PRELIMINARY ENVIRONMENTAL INVESTIGATIONS
of
EXISTING WASTE SITES
in the
YUKON TERRITORIES

SITE 19 - CRACKER CREEK HJ-33
SITE 20 - CANYON CREEK HJ-34
SITE 42 - HAYES CREEK NORANDA CAMP - CA 35

prepared for

INDIAN AND NORTHERN AFFAIRS CANADA

under

CONTRACT NO. 96-6129

FINAL REPORT
March 1997

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Executive Summary

An intensive preliminary environmental investigation was undertaken of three sites in the Yukon at the request of Indian and Northern Affairs Canada in the fall of 1996. This work was undertaken as part of the Action on Waste Program with the general purpose being to investigate these sites in greater detail in order to allow environmental and ecological risk assessments and to make recommendations regarding remediation.

MDA staff worked on-site with local personnel to complete the field work in late September and early October, 1996. Field work included the detailed topographical site surveys, geophysical surveys as required, preparation of site inventories, excavation of test pits, field screening of soils for PCBs, other ionizable contaminants and for volatile organic compounds (VOCs). Water and soil samples also were collected for further laboratory analysis. Property ownership information and historical data, including air photos were used with the results of the field and analytical data to prepare the final report and to make recommendations regarding remediation based upon risk assessment and risk reduction.

The three sites investigated as part of this work were:
- Site 19 - Cracker Creek
- Site 20 - Canyon Creek; and
- Site 42 - Hayes Creek Noranda Camp.

Sites 19 and 20 are former military camps and highway maintenance camps along the Alaska Highway and these sites are complex. Site 42 is a mining camp that has probably been in use periodically over the past 40 to 50 years.

Interestingly, although the wastes at sites 19 and 20 were scattered over large areas with some obviously concentrated disposal sites, the number of site-specific locations that indicated possible chemical contamination were very limited. Thus the actual amount of soil sampling and screening was considerably less than had been originally anticipated. This was fortunate, as the aerial extent of these two sites was much greater than had been suggested in the background reports that had been provided.

Site 19 - Cracker Creek exhibits extensive buried debris and some limited surface debris. This was confirmed through non-intrusive geophysical surveys and the excavation of shallow test pits. Nevertheless, there was no indication of chemical contamination of the soils here, based upon the results of the field screening techniques for PCBs and other ionizable contaminants and for VOCs, probably because much of the debris is metallic kitchen and vehicle waste. The one location where crushed drums were visible did not give rise too any indications of contamination of liquids leaking from these containers. Moreover, the silty/clay nature of the soils at this site, would tend to limit subsurface migration of any contaminants off site or downward into underlying aquifers. Cracker Creek, the local surface water is generally >500 m from the nearest burial site and migration of material from a burial site is not expected to be a concern to the surface water quality. Previous work has done a great deal to bury unsightly wastes, which from our evidence appear to be environmentally benign. Using this information in a qualitative way

for the Screening Level Assessment (SLA), **we conclude that there is no need for remediation at this site.**

Greater contamination, especially from hydrocarbons, may be evident in and about the old buildings of the maintenance camp but as these are now on private property (that of Mr. Boland) this area was outside of the purview of this investigation. **Also, although it is not considered a risk, we would recommend that the previously excavated portion of sub-site 19A be filled. We also recommend that the work at sub-site 19A be performed manually to minimize further disturbance of the vegetation. Debris at sub-site 19E should be removed and disposed of at an appropriate landfill.**

Site 20 - Canyon Creek is a large and complex site. It consists of numerous burial and surface disposal sites most of which are located a considerable distance (> 1 km) from the local surface water, Aishihik River. In contrast to Site 19, the soils in the vicinity of Site 20 tend to be coarser and generally lack the fine silty matrix. Consequently, the potential for off-site migration and subsurface contamination is increased. Nevertheless, of the waste sites away from the river (specifically the CANOL Pumping Station C (sub-site 20A), the triangular area on the south side of the Alaska Highway referred to here as sub-site 20B), it is our conclusion that these sites primarily contain metallic and other debris based upon the electro-magnetic survey . Based upon the field screening of soil samples, we were unable to identify any contaminants at concentrations that would suggest a concern at these sites. **We therefore conclude that remediation is not required at sub-sites 20A and 20B.**

Nevertheless, several parts of sub-site 20B contain quantities of surface debris which could be removed to an approved landfill for aesthetic reasons. This, however, is not an environmental concern of consequence. We also note that re-vegetation about this site is generally slow especially in areas where burning has occurred. This may be due to the loss of the organic matter from the burn layer. **We would therefore caution against site burning as a means of eliminating unsightly surface flammable matter at this site.**

Sub-sites 20C and 20E represent two distinct areas that were investigated as part of this study. Sub-site 20C is an area close to the current Alaska Highway along a former right of way that clearly received extensive dumped debris. The geophysical survey of this site was negative with respect to metallic debris suggesting that this was a disposal area of strip material from one of the highway reconstruction works. **Sub-site 20C, therefore, is not an environmental hazard and poses no foreseeable risk and is best left to continue the revegetation process.**

Sub-site 20E, the site of the old Highway Lodge, is still evident and is receiving minor quantities of modern wastes (e.g. tricycles, other metal debris). Without a detailed survey of the lot containing the commercial business operated by Mr. Beecher, we would not be able to establish unequivocably whether or not this site is on private property. Without this clarification we were unable to proceed with a site specific survey; nevertheless, the visual inspection of this site indicated that it is more likely to be an aesthetic concern than to pose an environmental risk. **Any subsurface risk is further mitigated by the distance of this site (> 1 km) from Aishihik River, the nearest surface water, and thus our SLA suggests no need for remediation. We**

do however recommend that the ownership of this site be defined and the owner (we expect it is now privately owned) encouraged to remove the debris and re-vegetate the site.

Two areas in site 20 are located close to the Aishihik River. The first, referred to here as the Military Dump (sub-site 20D) was expected to be a potential problem; however, the soil field screening for PCBs, other ionizable substances and VOCs as well as the analytical laboratory analysis of selected soil and water samples, did not indicate an obvious and immediate concern. Groundwater collected from shallow pits at the toe of the dump had concentrations for most analytes higher than in the surface water samples from Aishihik River. Chromium, copper, iron and manganese all exceeded either the surface water quality guideline for the protection of aquatic life and/or the raw water supply for drinking water (CCME, 1987). It should also be noted that the concentrations of aluminum and silicon are also high and the abundance of these in alumino-silicate minerals (e.g. feldspars and clays) suggests that these elevated concentrations may all be typical of groundwater in the area. Additional work using stable isotopes would be required to further determine the nature of these groundwaters, including their approximate age, and this was beyond the scope of the current work. While some of the water chemistry data may be higher than guidelines, there is no clear evidence that these groundwaters are being contaminated by landfill leachate. This could only be confirmed through a more intensive investigation at this site including the installation of test well upstream of the landfill. However, based upon the water quality data of the Aishihik River and other data from this investigation we do not think that this work is warranted at this time. Ongoing monitoring of water quality at the toe of the dump, consisting of large volume water samples to reduce the detection limit below the limit of solubility for these compounds, would determine the presence of chlorinated organic compounds and hydrocarbons in the water. A minimal program conducted every few years, with several samples collected at the toe of the dump during the summer season is recommended. **Based upon this information, the SLA for this site does not indicate the need for remediation of this site.**

The priority of a monitoring program for this site would have to be evaluated relative to other Yukon sites and in the context of INAC's budget to determine if there was sufficient concern to undertake such a monitoring program. We would not consider this site, even in the context of this study alone, as a high priority for monitoring.

Two other sub-sites are worthy of mention here as they can be considered new sites. The first, sub-site 20B-18, is a clearing between the roadway and the other waste sites in sub-site 20B. This site was not inspected as there was no obvious access to it. However, it is suspect only because of the tendency to find other waste disposal sites in natural or man-made clearings. **This is the largest clearing in the area and we recommend that the site be visually inspected to determine if it is a natural clearing with no waste.**

Another site at Canyon Creek, upstream of the military dump and on the north side of the Alaska Highway appears to have been extensively disturbed over a long period of time based upon the air photo study undertaken. Unfortunately, MDA staff could not find access to this site without crossing clearly posted private property and thus the site was not inspected and surveyed. Access would appear to be possible, at least on foot, along the electrical power corridor. This new site inspection is considered a priority as sub-site 20D was apparently not used until sometime after 1964 and consequently there must be an additional, as yet unexplored waste disposal site near this camp. We consider sub-site 20B to be too far away and too small for 20 years of refuse from a significant camp. On a positive note, the biological assessment of the Aishihik River, for which the upstream sampling site was adjacent to or downstream of this un-investigated area, was characterized by species indicative of clean water, thus indicating that the concern is not immediate, if there are any significant impacts at all. Ownership and access rights to this property would have to be clearly established prior to undertaking any work on this site. Ownership is complicated by the fact that the lot in question is indicated to be subject to a land claim but there is also a large building on part of the property. **The length of time that this site was worked (early 1940s through to at least the mid-1960s), its proximity to the base and its proximity to the Aishihik River, leads us to strongly recommend that an intensive follow-up investigation be undertaken of this new site prior to making a final decision on the results of the SLA status of Site 20 - Canyon Creek.**

The findings from this new site investigation would also be relevant to the importance placed in a monitoring program on the military dump (sub-site 20D) as discussed above. If this new site is a major disposal area, it is possibly of greater concern than the military dump site (sub-site 20D).

The sub-sites of **Site 42 - Hayes Creek Noranda Camp** are a little more complex due to the site physiography and the fact that at least certain parts of the site are apparently still in active use. Of the three sites investigated in this assessment, this site requires the greatest attention with respect to removal and cleanup of surface debris provided that the site is no longer subject to a mineral claim and is no longer in use. Due to the access difficulties to this site, however, this is not a trivial task. This debris could pose both an environmental quality hazard as well as possible physical danger to wildlife and humans (although it is a remote site). This is exclusive of the explosives found on the site, which to our understanding, have been or will be removed.. As well, the cleanup is not likely to be an INAC responsibility due to the ongoing mineral claim on this site and the clear ownership trail to this equipment and debris. The company responsible for the present conditions should be required to undertake the clean-up. As a result we do not provide Class "C" cost estimates for this site. We would be pleased to do so if requested by INAC.

While extensive surface debris is present, the extent of contamination apparently from hydrocarbons and waste oils is quite restricted spatially. Contaminated soils in the vicinity of the bulldozer are the most noteworthy. This is the only instance of contamination that was indicated by the field screening techniques and verified by the laboratory analyses. This soil had concentrations of Phenanthrene that exceed the current Ontario Surface Soil Criteria for this compound as well as the CCME Interim Criteria for Soil. The compound 1-methylnaphthalene, was also high but there are no guidelines for this compound. These guidelines are intended to protect potable groundwater and thus are not directly applicable to an SLA using aquatic populations as the VEC. Our inspection indicated the volume of contaminated soil to be small (one cubic metre or less) and thus this mass of contaminant would be quickly diluted if it reached surface waters. **We suggest that the removal of this soil is not a priority; however, we recommend that the contaminated soil be removed at the time the site is cleaned up, as the**

equipment is there to do so and we anticipate the additional costs will be minimal.

The greatest environmental impact on this site is likely the physical disturbance of the creek bed from placer mining and access via tracked vehicles. Nevertheless, there is very little that can be done about this now and, in the overall context of the watershed, the disturbed site represents only a small area.

1. INTRODUCTION

At the request of Indian and Northern Affairs Canada (INAC), MDA undertook preliminary environmental investigations under Standing Offer Contract No. 96-6129 for three sites in the Yukon Territory, specifically:

- AES-AOW Site No. 19 - Cracker Creek at mile 987.5 of the Alaska Highway;
- AES-AOW Site No. 20 - Canyon Creek comprised of several sites between miles 995.5 and 1000.0 on the Alaska Highway; and
- AES-AOW Site No. 42, the Hayes Creek Noranda exploration camp.

The investigation of these three sites has followed the Preliminary Environmental Site Investigation Strategy (PRESIS) outlined in Figure 1. This included a review of historical data in the form of aerial photographic records, land ownership, etc. This initial review helped focus the remainder of the investigation and created a "short list" of possible chemical contaminants which in turn created priorities for the initial field pre-screening. Nevertheless, the PRESIS had to remain flexible to allow for the actual conditions identified in the field whether or not this was a worse situation, or a more positive situation, than had been anticipated.

Physical site assessment, as outlined in Figure 1, included site observations, detailed mapping surveys of the site, analysis of remotely sensed data and historical data, geophysical surveys and test pits etc. Control surveys based on locally derived grids have been transferred to mapping grade UTM (universal transverse mercator) projections and include permanent site references and benchmarks for future uses. All mapping has also been presented digitally in an AutoCad format which is readily incorporated into most existing geographic information systems.

