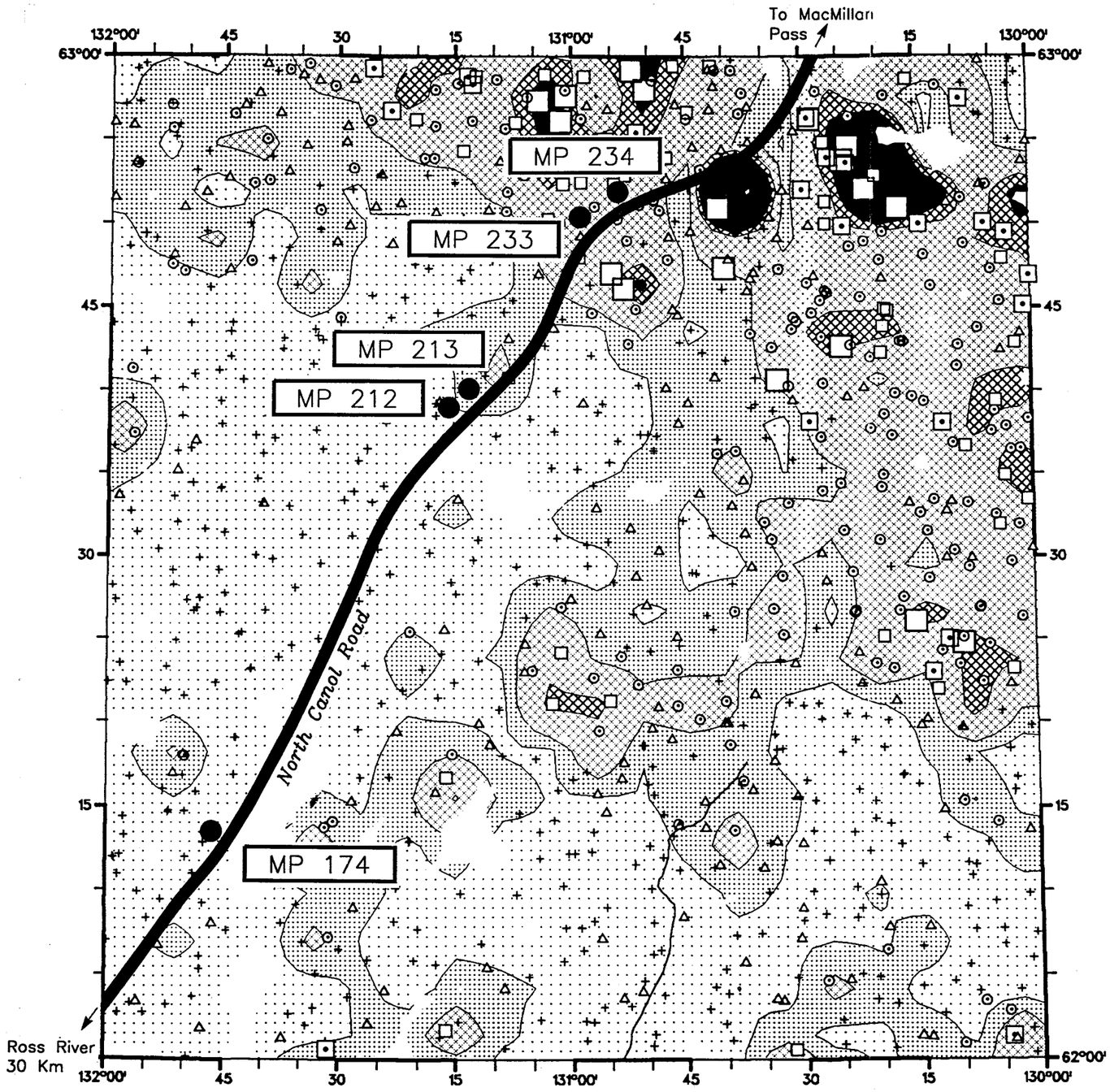
File: E:/96769/GEOCHEM.DWG

BARIUM

Canol Road Site Assessments
Background Geochemistry

Gartner Lee

Figure No. C–2



YUKON 1990
NTS 105J

CADMIUM--AAS
IN
STREAM SEDIMENTS

PPM		%TILE
51.7 -	□	- MAX
14.2 -	⊡	- 98
11.2 -	□	- 95
8.7 -	⊙	- 90
3.6 -	△	- 70
1.6 -	+	- 50
< detection -		- MIN

886 SAMPLES

PPM	%TILE
51.7	MAX
11.2	95
8.7	90
3.6	70
1.6	50
< detection	MIN

886 SAMPLES

0 5 10 15 20 KM

● SITE LOCATION

Source:
GSC Open File 2173, Canada–Yukon Economic Development Program (1989–1990)