Through MDA's extensive experience with Arctic environmental projects, we are very cognizant of the concerns about terrain and biological disturbance of sensitive northern environments. We therefore adopted the use of highly portable equipment, and non- or minimally-intrusive techniques to do this work. Specifically, geophysical techniques were used extensively to identify and investigate subsurface targets. This permitted the use of hand excavated pits at target sites minimizing the environmental impact, providing quick and efficient confirmation of

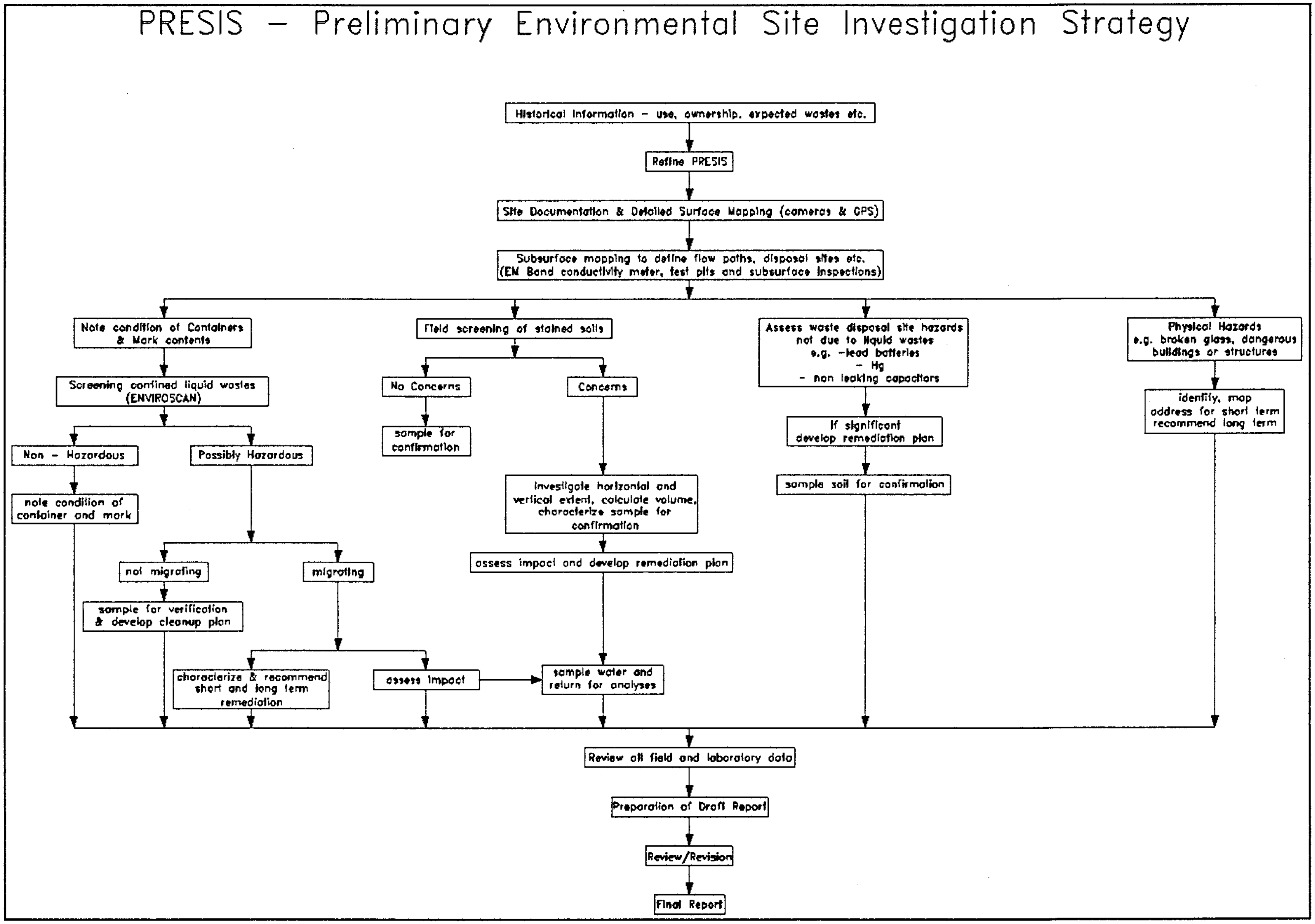


Figure 1: Outline of the Preliminary Enviromental Site Investigation Strategy (PRESIS) used to guide the work for each site

the geophysical data, and providing appropriate subsurface samples. This is both cost-effective and environmentally responsible at Arctic sites and was essential at the Hayes Creek Noranda Camp site due to the fact that access to this site was by helicopter.

Reconnaissance of contaminated sites involves the identification of areas with a high probability of contamination, confirming the presence, nature and magnitude of the contamination, and then formulating a suitable remediation program. The importance of this initial reconnaissance phase cannot be over-emphasized, as the information it yields largely determines the magnitude and direction of the entire remediation effort.

Traditionally, field site reconnaissance has primarily involved the collection of soil and water samples, although samples of other media may also be acquired as necessary. Samples are usually transported to off-site analytical laboratories for detailed analyses and such analyses usually yield accurate and precise data. Unfortunately, high laboratory fees, slow return of analytical results, and the procedures inherent in transporting potentially hazardous materials can make detailed site investigations cumbersome due to the fact that real time data are not available and costs escalate due to the need to revisit sites after completing the chemical analysis. As a result, more money is often spent in remediation than may initially be required if the site had been surveyed in detail.

Field site investigation using fast, low cost, on-site sample pre-screening has several virtues. Although not intended to replace high-accuracy laboratory analyses, the screening of soil samples in the field can significantly increase reconnaissance program efficiency. Sample screening can quickly and confidently delineate areas warranting detailed investigation. Precise delineation of priority areas during the early stages of the reconnaissance program can optimize the expenditure of resources otherwise used inefficiently in "hit and miss" sample collection and analysis. MDA has made extensive use of field screening technologies to enhance the quality of the information collected and to reduce the costs

2. DESCRIPTION OF SITES

Sites AES-AOW No. 19 - Cracker Creek and AES-AOW No. 20 - Canyon Creek, are related to military activities during the construction of the Alaska Highway, subsequent highway maintenance and the CANOL pipeline. As such, activities at these two sites are quite different with respect to their geography, setting and probable contaminants when compared to AES-AOW Site No. 42, the Hayes Creek Noranda exploration camp. These differences were noted as part of the planning for these investigations and have been considered during the development of the investigation strategy. The general location of the three sites are shown in Figure 2.

2.1 Site No. 19- Cracker Creek

The Cracker Creek site consists of a large military camp and dump-site generally located at mile 987.5 of the Alaska Highway (Figure 3). The site has apparently been cleaned up pursuant to C.E. Eedy's assessment of 1976 and it is our understanding that this cleanup was limited to the removal of surface debris such as barrels and car bodies. It is our further understanding that there was no testing for contaminants at that time. This site was operated from 1942 to the 1960's (Laberge Environmental Services, 1993).

This site is located in the Subalpine Northern Cordilleran Ecoclimatic Region (Ecoregions Working Group, 1989). Summers are cool and winters are very cold. Average precipitation is of the order of 400 to 600 mm, with June through August being the wettest months. Vegetation at these sites is dominated by stands of black spruce with understories of Labrador tea, cottongrass, sedge, moss and lichen.

Soils, generally Brunisols and Cryosols in depressions, are poorly developed gravels with sandy-clay matrix. This is a sensitive environment due to the slow growth rates of the vegetation, the slow rate of soil development and the natural habitat provided for a variety of species, including squirrels and lynx which are trapped in this area. This is an area of discontinuous permafrost in the summer.

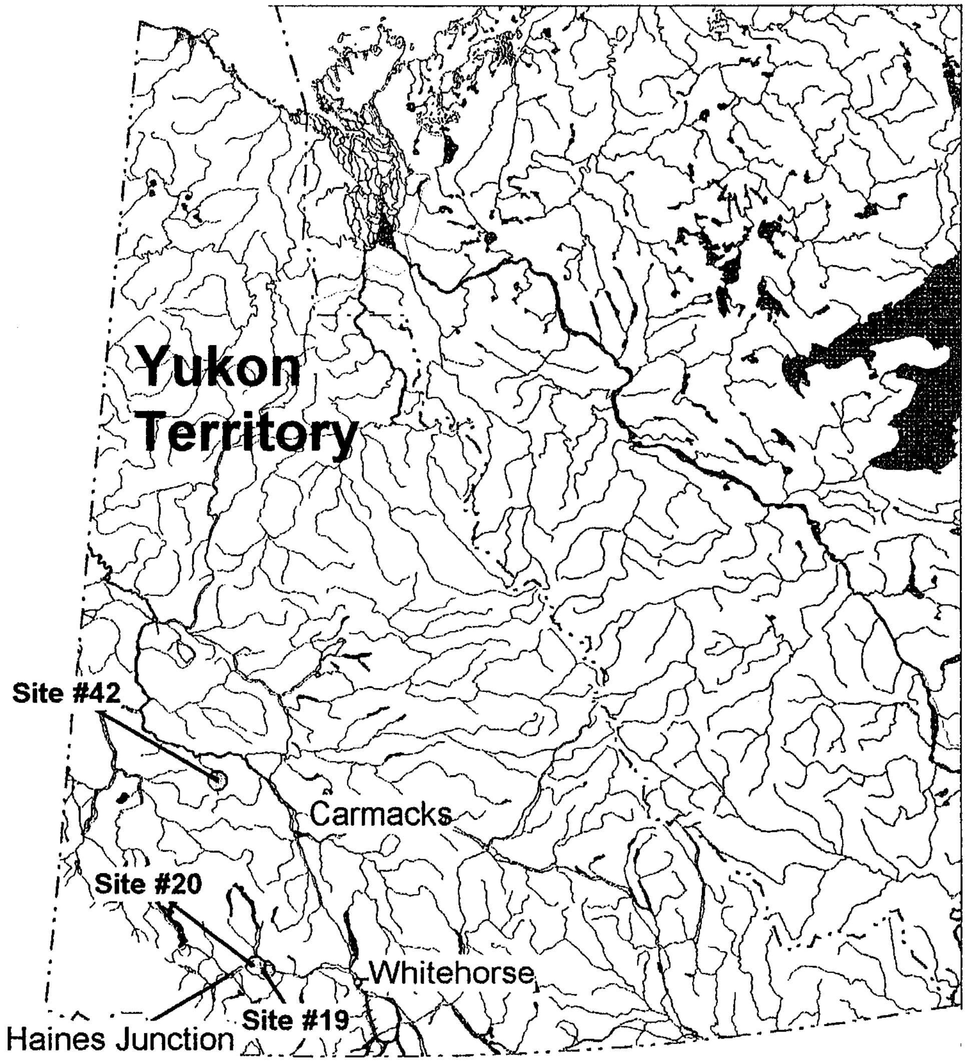


Figure 2: General location map of Yukon Territory showing approximate locations of the AES - AOW Site Numbers 19, 20 and 42.