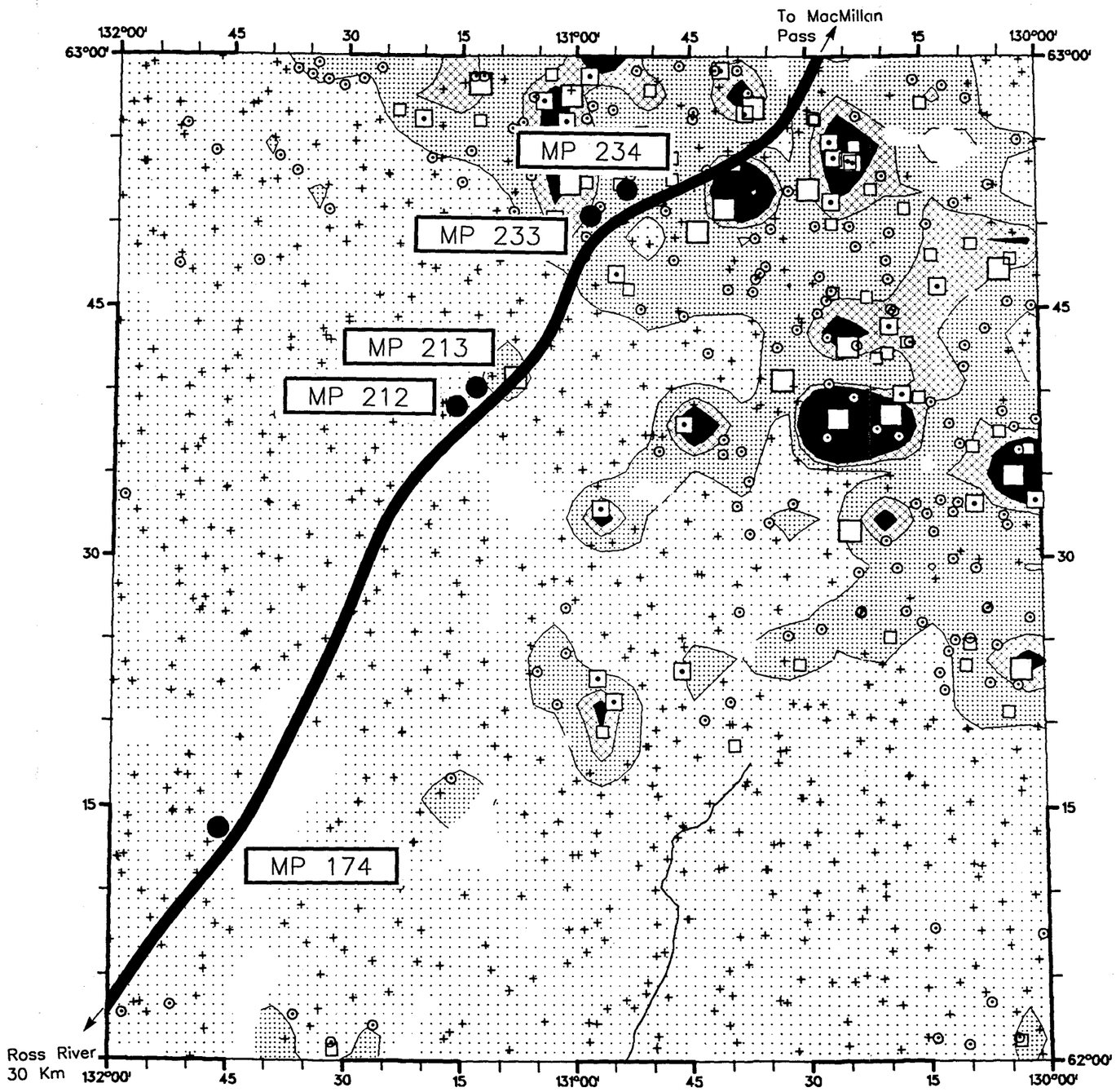
File: E:/96769/GEOCHEM.DWG

CADMIUM

Canol Road Site Assessments
Background Geochemistry

Gartner Lee

Figure No.
C–3

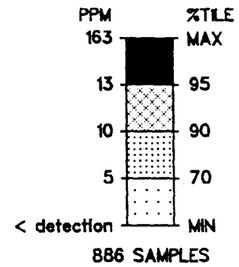


YUKON 1990
NTS 105J

MOLYBDENUM–AAS IN STREAM SEDIMENTS

PPM		%TILE
163 -		- MAX
20 -		- 98
13 -		- 95
10 -		- 90
5 -		- 70
< detection -		- MIN

886 SAMPLES



0 5 10 15 20 KM

● SITE LOCATION

Source:
GSC Open File 2173, Canada–Yukon Economic Development Program (1989–1990)