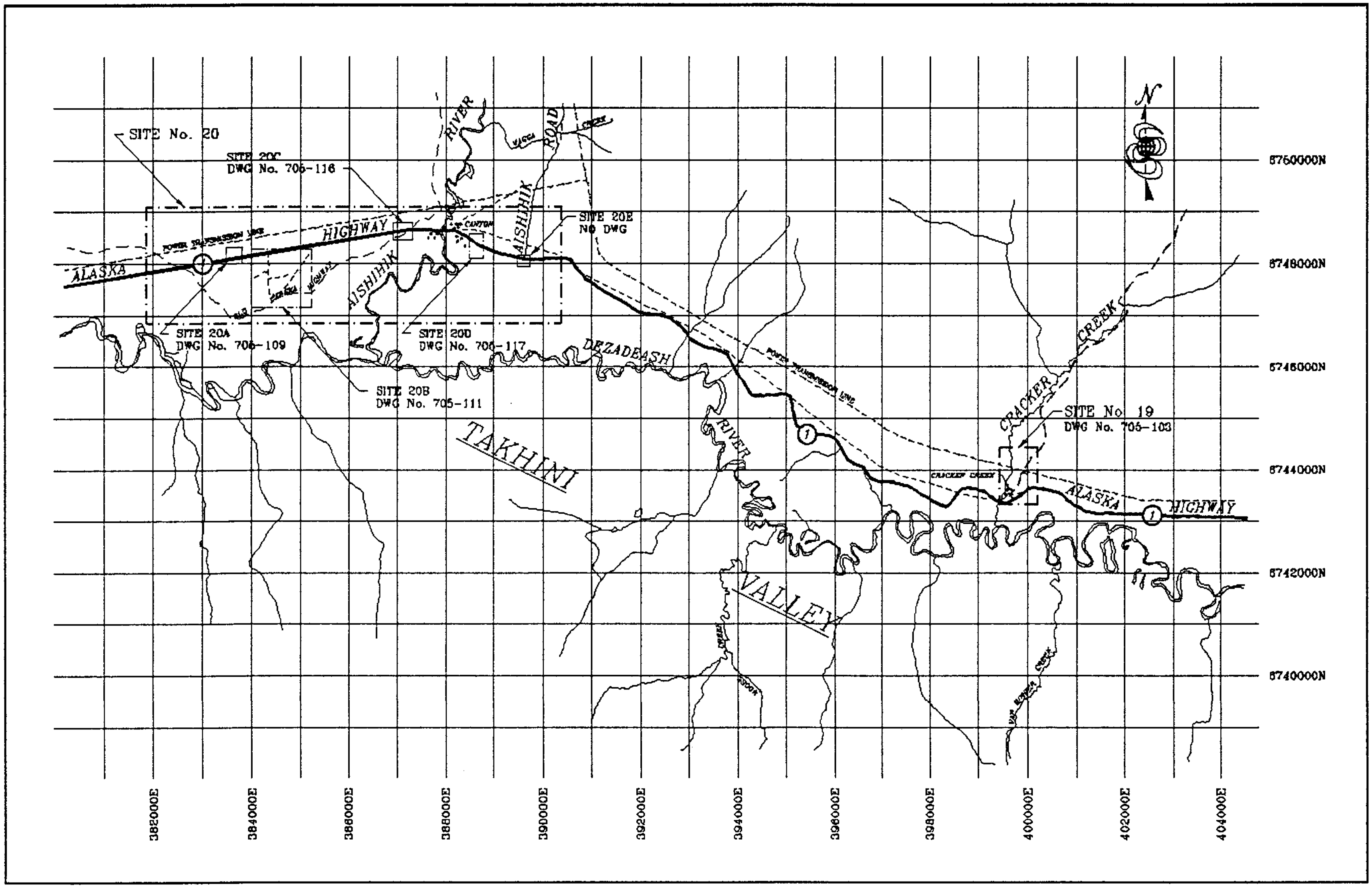
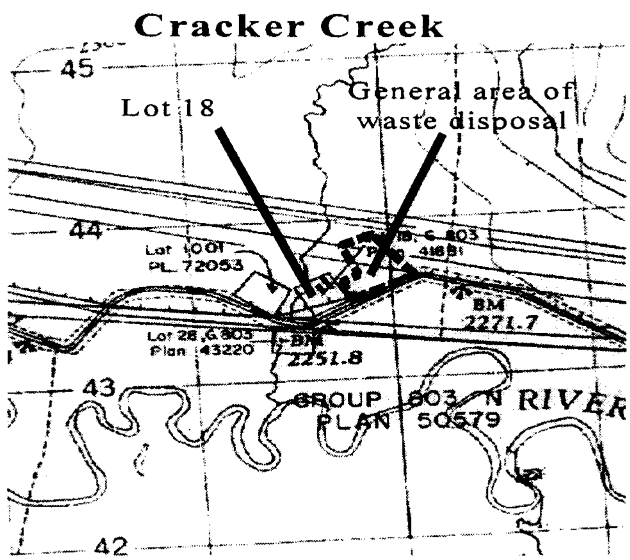


Figure 3: Area plan for AOW Site 19 - Cracker Creek and Site 20 - Canyon Creek, Yukon Territory

According to E.B. Eedy's 1976 report, the disposal site is approximately 3 acres in size being 150 m long by 120 m wide with the depth of the waste being 0-2 m. A portion of the site is open and the remainder is covered. The dump has occassional cover in the 2 small refuse areas which are (20 x 30 m in size). The site was apparently closed by covering with soil which has subsequently been overgrown in part.

Ownership of the property is apparently the Crown including Lot 1001, Plan 72053 and Lot 28, G. 803, Plan 43220, which are not titled. The only lot which is privately owned is Lot 18, G. 803, Plan 41881 which is owned by Mr. Christopher Joseph Boland. This property is the site of the former camp, as illustrated in Figure 4, and it is adjacent to the waste site. There are, to the best of our knowledge, no First Nations land claims affecting this site.

Figure 4: Recent property map of Canyon Creek showing the identified lots in the area of the site and identifying Lot 18 as the property of Mr. C. Boland adjacent to the disposal area



2.2 Site No. 20-Canyon Creek

This site, is very large and is comprised of several sub-sites extending along the Alaska Highway between mile 995.5 and 1000.0 as outlined in Figure 3. Included is the former CANOL Pumping Station C and associated disposal sites and adjacent lands. The Pumping Station itself is complex consisting of at least three disposal sites on the east side of the river, one in the vicinity of the remains of the Pumping Station and two to south side of the current Alaska Highway right of way.

On the east side of the Alaska Highway crossing of the Aishihik River, a large refuse dump, which has been buried and is no longer active, is located in the Canyon, along an abandoned meander bank. Another known site exists at the junction of the Asihihik Road and the Alaska Highway (Lot 1019) at the site of highway lodge that was burnt in 1977. Additional sites may exist in the immediate vicinity of the river; however, as indicated in Figure 5, many of these lots are now private property and access is difficult to the land claim areas to the north of the Highway.

Property ownership at this site is as follows:

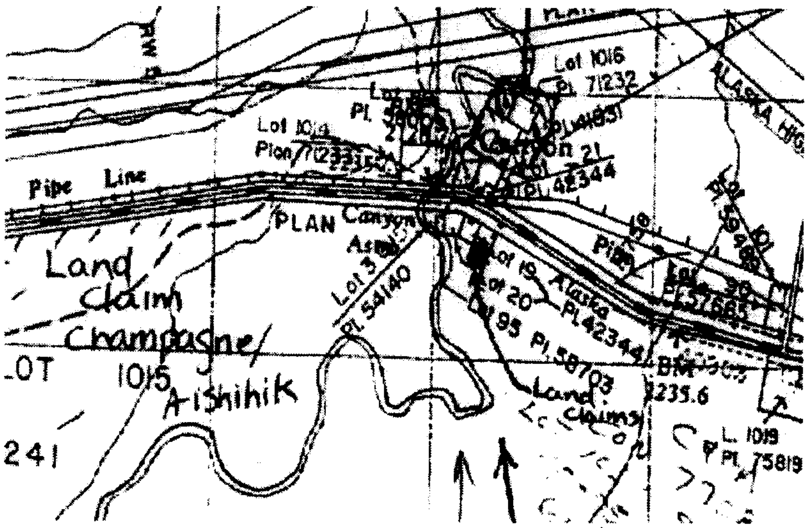
- Lot 31, G15 Plan 54140 - not titled
- Lot 95, Plan 58703 - not titled
- Lot 19, Plan 42344 - owner: Dorothy Pearl Clunies-Ross
- Lot 20, Plan 42344 - owner: John Clunies-Ross
- Lot 1014, Plan 71233 - not titled
- Lot 89, Plan 58009 - owner: Patricia Maryon O'Brien
- Lot 21, Plan 42344 - owner: Canadian Mortgage and Housing Corporation
- Lot 1016, Plan 71232 - not titled
- Lot 15, Plan 41831 - not titled

There are three land claims sections according to Land Maps inspected at both YTG and Federal Offices in Whitehorse. The land claims by the Champagne/Aishihik First Nations are outlined in the property ownership maps obtained from the Yukon Territorial Government (copies provided in Appendix 1) and are:

- Lot 1021 adjacent to Lot 19 on south side of the Highway
- Lot 1015, Plan 71241 on the south side of the Highway
- Lot 1022, North of the Highway and east of the Aishihik River and encompassing Lot 1016 and Lot 15.

This last area of land claims was apparently inaccessible from the Alaska Highway due to the privately owned lots along the Highway (see Figure 5). Access may be possible off of the hydro line right of way or generally from the north but nothing obvious was found during the on-site investigations. This site will be considered further below.

Figure 5: Enlarged property map for the Canyon Creek area in the immediate vicinity of the Alaska Highway crossing at Mile 996.3



The overbank dump-site is on Crown Land. The site of the burned highway lodge (1997) at Mile 995.5 is believed to be part of Lot 1019, Plan 75819, and it is therefore believed to be on private property owned by Brenda and Maria Beecher of Haines Junction.

This site is generally located in the Subalpine Northern Cordilleran Ecoclimatic Region (Ecoregions Working Group, 1989). Summers are cool and winters are very cold. Average precipitation is of the order of 400 to 600 mm, with June through August being the wettest months. Vegetation at these sites is dominated by stands of black spruce with understories of Labrador tea, cottongrass, sedge, moss and lichen. The presence of the deeply incised river valley likely creates some micro-climate characteristics such as increased heating in the summer in the valley.

Soils, generally Brunisols and Cryosols in depressions, are not well developed and are developed on gravels with sandy-clay matrix within the valley. Outside of the valley, the tendency is toward coarser material, basically gravels with a coarse to medium sand matrix. This is a sensitive environment due to the slow growth rates of the vegetation, the slow rate of soil development and the natural habitat provided for a variety of species, including squirrels and lynx which are trapped in this area. This is an area of discontinuous permafrost in the summer. Vegetation at the site consists of white spruce on undisturbed lands and relatively young willow and aspen on disturbed lands. This information proved to be extremely useful to the on-ste investigation in that the presence of willow and aspen or the complete absence of vegetation was very useful in identifying possible additional disposal sites and confirming the boundaries of previously identified sites.

2.3 Site No. 42- Hayes Creek Noranda Camp

This site is distinct from the other two sites in that it is relatively recent, is a mine camp and was not used by the military. A further distinction is that this is a remote site with only convenient access being by helicopter. Explosives have been reported at the site and although there are indications that they have been removed, there was the added risk of additional material being found. This site is comprised of four sub-sites which are dispersed in the general area along a distance of approximately 10 km.

One of the sites identified is the old CA32 Hayes Creek Noranda Camp; this was a mine camp/airstrip that has been abandoned. It has an EP rank of 2 (or a moderate risk of hazards) that may be of public concern. Hazards may be impacting the surrounding environment (e.g. fuel drums in water) but evidently the inventory is incomplete. There were a large number of drums ($\approx$ 160) at this site as per the 1993 INAC "Q & A" report. One hundred and thirty empty drums had been removed according to Gordon Allison's evaluation in 1989.

Site CA33 called Hayes Creek has been deleted from the A.E.S. waste site inventory, but it is on the Dept. of Public Works Mines list. This site consists of an area about 50 m by 50 m. The site inventory consists of 32 empty drums and 1 or 2 half full of diesel fuel, tires, 2 fuel tanks (1,000 gallons) and miscellaneous lumber etc.

Site CA34, called Klines Gulch Airstrip has been deleted from the A.E.S. waste site inventory, but it is on the Dept. of Public Works Mines list. The site inventory here consists of 61 empty drums and 4 full ones with diesel fuel. This site has 7 tent frames with 6 metal and 1 wood frame. There is a lot of "campsite-type" refuse as well as caterpillar parts and other miscellaneous waste. There is a 12' X 12' cabin on site which contains dishes, foamies, stove, fridge, freezer, tools etc. It is reported that this site contains a box of blasting caps (blasting agent, 25 kg explosive type B all contained in shed), although we have learned that these subsequently have been removed. In addition, propane cylinders, propane heaters, caterpillar parts, tracks, bed frames etc. can be found on this site. The evaluation of the site suggests there is no pollution potential, it's mainly aesthetics/human hazard.

Site CA35 is located approximately 1 km north of Kline's Gulch. This was an active mining camp that, as of the 1993 DIAND report, was still in use. Forty-eight empty drums were found, as well as eight, 100 # propane tanks. Removal was to be by skid in the winter along to the Casino Trail. Ownership was to be valid for Noranda between 1989-1995 according to the 1993 site report. The site inventory consists of 48 empty barrels with a few partial drums containing diesel. The debris on site consists of oil pails, miscellaneous scraps, wood and lumber. On site there are 2 frame cabins in use (at the time of the report) and 2 old log buildings (most drums and other debris on site is quite old - one of the log cabins had 1935 written on it). It is believed that there is no pollution potential, and aesthetics are the primary reason for this clean up.

This site is in the Subalpine Northern Cordilleran Ecoclimatic Region with short cool summers and long cold winters. This region occupies low- to mid-elevations (900 to 1500 m) in mountainous terrain. The frost-free period is generally 40 to 60 days although some valleys may have frost-free periods of 70 to 90 days although frost can occur in any month. Mean annual temperatures are in the range of 0 to -5°C, while precipitation is of the order of 400 to 600 mm per year with June, July and August being the wettest months (Ecoregions Working Group, 1989).

Vegetation in the area is generally white spruce, lodgepole pine and alpine fir with tree stature decreasing with elevation. Mid- and low-slopes are dominated by stands of black spruce with understories of Labrador tea, cotton grass, sedge, moss and lichen. Drier mid- to low- subalpine

sites may support trembling aspen, balsam poplar and lodgepole pine with understories of bearberry, grass, moss and lichen (Ecoregions Working Group, 1989).
Overburden and soil coverage in the vicinity of Hayes Creek is thin and discontinuous. Soils are mineral-based, having less than 25% organic content. The soil texture is predominantly sandy gravels with minimal weathering or development and are predominantly Brunisols (Ecoregions Working Group, 1989).

The general geomorphology and geology of the Hayes Creek site is presented briefly here as this is relevant to the historical and current use of the site. This information is taken from the most recent geological report on the area prepared by Bostock (1936). The Hayes Creek site is located within an unglaciated region of the Dawson Mountain Range at an approximate elevation of 900 m above sea level. The surrounding area is quite hilly, having a vertical relief of 450 to 600 metres. The site is located at the far northern edge of what was traditionally regarded as the best gold prospecting area in Carmacks District. Evidence of placer mining activity at Hayes Creek as early as 1898 has been discovered, and some good (but not economically important) pay from the site has been reported.

The field site has moderately complex geology, with at least three distinct geological units exposed within the immediate area of Hayes Creek. The area is underlain by Precambrian (>570 m.y. old) metamorphic basement rocks of the Yukon Group, composed of inter-bedded mica-quartz schists, quartzites and banded gneisses, all of sedimentary origin. The Yukon Group rocks are intruded from beneath by 53-160 m.y. old pink porphyritic granites which were exposed to the surface after erosion of the overlying Precambrian rocks.

Erosion in the area ceased with the deposition of thick 7-26 m.y. old grey and pinkish andesite and basalt lava flows (the Carmacks Volcanics) which were also subsequently folded, warped and eroded. The Hayes Creek field site is located primarily on the exposed intrusive granites, with Precambrian basement rocks lying immediately to the northeast, and the younger volcanics immediately to the southeast. Hayes Creek has a deeply cut, straight valley with a relatively steady gradient. The stream gravels are coarse, slightly rounded and composed of local rocks transported via steep tributary streams.

Although there are mine claims on these sites, the land is the property of the Crown.

3. METHODOLOGY

3.1 Review of Existing Data

As noted in the Site Descriptions above, MDA has reviewed existing material provided by INAC on each of the sites as well as other background information. Land title searches of the sites have been conducted as discussed above.

3.1.1 Site 19 - Cracker Creek

The 1976 site description by C. E. Eedy described the site as consisting of 19 buildings, two old covered refuse areas, 9 vehicle hulks plus some additional scrap metal, no liquid sewage, some biodegradable garbage and minimal oils and chemicals. The buildings on this site are all located on Lot 18 (G.803, Plan 41881) which is adjacent to the waste site and owned and occupied by Mr. Christopher Joseph Boland. MDA personnel met with Mr. Boland several times while on-site in September, 1996, to explain the objectives of the assessment as well as to enlist his support in identifying the location of waste burial sites and their contents. As Lot 18 is privately owned, it is not part of this survey. At the time of inspection, all buildings on the site outside of the apparent boundaries of Lot 18 had been removed except for their concrete footings. Surface barrels and car bodies are no longer present on the site.

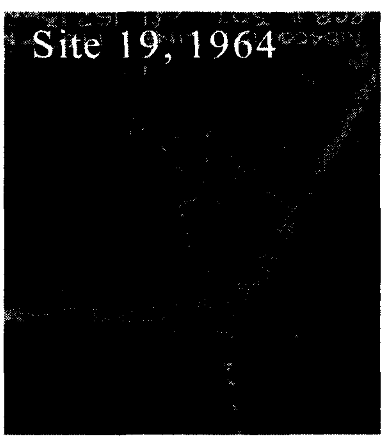
Cracker Creek stands out in that Mr. Terrence Kennedy, Forestry Officer, Yukon Forest Service, identified the dump at Cracker Creek as the **worst** he had ever seen (Laberge Environmental Services, 1993). This dump serviced the lodge, CNT, and the maintenance camps. The garbage was scattered over an area of approximately 10 acres in a mature pine forest behind the sites. Potential contaminants or other wastes identified through oral interviews include for any of these highway right of way dump sites include pesticides, PCBs, and herbicides. The latter were used to control vegetation along rights of way (Laberge Environmental Services, 1993).

According to E.B. Eedy's 1976 report, the disposal site is approximately 3 acres in size being 150 m long by 120 m wide with the depth of the waste being 0-2 m. A portion of the site is open and the remainder is covered. The dump has occasional cover in the 2 small refuse areas which are (20 x 30 m in size). The site was apparently closed by covering with soil which has subsequently been overgrown in part. There is apparently no record of additional investigations at this site since 1976.

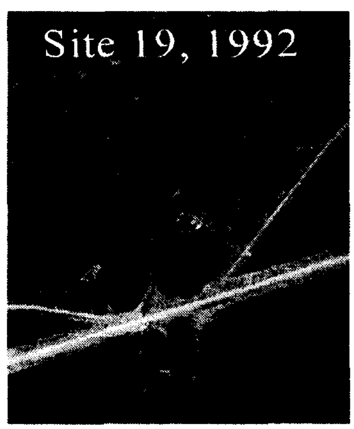
On November 19, 1996, Dr. D. Gregor met with Mr. Jim Coxford, P. Eng., Manager Design and Construction; Mr. Dick Stilwell. P. Eng., Aggregates and Materials Engineer; and Mr. Florian Vedress, Operational Services Manager, all of the Yukon Community and Transportation Services regarding the recent reconstruction of the Alaska Highway at this site. Mr. Stilwell was the engineer in charge of this work. The concern here was with respect to whether or not any waste material was discovered and buried as part of this construction especially as part of the obviously recent filling along the sides of the old right of way. This work was undertaken by a private contractor and Mr. Stilwell indicated that there was no reported excavations of wastes and that the material placed along the old right of way was likely strip material from the new right of way. The old bridge crossing Cracker Creek was collapsed on-site with the steel beams being salvaged as a new culvert was placed just to the west of the old stream crossing resulting in a realignment of the stream channel closer to the natural channel. This is evident in the changes shown in Figures 6a and b.

Figure 6: Airphotos of Site No. 19, Cracker Creek site in 1964 (a) and 1992 (b) showing the general location of the waste sites relative to the Cracker Creek crossing of the Alaska Highway and the Boland property

a



b



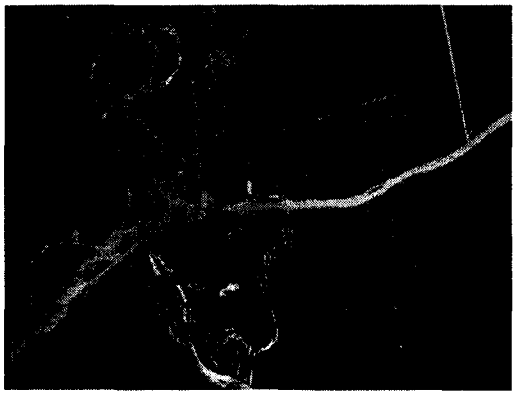
3.1.2 Site 20 - Canyon Creek

This site extends along the Alaska Highway as several sub-sites for a distance of over 8 km. This discussion will consider the site in an east to west direction and will focus on the waste sites that have already been identified. Additional sub-site discussion will be undertaken below under sections dealing with the results of this investigation.

According to the Environment Canada report based upon an inspection on August 26, 1983, the disposal site at mile 995.5 on the Alaska highway and at the intersection of the Aishihik Road is the Canyon maintenance site, which is approximately 100 m in length by 90 m wide with waste being 0-1 m in depth. The main source of the waste was the highway lodge. Biodegradable garbage and non-degradable garbage is present with the possibility of industrial waste (at this site there is/was an open dump with burning). As evidenced in Figure 7, there was no activity at this site in 1964 and thus the site was in operation for a relatively short time as the lodge burned down in 1977. The debris was apparently unsightly and was presumably cleaned up following the 1983 evaluation. With the assistance of Mr. Leonard Beecher who is the operator of the general store and gasoline station at this location (the present owners of Lot 1019, Plan 75819 are Brenda and Maria Beecher of Haines Junction) MDA staff (R. Dreyer and D. Gregor) inspected this site on September 24, 1996. The footings of the lodge following the fire are still present and considerable old and some newer debris is present. Mr. Beecher showed us other areas of the lot where some vehicles remained as well as some minor debris piles. While there is material here that could be cleaned up, none of it appears to be hazardous, rather it is unsightly. As well, without a survey of the lot we were not able to determine whether the material was on private or crown land. The old lodge foundation site is just a few metres to the east of the current store buildings and thus we assumed that this site is now privately owned.

Mile 996.3 is the site of the former US military Canyon Creek Relay Station and maintenance camp. It is located on both sides of the highway and immediately to the east of the Aishihik River. The Environment Canada report on this sub-site refers to two sites at this location, one at Mile 996.3 and the other at Mile 996.4 (Old Alaska Highway). Unfortunately, there is not

Figure 7: 1964 airphoto of Site No. 20, Canyon Creek east site showing the absence of any activities on the south side of the Alaska Highway at the intersection of the Aishihik Highway and the main relay station location in the valley.



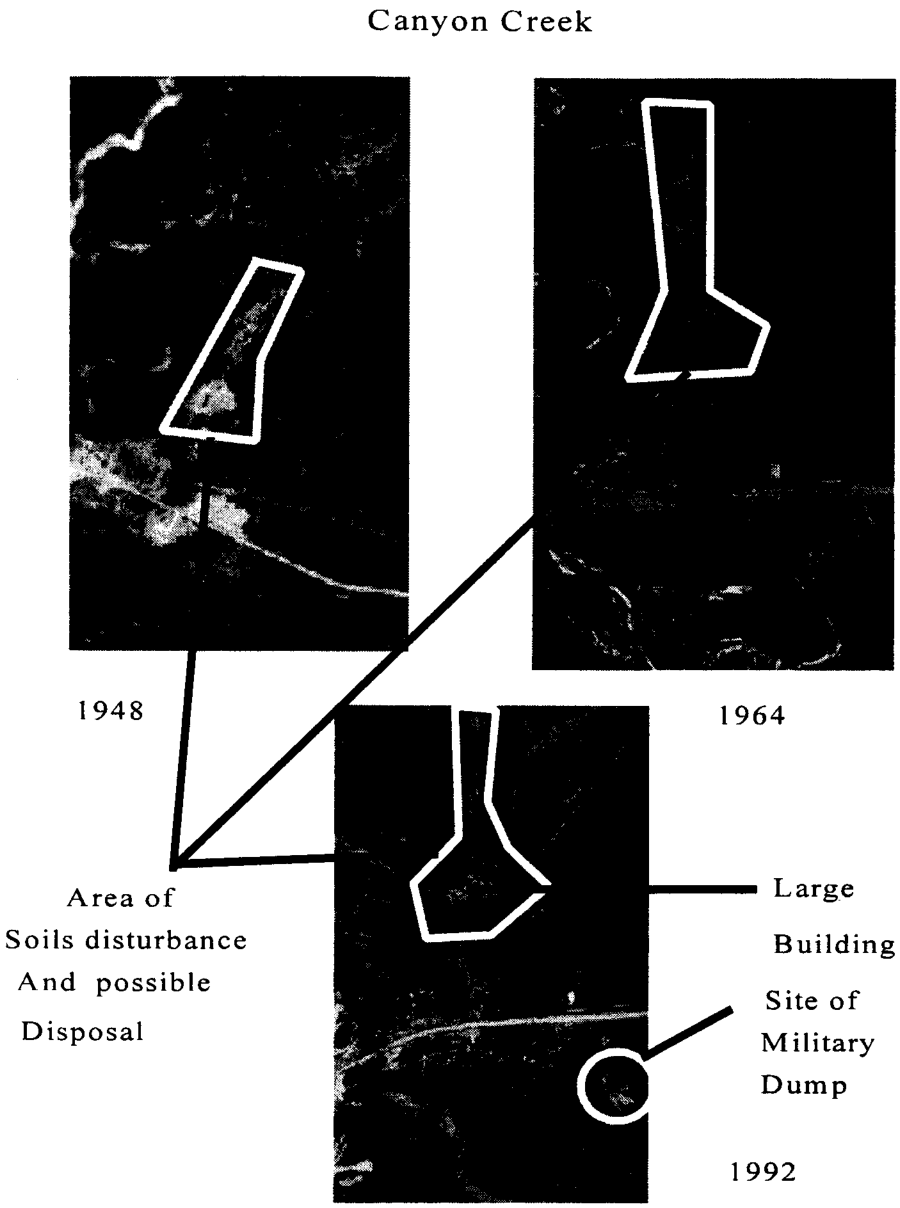
sufficient information provided on the Environment Canada reports of September, 1983 to clearly identify these two sites. Consequently, this whole area east of the River is treated as a single sub-site for the purposes of this report. The 1983 report indicates the site at Mile 996.3 to be 250 m long by 200 m wide with an approximate depth of 0-1 m. There are small covered areas on the south side of the highway with two dump sites which were not visually inspected in 1983 as part of the Environment Canada survey. Surface wastes at one time reportedly consisted of tins, 45 gallon drums, grease barrels, tires and wood debris from the buildings. Some of this material was removed during a cleanup in the 1970's. A former military dump existed over the embankment which is the bank of the Aishihik River along an abandoned meander channel to the southeast of the river crossing. A pit in this area was also being used as a local municipal waste disposal site.

The background material provided on the site (see Appendix 1) at Mile 996.3, indicated that material on the private property (perhaps now crown land) included concrete foundations from former maintenance buildings and abandoned vehicle hulks, engine blocks and vehicle components. As the concrete foundations are obvious on the north side of the current Highway, we can not help but conclude that the Environment Canada reports for both Mile 996.3 and Mile 996.4 refer to the total area on both sides of the highway. Further the report for Mile 996.4 indicates that the site covers a total of 10 acres (≈4 ha) suggesting that this refers to the entire area.