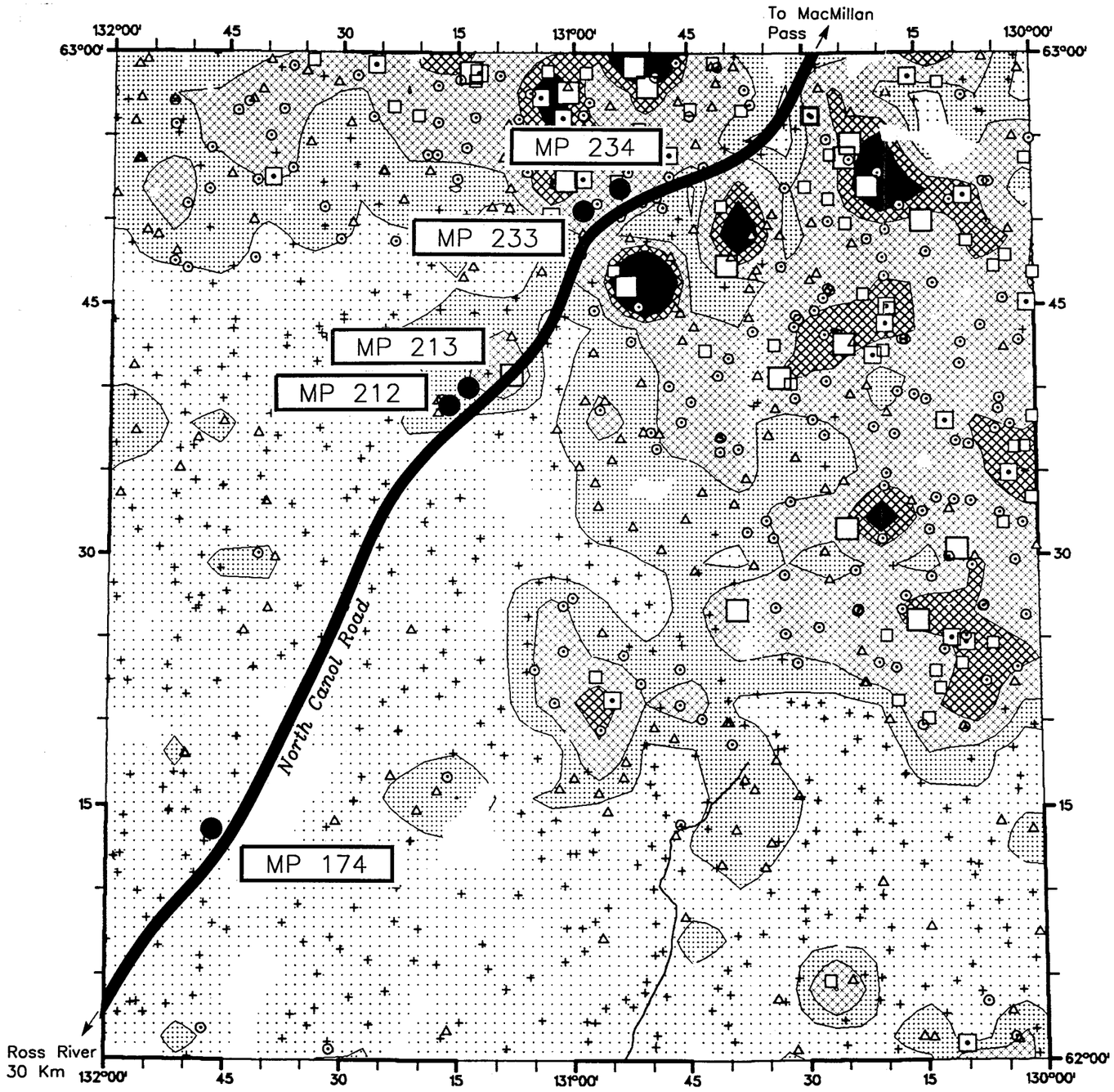
File: E:/96769/GEOCHEM.DWG

MOLYBDENUM

Canol Road Site Assessments
Background Geochemistry

Gartner Lee

Figure No.
C–4



YUKON 1990
NTS 105J

NICKEL–AAS
IN
STREAM SEDIMENTS

PPM	%TILE
741 -	- MAX
203 -	- 98
152 -	- 95
114 -	- 90
63 -	- 70
37 -	- 50
< detection -	- MIN