The complexity of this sub-site can be appreciated by comparing the air photo in Figure 7 with the property maps provided in Figure 5. Much of the land area immediately along the highway, including the former military buildings and concrete foundations, is now in private hands and consequently, these areas were not inspected. Further, the private property boundaries apparently precluded access from the Alaska Highway to the large disturbed area on the north side of the highway and immediately on the east of the River referred to on the property map as Lot 1022 and highlighted in Figure 8 through a comparison of the site over a 40 year period through a series of three "snapshots". As can be seen in Figure 8, there was excavation along the northeast of the crossing as early as 1948. This had expanded by 1964 but by 1992, activities had declined. However, in the 1992 airphoto, there is obviously a large building on this site suggesting that this area is private or considered private even though our land ownership information indicates that this area is part of a land claim. Due to this uncertainty of ownership, we did not undertake a detailed inspection or even a visual inspection of this site. We further note that the excavation that we observe in the air photos may simply be the result of aggregate removal for construction purposes. Nevertheless, as noted by Mr. Terrence Kennedy in a January 21, 1993 interview (Laberge Environmental Services, 1993) gravel pits were often used as dumps. MDA recommends that the ownership of this site be further investigated and that due to the extent of the area and its proximity to the river, that with the appropriate approvals for access, a further investigation of this site be undertaken.

The Canol Pump Station C is also part of Site 20 and is located above the river bank to the west of the river crossing. There are in fact two large areas associated with the Pump Station. First, the area in the immediate vicinity of the station itself on the north side of the highway and approximately 3.5 miles west of the river crossing. Second, a large area to the south and east of the highway and Pump Station along a series of trails and the old Highway right of way where there are numerous minor surface and buried disposal sites. Some of these sites can be picked out along the trails in the 1948 photographs (see Figure 9), and as evidenced from the debris they are largely if not entirely of military origin. These sites will be discussed further below. Within

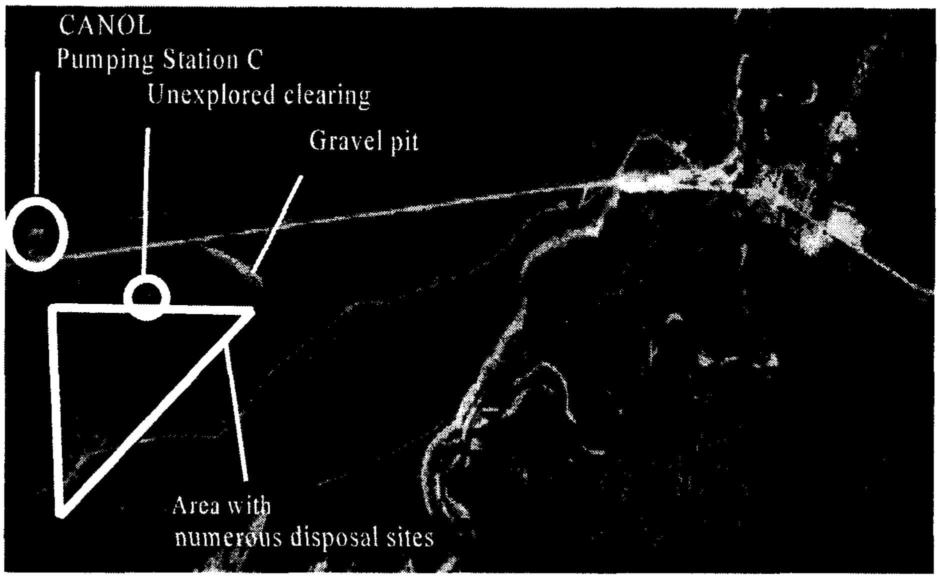
Figure 8: Comparison of airphotos of Site No. 20, Canyon Creek east area showing the area of excavation on the north side of the Highway and adjacent to the east bank of the Aishihik River and the military dump site in 1948, 1964 and 1992.



this triangular area we have noted a large cleared area approximately 0.5 km from the present Highway and about equidistant between the two trail access points to the Highway. We did not inspect this site and we believe that it is a natural clearing as there is no evidence of trails into the site. Nonetheless, we recommend that this be confirmed through a quick visual inspection when the snow is gone.

In the 1983 Environment Canada report, the Canol Pump Station C consisted of two concrete foundations and wood debris from collapsed buildings. The refuse dump here was apparently no longer active. As noted above, there was extensive accumulated refuse along the abandoned Alaska Highway right of way, access roads and trails on the south side of the present Alaska Highway right of way in the vicinity of the Pumping Station.

Figure 9: 1948 airphoto of the Site No. 20, Canyon Creek west area showing the CANOL Pumping Station C site and associated area with numerous waste disposal sites, unexplored clearing and active gravel pit



While at Haines Junction conducting the work at Canyon Creek, Dr. Gregor met with Mr. Gordon Allison, Land Management Officer and Ms. Linaya Workman, Renewable Resources Officer for the Champagne-Aishihik Band to discuss the intent of the site investigation at and about Canyon Creek and to access additional local information. Their assistance in locating some of the sites that had been identified in the early site investigation reports was invaluable.

3.1.3 Site 42 - Hayes Creek Noranda Site

Site 42 of this assessment actually consists of four contiguous sites which are all considered here as the Hayes Creek Noranda Site. The four sites range over several kilometres with the Klines Gulch Airstrip site covering the largest area, approximately 5 ha. Each of the four sub-sites will be considered separately. All of these sites are likely to be in use from time to time.

One of the sub-sites identified is the old CA32 Hayes Creek Noranda Camp (62° 34' 0" N, 137° 55' 30" W). This was a mine camp/airstrip that according to the Yukon AES Waste Site Inventory dated May 15, 1995 had been abandoned. It has an EP rank of 2 (or a moderate risk of hazards) that may be of public concern. Hazards may be impacting the surrounding environment (e.g. fuel drums in water) but evidently the inventory is incomplete. There were 140 drums stamped "Int. Mine Service"; 8 drums at the Noranda Camp with 12 more counted in the area (Yukon AES Waste Site Inventory Report, May 15, 1995). One hundred and thirty empty drums were removed following Gordon Allison's inspection in 1989.

Sub-site CA33 called Hayes Creek (62° 40' N; 138° 01' W) is a placer mining site although it has been used for other mining activities more recently as indicated by the presence of drill stem on-site. It has been deleted from the Arctic Environmental Strategy (AES) waste site inventory, but it is on the Dept. of Public Works Mines list. This site consists of an area about 50 m by 50 m. The site inventory (based upon G. Allison's inspection of October 30, 1989) consisted of 32 empty drums and 1 or 2 drums half full of diesel fuel, tires, 2 fuel tanks (1,000 gallons) and miscellaneous lumber etc.

Sub-site CA34, called Klines Gulch Airstrip (62° 38' 30' N; 138° 03' W) has been deleted from the A.E.S. waste site inventory, but it is on the Dept. of Public Works Mines list. The site inventory here in 1989 consisted of 61 empty drums and 4 full ones with diesel fuel. This site had 7 tent frames with 6 metal and 1 wood frame. There was a lot of "campsite-type" refuse as well as cat parts and other miscellaneous waste. There was a 12' X 12' cabin on site which contains dishes, foamies, stove, fridge, freezer, tools etc. It was reported (site report of G. Allison, October 30, 1989) that this site contained a box of blasting caps (blasting agent, 25 kg explosive type B all contained in shed), although we have learned that these subsequently have been disposed (B. Hartshorne, DIAND, AES Action On Wastes, Whitehorse, September, 1996). In addition, propane cylinders, propane heaters, cat parts, tracks, bed frames etc. were found on this site. The evaluation of the site suggests there is no pollution potential, it's mainly aesthetics/human hazard. This site reportedly occupies approximately 5 ha and consequently is the largest of the four sub-sites.

Finally, sub-site CA35, Klines Gulch (62° 39' 30" N; 138° 01' 30" W) is one km north of Kline's Gulch Airstrip and is actually located in the Beaver Creek district although it is considered here due to its proximity to other sub-sites in the Carmacks District. This was an active mining camp that, as of the 1989 DIAND inspection report (prepared by G. Allison, October 30, 1989) was still in use. The site inventory in 1989 consisted of 48 empty barrels with a few partial drums containing diesel. The debris on site consisted of oil pails, miscellaneous scraps, wood and lumber. On site there were 2 frame cabins in use (at the time of the report) and 2 old log buildings (most drums and other debris on site were quite old - one of the log cabins had 1935 written on it). Cleanup was mainly for aesthetic reasons (Laberge Environmental Services, 1993). Removal was recommended to be by helicopter to Minto (60 km) or Pelly Ranch (40 km) for subsequent truck transport. Alternatively, it was also noted that it may be possible to skid the debris out in the winter trail to the Casino Trail. Ownership was to be valid for Noranda between 1989-1995 (Laberge Environmental Services, 1993).

3.2 Field Work Program

As outlined in the PRESIS (Figure 1) MDA followed a rigorous and systematic site investigation of each site and sub-site. The highly qualified personnel used on-site during the site assessment allowed MDA to adjust this strategy as appropriate to the local conditions and to new information obtained at the site. As well, MDA retained the assistance of local Yukon personnel to ensure familiarity with the geography, an awareness of local issues and concerns and to provide effective community liaison as necessary.

3.2.1 Site Reconnaissance and Mapping

The emphasis of this component is to fully document the surface of the site. This was achieved through the use of a reconnaissance level survey of the sites to identify the general state of the sites and to determine the priority areas for further surface and subsurface investigations. Once the preliminary work was completed, detailed total station surveys were prepared for the sites identified to require subsurface assessments. In addition to providing the survey grids for sampling and subsurface geophysical investigations, these surveys allow the preparation of a detailed site map for the clear identification of sampling sites, photographs and areas of concern. These maps will be used in this report for presentation of the information. Second, and perhaps even more importantly, the detailed surveys will allow future investigations to return to exact locations that are identified as part of this work either for follow up investigations or ongoing site-monitoring. Wherever possible, these site control surveys have been tied to permanent site references and benchmarks for future uses. In addition to the drawings, all mapping has been provided digitally in an AutoCad ".DWG" format, which is readily incorporated into most existing geographic information systems.

The resolution of these surveys and the resultant maps was determined on-site to optimize the field time by directing the highest level of effort toward the sites that are of greatest concern. As noted above, this priority was established at the time of initial site reconnaissance.

3.2.2 Subsurface Mapping and Investigations

Based upon the available information, site inspection and the detailed surface mapping as described above, subsurface investigations were undertaken at each disposal site that the surface reconnaissance suggested that this work was required.

The first level of inspection used was a simple hand held metal detector which was used in a random survey fashion to quickly determine if the site contained buried material or merely surface material. The metal detector was used in association with shallow, hand dug pits to confirm the results. If this inspection suggested the need for additional investigation, a gridded geophysical survey was achieved using a hand held terrain conductivity metre as well as test pits. The grid density used was determined on-site based upon the evidence at hand suggesting the potential of subsurface target material. The purpose of this subsurface mapping was to identify potential targets (sources of pollution); water table level, contaminant plumes, subsurface flow direction, and soil stratigraphy. If any "hot spots" were identified in this preliminary assessment, additional geophysical investigations would be appropriate prior to extensive, invasive investigation.

The instrument of choice for locating subsurface magnetic or electrical conductivity anomalies was the Geonics EM31 with an electronic data recorder. In general, the EM31, a terrain conductivity tool, was selected as i) it can be operated by one person, ii) is useful to a depth of 2 to 6 m (depending on the size of the target) which was well in the range of any waste sites that we anticipated encountering, iii) can be useful in identifying barrels and other buried metal debris, and iv) can be used to map contaminant plumes which show a conductivity differential relative to the ground water. Geophysical methods enable rapid, flexible subsurface reconnaisance over relatively large areas. Such surveys result in maximal coverage of areas of interest while reducing the need for time consuming invasive measures such as drilling or excavation.

Electromagnetic (EM) geophysical methods measure the bulk electrical conductivity and magnetic inductance of subsurface materials by measuring their response to an artificially induced electromagnetic field. The Geonics EM31 is a battery-powered shoulder-carried instrument which generates a primary EM field within a transmitter coil which is simultaneously transmitted directly along a horizontal 3 m boom and indirectly through the adjacent subsurface to a corresponding receiving coil. The primary EM field transmitted into the subsurface induces secondary EM fields in electrically conductive underground materials which cause phase and amplitude interference between the transmitted and received electromagnetic pulses. The magnitude of this interference gives information on the size and proximity of magnetic subsurface targets.

The EM 31 measures the response of the earth to an externally applied time varying (oscillating) magnetic field using a transmitter to activate the earth, and a receiver to measure the response. Relative spatial variations reflect variations in the electrical conductivity of crustal rocks and/or anthropogenic material. The alternating current flowing in the transmitter produces an alternating magnetic field about the transmitter. This primary field (V_p) will induce a voltage response in the receiver; which is compared to the secondary induced field (Vs). If, however, a good electrical conductor (target) exists on or beneath the ground, an alternating voltage will also be induced about this conductor by the primary field which intersects it and, since this is a conductor with finite resistance, an alternating current (eddy current) (V_s) will also be detected at the receiver. The voltage of this secondary signal will be out of phase depending on the response of the target. Consequently, two phase values are recorded for each measurement; the difference between the V_s and V_p which is referred to as "in-phase"; and the phase difference between the two voltages induced in the receiver, also referred to as the "out-of-phase" part. That is the two signals V_s and V_p will be "out of step" with each other and this phase difference is also diagnostic of the buried conductor.

The EM31 magnetometer was capable of real-time detection of drum-sized magnetic targets within 1.5 m of ground surface, and was primarily used to confirm the presence or absence of metal targets in areas suspected of being previously excavated.

Soil samples were collected from test pits and surface sites for particle size analysis, contaminant screening if required and subsequent laboratory analysis. As well, water tables were confirmed from test holes. Care was taken to ensure that buried containers that were investigated were not punctured resulting in the creation of a leak.

3.2.3 Surface Waste Investigations

The PRESIS indicated that all apparent surface wastes would be tagged for subsequent sampling and further investigation as appropriate, at the time of preparation of the detailed site maps, if there was any potential for contamination from these wastes. That is the wastes had to pose more than a visual or aesthetic concern. Containers with liquids or solids that were not clearly labelled and sealed were noted on field notes. Containers that were not sealed and appeared to contain liquid wastes and that could be safely opened were field screened to determine contents in a generic fashion (i.e chlorinated compounds or hydrocarbons only) as this was feasible with the on-site equipment. Any chlorinated wastes and those that could not be identified were to be documented and sampled if possible for laboratory analysis and appropriate follow-up.

Soil samples were generally 500 g in mass and were obtained using a small stainless steel hand spade that was cleaned on-site with hexane and rinsed with ultra-clean water. Liquids were sampled using a steel thief-type sampler similarly cleaned with hexane and ultra-pure water.

3.2.4 Subsurface Site Assessment

Being cognizant of the concerns about terrain and biological disturbance of sensitive northern environments, MDA took every effort to minimize additional terrain disturbance in the excavation of test pits. This is merited on the basis that some of these sites are 50 plus years of age and have still not or are just beginning to re-vegetate. Thus, if the sites are found to be for all intents and purposes benign, further disturbance of the site should be kept to a minimum. We therefore used only hand tools for visual subsurface investigations which was reasonable given that most of the sites were reportedly shallow (< 1 m). This was both cost-effective (especially at site 42 which had only helicopter access) and environmentally responsible.

Every effort was made to explore possible subsurface contamination sources. Whenever this was undertaken, it was on the basis of there being no apparent risk of worker exposure exceeding the level of the personnel protective equipment on hand and that there was no obvious danger of causing increased environmental hazards.

3.2.5 Field Screening of Surface and Subsurface Soil, Sediment and Liquids

Reconnaissance of contaminated sites involves the identification of areas with a high probability of contamination, confirming the presence, nature and magnitude of the contamination, and then formulating a suitable remediation program. The importance of this initial reconnaissance phase cannot be over-emphasized, as the information it yields largely determines the magnitude and direction of the investigation, the sampling for the detailed laboratory analyses and ultimately, the entire remediation effort.

Traditionally, field site reconnaissance has primarily involved the collection of soil samples, although samples of other media may also be acquired as necessary. Samples are usually transported to off-site analytical laboratories for detailed analyses and such analyses usually yield accurate and precise data. Unfortunately, high laboratory fees, slow return of analytical results, and the procedures inherent in transporting potentially hazardous materials can make detailed site investigations cumbersome, expensive and inefficient.

Field site investigation using fast, low cost, on-site sample pre-screening has several virtues. Although unintended to replace high-accuracy laboratory analyses, the screening of samples in the field can significantly increase reconnaissance program efficiency. Sample screening can quickly and confidently delineate areas warranting detailed investigation. Precise delineation of priority areas during the early stages of the reconnaissance program can optimize the expenditure of resources otherwise used inefficiently in "hit and miss" sample collection and analysis.

As part of the field screening at these sites, soil vapor probes were used for hydrocarbons, and the innovative technique referred to as "ENVIROSCAN" offered the potential for low cost, rapid screening for chlorinated substances such as PCBs. Pre-screening of samples for volatile organic compounds (VOCs) prior to laboratory submission was accomplished using a Photovac Model 2020 portable photo-ionization detector. The Photovac Model 2020 is a hand-held photoionization detector (PID) used for the rapid detection of VOCs in soils. Photo-ionization involves the creation of an electrical charge in a gas sample using visible light radiation. The vapour's resulting electrical charge is detected by a voltmeter and used to calculate total VOC concentration.

The Photovac Model 2020 constantly samples air through an intake port and ionizes the sample using a 10.6 eV lamp prior to voltmeter analysis. The unit provides a constant, real-time readout of total VOC concentration at levels as low as 0.1 ppm. The Photovac unit was used to screen soil samples for the presence of VOCs, helping to determine which samples were priority candidates for detailed laboratory analysis.

Pre-screening for PCBs and other chlorinated compounds was performed using a Barringer Instruments IONSCAN Model 250 ion mobility spectrometry (IMS) detector with a custom designed thermal desorption/pre-concentrator unit for soils. The "ENVIROSCAN" uses observations of ionized particle behaviour to identify analyte substances, including PCBs. The use of ion mobility spectrometry techniques for analysis of semi-volatile chlorinated compounds (SVCCs) in soil samples is based on four fundamental principles:

1) SVCCs cling to the surfaces of the soil particles that they come into contact with.
2) The application of heat can vaporize trace amounts of these SVCCs from soil particles.
3) The vaporized SVCCs can be converted into electrically charged molecules.
4) The speed with which ionized SVCCs drift within a controlled electrical field (ion mobility) is a distinctive characteristic which can be used to detect and identify them.

Ion mobility spectrometry, or plasma chromatography, is an analytical technique using observations of ionized particle behavior to detect and identify ionizable substances. Relative ion drift velocity compared to that of a calibrant within a controlled electrical field (ion mobility) is a diagnostic characteristic which can be used for identification. The IONSCAN Model 250 was used for organochlorine pre-screening of soils to determine locations where additional sampling was required and to prioritize samples for submission to an analytical laboratory.

The Model 250 instrument contains a sealed 15 millicurie ^{63}Ni radioactive source for particle ionization which poses no direct radiation hazard. The detector is auto-calibrating, has a maximum analysis time of 20 s, and may be programmed to search for a maximum of 45 individual ionized compounds. The instrument's analytical results are downloaded to a peripheral PC for storage, detailed analysis, and graphical output. A vapour pre-concentrator unit was used to concentrate compounds sorbed on raw soil samples onto 2 cm Teflon cards prior to IONSCAN analysis.

This combination of field screening with the ENVIROSCAN and the soil vapor analyser allowed MDA to confirm the absence of contaminants at the actual time of site assessment. If evidence of contamination was indicated at any specific location, a detailed three dimensional picture of the contaminated area could be immediately initiated. This approach increased the on-site personnel time and the technical field costs but also increased the efficiency of the on-site personnel while reducing the expense of the laboratory analyses. Laboratory analyses were used to confirm and refine the results of the field screening.

Interestingly, although the wastes at sites 19 and 20 were scattered over large areas with some obviously concentrated disposal sites, the number of site-specific locations that indicated possible chemical contamination were very limited. Thus the actual amount of soil sampling and screening was considerably less than had been originally anticipated. This was fortunate, as the aerial extent of these two sites was much greater than had been suggested in the background reports that had been provided.

3.2.6 Laboratory Analyses

PAHs in soils were the focus in many areas in this study due to the possibility that waste oils had been disposed of and due to leakage from refuelling stocks. It was also anticipated that oil spills may have occurred at the CANOL Pumping Station C causing PAH contamination. PAHs in the soils remain a concern even after several decades despite some potential for intrinsic biodegradation of hydrocarbons, even at these northern sites. Where there is clear evidence of chlorinated wastes present, this will normally supersede the concern with non-chlorinated hydrocarbons. Due to our capability to pre-screen for chlorinated contaminants and hydrocarbons, we used the laboratory analysis to confirm presence, to detail the specific compounds and to determine concentrations of chlorinated organic compounds and hydrocarbons. Field screening combined with geophysical tools and visual investigations would have been used to determine the zone of contamination and migration pathway if zones of significant contamination had been identified in the field.

All soil and water samples collected in the field for screening were retained at approximately 4°C (we can not guarantee that these temperatures were maintained at all times during in-field storage and shipping although samples were stored and shipped in a cooler) for subsequent laboratory analysis. The samples selected for laboratory analysis were those that the field screening indicated possible contamination or were samples from sites where there was a specific interest in confirming the presence or absence of contaminants.

Water samples were not a high priority for trace organic contaminants and hydrocarbons due to the low water solubility of these compounds. However, water samples can indicate possible contamination from wastes as a result of leaching of contaminants by groundwater passing through the site. In particular, wastes could generate high levels of ions and some metals due to dissolution below the surface and while these may not be an environmental concern on their own, they could help identify the presence of, for example, metals and contaminant plumes from organic contaminants. Consequently, water samples were collected when considered appropriate from the groundwater of test pits where contamination was suspected. As well, in such cases, surface water samples were collected for background purposes.

Target analytes included the following:

Water (only inorganic analytes were considered as the likelihood of detecting hydrocarbons and chlorinated compounds is quite low unless special sampling and analytical procedures are used which are not warranted unless contamination of soils and/or sediments is confirmed)

- nitrite and nitrate, fluoride, bromide, chloride, ortho-phosphate, sulphate
- metals, including mercury (see complete list below)

Soil/sediment

- organochlorine pesticides, mirex, toxaphene and total PCB
- 18 polycyclic aromatic hydrocarbons (see complete list below)

Soil quality guidelines will follow those outlined in the "Proposed Guideline for the Clean-up of Contaminated Sites in Ontario (MOEE, 1994) and the draft CCME Soil Quality Guidelines (CCME, 1997). By using soil quality guidelines as benchmarks, adverse biological effects are not predicted when the measured concentrations of soil-associated chemicals at a site are at or below the quality guidelines (CCME, 1995). If soils are not above the soil quality guidelines, further investigation of the soil quality may not be necessary depending on the site.

3.2.7 Biological Site Assessment

Chemical screening can indicate whether or not contaminants are located on-site; however, the mere presence of contaminants does not necessarily pose a risk. Environmental impacts can be assessed through a number of methods with laboratory based toxicity screening being the most common. For the purposes of a level 2 environmental risk assessment, only a very preliminary biological evaluation was undertaken. Our evaluation took the form of a basic biological inventory of biota observed in the area. A field sheet with supporting evidence describing the weather conditions, current speed, substrate type, water depth and a sketch of the area was filled out for each site. These field sheets included measurements of water pH, conductivity and temperature. Biota were collected via kick and grab samples. A Benthos (C.A.B.) tube was used to collect samples however the rocky nature of the bottom made it easier to kick samples directly into the screen as well as by turning over rocks. Samples were composited and sorted using a 500 μm sieve. Macroinvertebrates found in the sieve were placed in specimen bottles and preserved using a 50% solution of alcohol. Identifications were performed using a dissecting microscope and confirmed through the use of biological field guides and keys. Classifications of the aquatic insects were made to Order and in some cases to Family. Water samples were also collected at both the upstream and downstream sites.

Terrestrial biota (vegetation and wildlife) were only assessed from the perspective of species avoidance for wildlife and signs of stress for vegetation. This information, especially the latter, was useful in determining the extent and impact of site disturbance.

4. RESULTS OF INVESTIGATION

4.1 Description of Site

The general area plan for sites 19 and 20 is shown in Figure 3 (drawing 705-101). The general locations of more detailed drawings within both of these two sites are also illustrated. As noted above, site 42 consists of four sub-sites located along the Hayes Creek watershed as illustrated in Figure 10 (drawing 705-102). Please note that only drawings and photographs that are specifically referred to in this text are provided here. A complete set of drawings and photographs from the sites including photograph location maps are provided in Appendices 2 and 3. Appendix 4 contains the air photographs used as part of this study.

4.1.1 Site 19 - Cracker Creek

The detailed site plan of Cracker Creek is provided in Figure 11 (drawing 705-103). This site is scattered across an area estimated to be approximately 28 ha., although only about 9 ha of this area were surveyed in detail as part of the 9 sub-sites that were identified. The smallest sub-site is 19A which is shown in Plate 1. This site consisted of metal debris, primarily tins and cans, and had been partially excavated. MDA was unable to learn who, when or why this excavation was undertaken either from the local landowners or from the INAC office. The small area of this site and the visible contents led us to conclude that there was little possibility for contaminants to exist at this site and no further investigation was undertaken.