886 SAMPLES

PPM	%TILE
741	MAX
152	95
114	90
63	70
37	50
< detection	MIN

886 SAMPLES

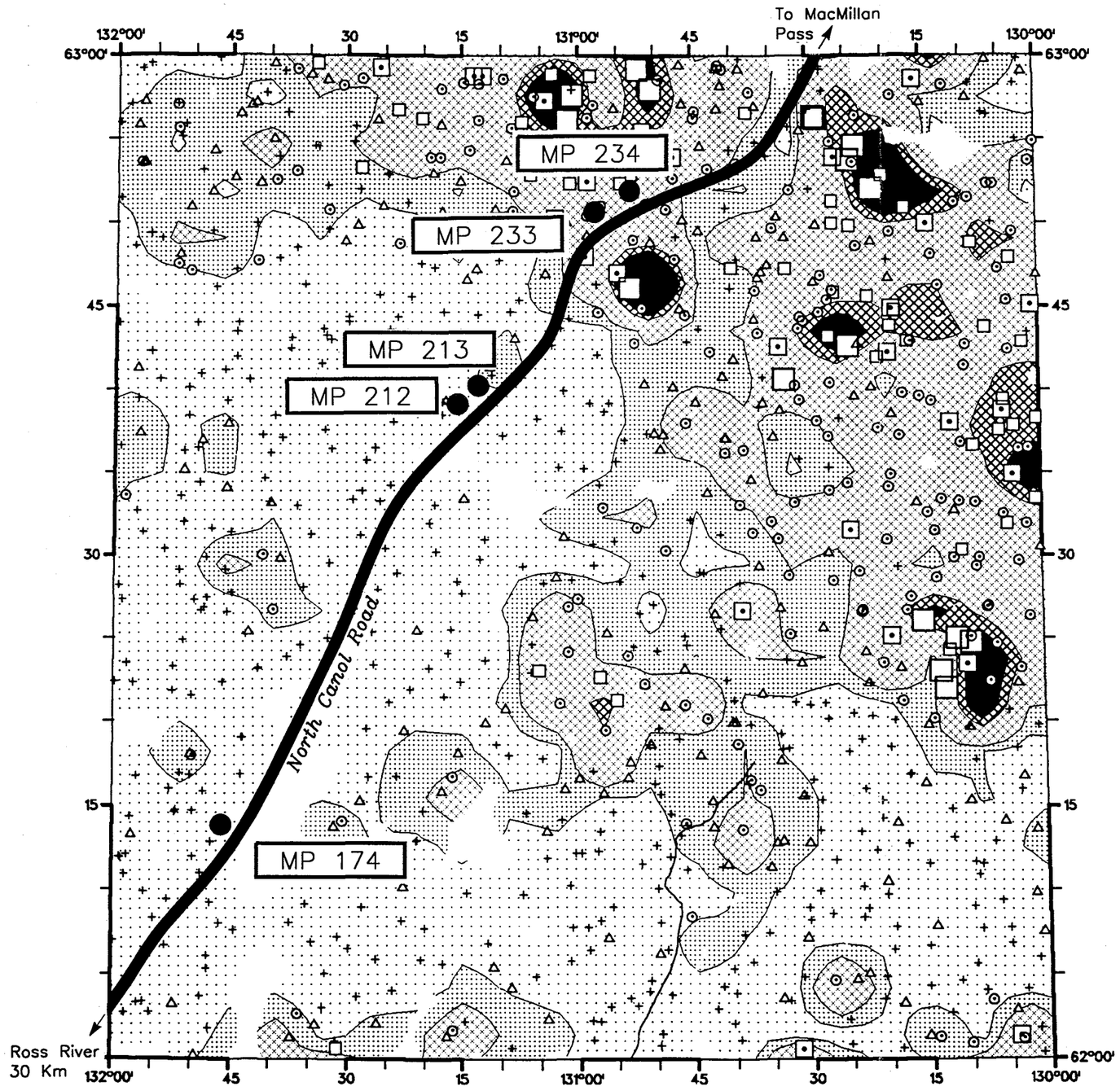
0 5 10 15 20 KM

● SITE LOCATION

Source:
GSC Open File 2173, Canada–Yukon Economic Development Program (1989–1990)

File: E:/96769/GEOCHEM.DWG

NICKEL	
Canol Road Site Assessments Background Geochemistry	
Gartner Lee	Figure No. C–5



YUKON 1990
NTS 105J

ZINC–AAS
IN
STREAM SEDIMENTS

PPM	%TILE
5060 -	- MAX
1520 -	- 98
1130 -	- 95
906 -	- 90
334 -	- 70
198 -	- 50
< detection -	- MIN

886 SAMPLES

PPM	%TILE
5060	MAX
1130	95
906	90
334	70
198	50
< detection	MIN

886 SAMPLES

0 5 10 15 20 KM

● SITE LOCATION

Source:
GSC Open File 2173, Canada–Yukon Economic Development Program (1989–1990)

File: E:/96769/GEOCHEM.DWG

ZINC	
Canol Road Site Assessments Background Geochemistry	
Gartner Lee	Figure No. C–6