Sub-sites 19B, C, E, F and G were areas where extensive clearing had occurred and the presence of surface debris suggested possible burial. These sites had been identified in the earlier investigations of these sites (see section 3.1.1) and are clearly visible as cleared areas in the 1948 and 1964 aerial photographs. Although considerable regeneration of natural vegetation has occurred at these sites, the cleared areas are still quite visible on the ground as evidenced by the sharp transitions in vegetation shown in Plate 2. In these fill areas, various earth and root mounds still remain with metal debris protruding as illustrated in Plate 3. In some cases, especially 19E and F, the natural grass remains sparse as illustrated in Plate 4 and the shrubs and trees have failed to regenerate. Due to the presence of buried material at sites 19B,C,E,F and G, these sub-sites were geophysically surveyed with the EM31. These results and their interpretation will be discussed below.

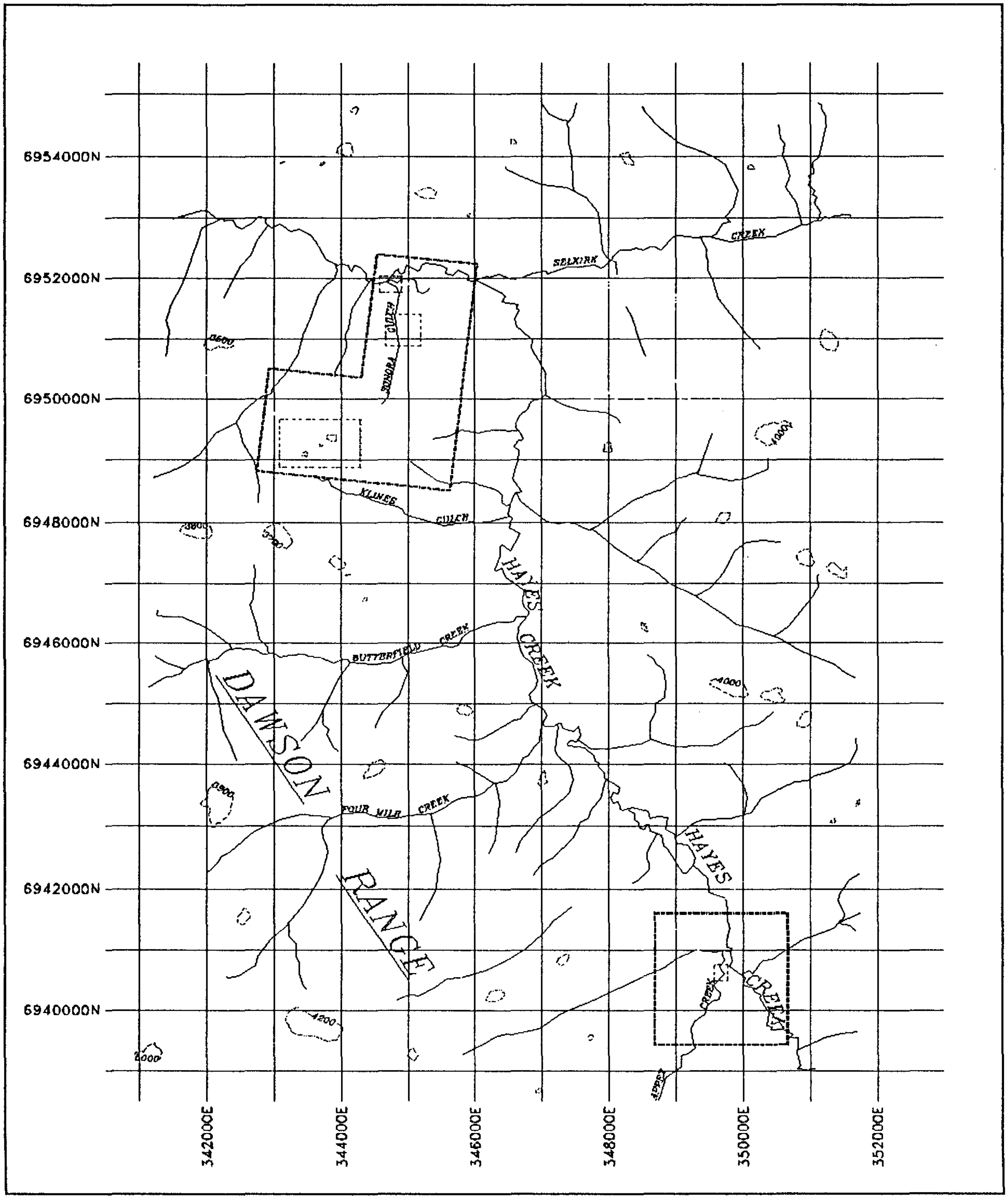


Figure 10: General site plan for Site 42 - Hayes Creek Noranda Camp

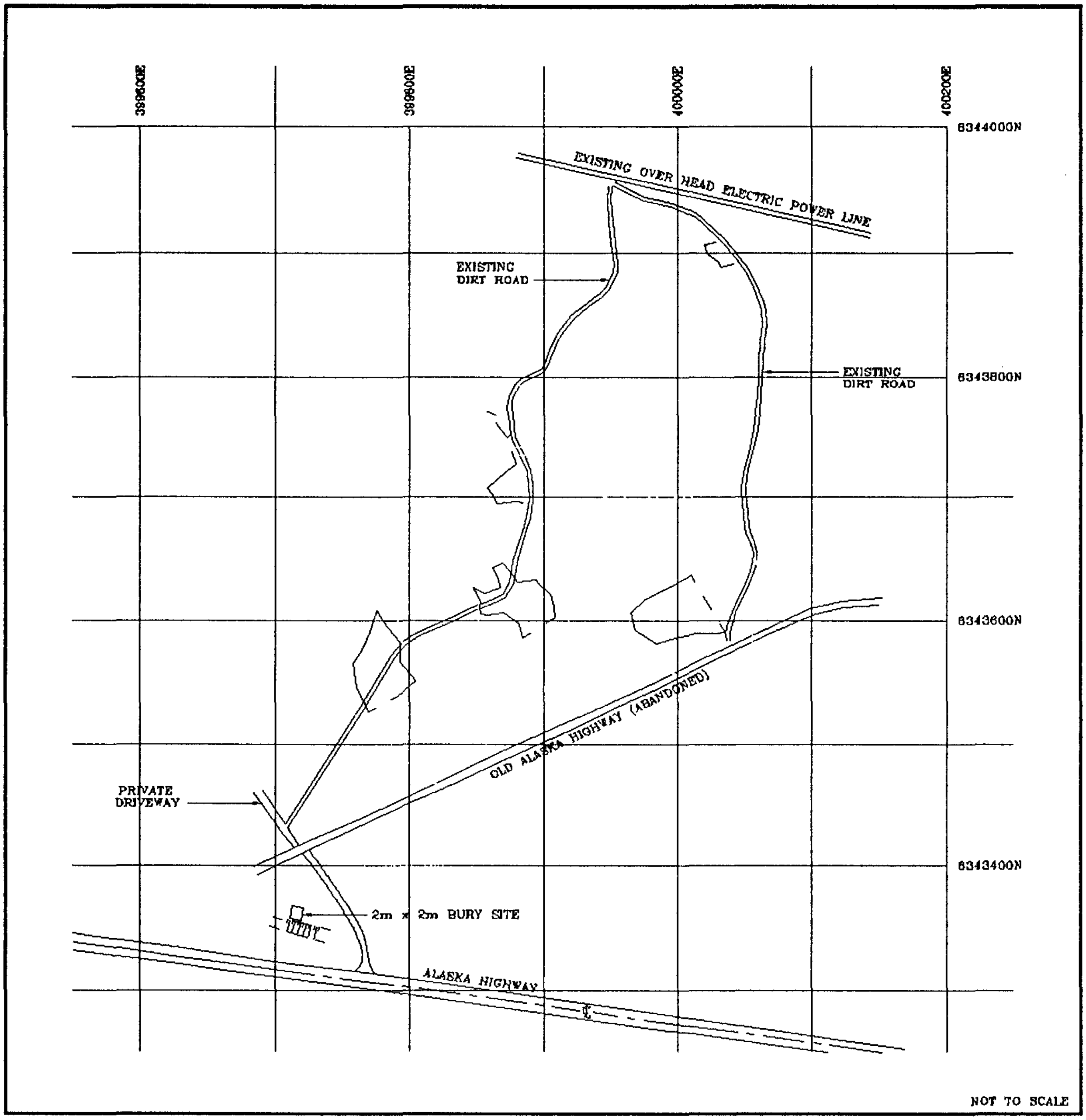


Figure 11: General site plan for Site 19 - Cracker Creek showing locations of sub-sites 19A through 19I

Several sub-sites warrant special mention here. Site 19D was a rectangular area with obviously younger vegetation than the contiguous land. This sub-site was surveyed extensively but without any evidence of metallic debris present (see below for results) and thus it has been assumed that while this area was cleared, the native soils were not disturbed by stripping and burial and natural regeneration of the vegetation is occurring. Sub-site 19G was a cleared area but there was no evidence of burial of metal debris based upon the results of a randomized geophysical survey and thus this site was not investigated further. Sub-site 19H, is aesthetically the worst part of the entire site as illustrated in Plate 5. This surficial debris consists mainly of old food tins and other metal debris, crates, broken china and glass. Only a very minor portion of this debris is recent.

Site 19I is quite a large area (approximately 1 ha) which has obviously been extensively disturbed as illustrated in Plates 6 and 7 (sub-site 19I, photos 1 and 2). Based upon discussions with Mr. Boland, this site was apparently used for fill and then was refilled with strip material and possibly refuse from the bridge at the time of construction of the new highway right of way. It was evident in the 1948 air photos and appeared to be most obvious in the 1964 air photos. Mr. Dick Stilwell, P. Eng., Yukon Community and Transportation Services, confirmed that it likely received strip material but indicated that the bridge was used as a fill at the stream crossing site except for the steel which was removed for recycling. A randomized EM31 survey of this site confirms Mr. Stilwell's comments as no metal targets were indicated.

4.1.2 Site 20 - Canyon Creek

This site has been divided into 5 subsites as illustrated in Figure 3. Sub-site 20A is the CANOL Pumping Station C site. As illustrated in Figure 12 (drawing # 705-109) this entire site is large covering at least 1.25 ha; but with three smaller debris sites exclusive of the concrete foundation remains of the pumping station (see Plates 8 and 9 {sub-site 20A, photos 1 and 2}), looking west and east respectively). One debris site is immediately to the south of the pumping station and consists of timber, wood and asphalt shingles. Another similar, but smaller site is located to the north of the pumping station. The main burial site is located to the east of the pumping station and there is only limited evidence of surface debris here in the gravelly soil. This site has been subjected previously to some excavation, evidently for inspection purposes, and this has exposed some of the burial

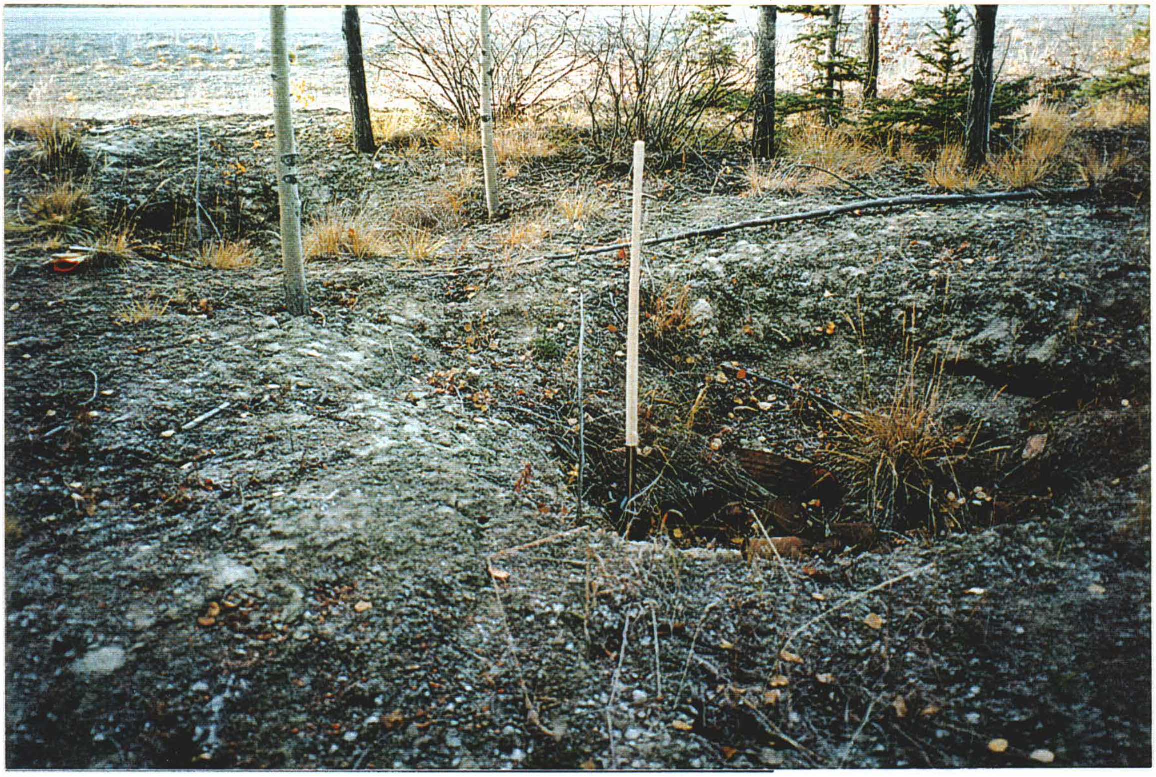


Plate 1

Plate 2


Plate 3

Plate 4

Plate 5

Plate 6


Plate 7

Plate 8


material including a section of the steel 3 inch pipeline used along this route. This burial site was surveyed geophysically.

Figure 13 (drawing 705-111) outlines the large area of 17 discrete waste disposal and debris sites comprising sub-site 20B. Also shown here as sub-site 20B-18 is the large clearing identified on the airphotos as noted in section 3.1.2 but not investigated due to the fact that we were not aware of this site until observing it on the air photos following the on-site investigations. It was not obvious on the ground as there is no access trail evident. This entire sub-site covers approximately 80 ha of land but the actual area of the debris sites are, fortunately, much smaller. The site is generally treed except in the vicinity of the debris sites which were either natural clearings or the vegetation had been removed or destroyed. This is best illustrated in Plates 10 and 11 (sub-site 20B, photos 1 and 2) which show the clearings surrounded by healthy coniferous forests. Some of the sites show evidence of burning (see Plate 12 {20B3}) which may be the reason for the lack of vegetation still in the central parts of these debris sites. Possibly, the fires destroyed the natural vegetation cover and removed the organic matter from the sandy soil, thus greatly increasing the time for plant regeneration (see Plate 13 {20B4}).

All of the 17 sub-sites were investigated either with a metal detector (sites 20B-1, 3, 4, 6, 7, 8, 9, 10, 12, 13, 14, 16 and 17) or with the EM31 (sites 20B-2, 5, 11 and 15). As well, numerous shallow pits were dug at these sites to confirm the presence or absence of buried debris. While the majority of these sites had the appearance of just being a convenient spot to dump a load of wood and other debris, several of them had the appearance of being an area where the natural vegetation had been cleared and debris had been buried. This is especially noticeable along the trail running south from the Alaska Highway at chainage 1607.914 km, as there had been extensive clearing along both sides of this trail. The trees and stumps had been pushed into windrows along both sides of the trail as is clearly seen in the 1948 air photos.

Sub-site 20 C is located at the junction of the old highway right of way and the current highway on the west side of the Aishihik River crossing and above the river bank. It consists of a number of disposal sites along the old highway right of way. This area was geophysically surveyed to


Plate 9

Plate 10


Plate 11

Plate 12

determine the nature of the subsurface although it appeared that only old asphalt and road bed material had been disposed of in these sites. There was no evidence of truck and automotive wastes nor of domestic wastes.

The area described as the military dump in previous reports and considered here as Site 20D - Canyon Creek east, was the area of greatest concern in this overall study. This had been reported as an extensive area of dumping and as such could have included a wide range of wastes including liquids, such as contaminated oils, pesticides, solvents etc. As well, this site is close to the river in that the dump is over the bank of a meander scar. While this channel is no longer utilized by the river during low flows, it is conceivable that flood waters enter this channel or that at some time in the future, realignment of the channel could result in erosion of this fill site. Careful inspection of the air photos for 1948 and 1964 suggest that this site was not as yet being used for disposal as the surface does not appear to be disturbed as numerous other areas are. This is good news in the sense that the disposal is more recent, sometime between 1964 and the time of the 1983 survey which identified this area as having "... extensive accumulated refuse along the access road, former military dump over embankment and recently excavated disposal pit for refuse. This site is presently clear of surface debris except over the bank and down into the abandoned meander channel.

However, since this dump (sub-site 20D) was not active prior to 1964, there is the strong likelihood of there being an additional disposal area that was used for the 20+ years prior to the use of sub-site 20D. As Canyon Creek was a significant camp, there would have been considerable waste generated and we do not believe that the debris from Site 20B on the west side of the river, was the likely disposal site for this camp due to its relative distance from the camp. Consequently, there is the strong likelihood of there being additional disposal sites in this area that have not been identified by the 1983 Environment Canada investigations nor by this study. We believe the most likely area for this to be the extensively excavated area along the east bank of the Aishihik River on the north side of the present Highway (see Figure 8). As noted above, at the time of the field investigation, we could not find access to this area without crossing private property. We strongly recommend that additional investigations be undertaken in this area. Site 20E Canyon Creek as located in Figure 3, was discussed in Section 3.1.2 and as stated there, the site did not warrant additional work

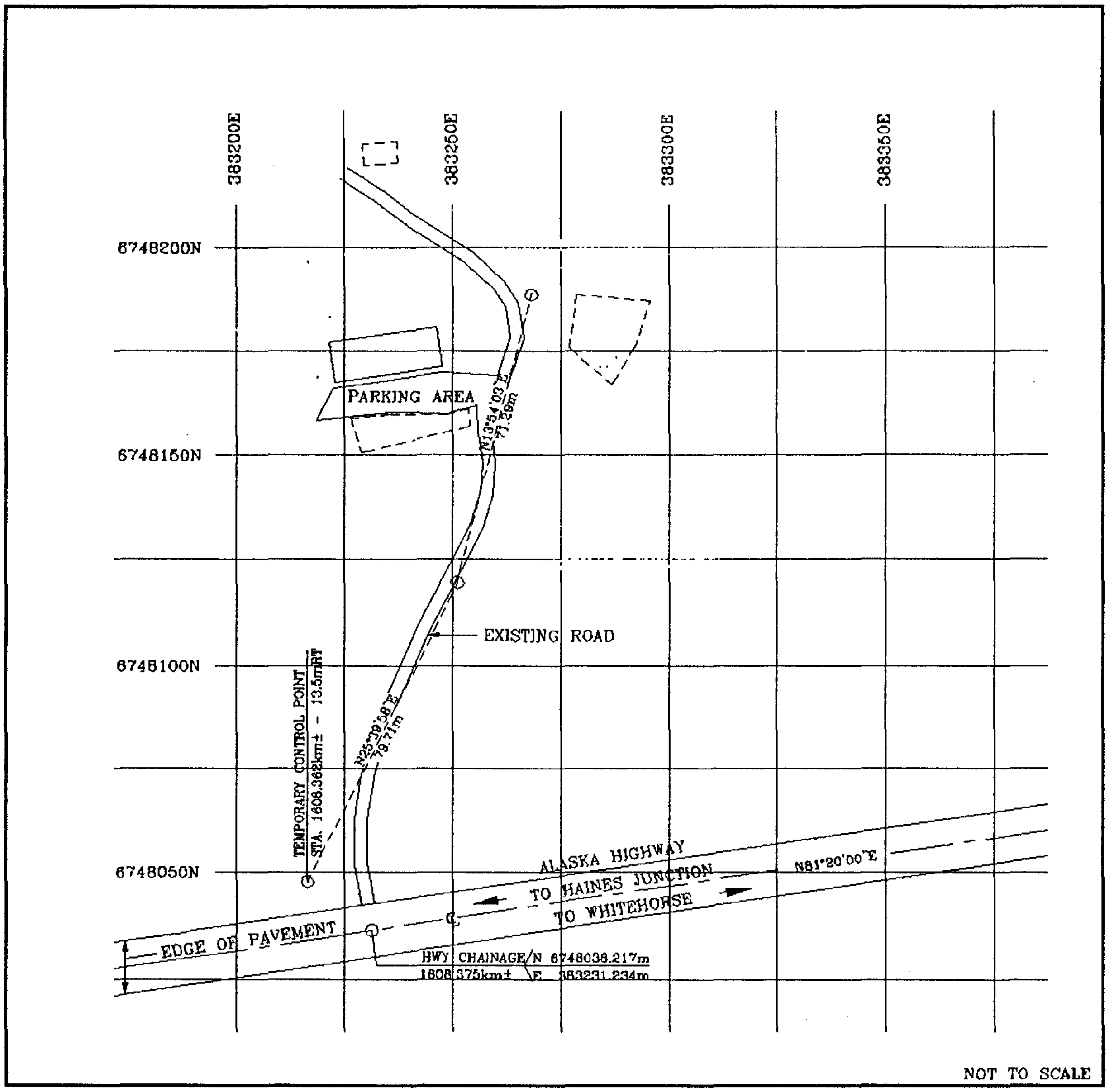


Figure 12: Detailed site plan for sub-site 20A - CANOL Pumping Station C at Canyon Creek site

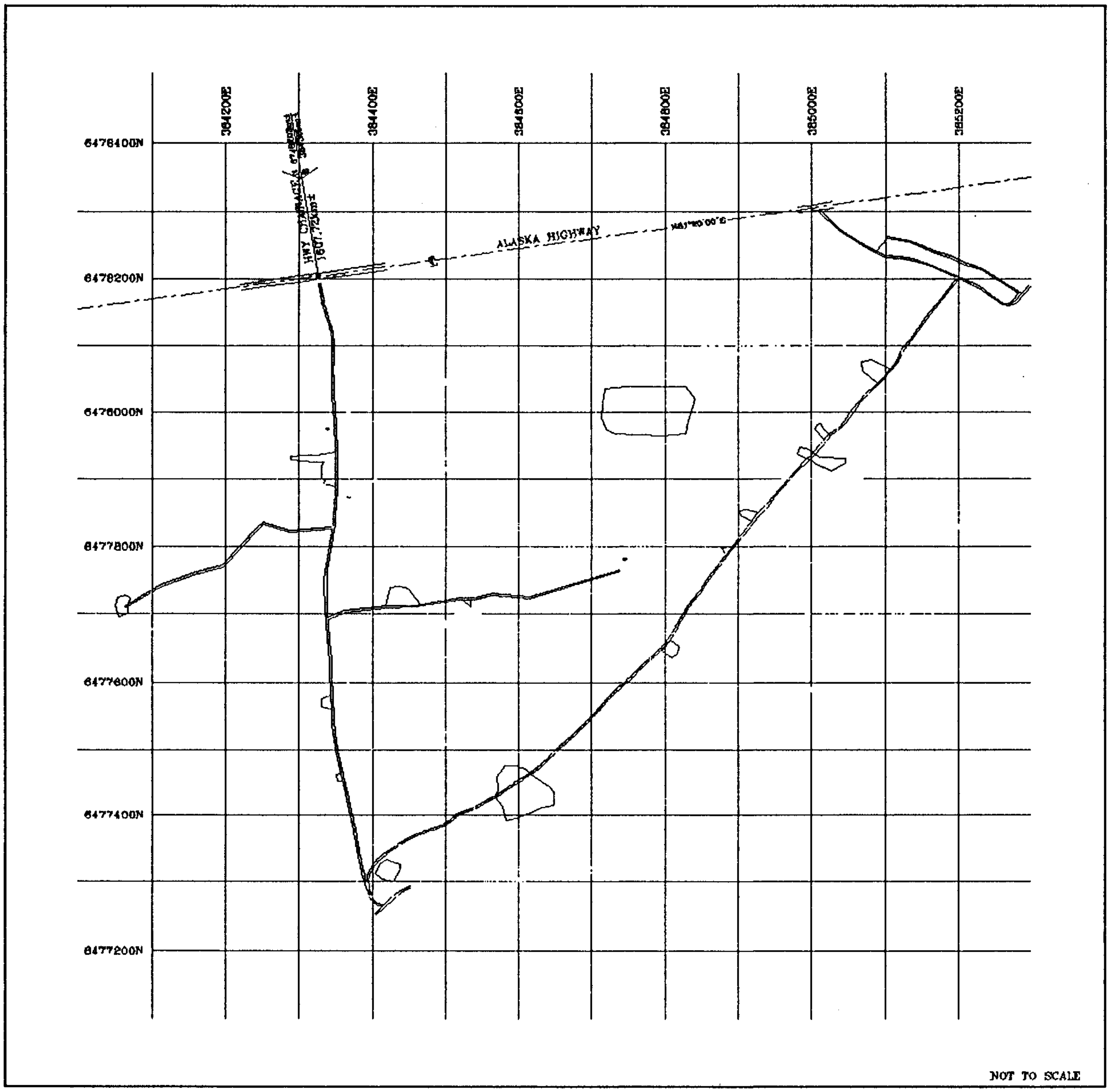


Figure 13: Detailed site plan for sub-site 20B on the southwest corner of Site 20 - Canyon Creek west

and is believed to be on private property.

4.1.3 Site 42 - Hayes Creek Noranda Camp

Access to site 42 was via helicopter as this was a remote site. Members of the party were flown to the sites out of Carmacks and Minto. The general area plan is shown in Figure 10 (drawing 705-102). Detailed sub-site plans will be discussed below. Site 42 consists of 4 sub-sites (site CA-35, CA-33, CA-34 and CA-32). At each site a current inventory was taken, the results of which are shown below. In many cases, not much appears to have changed since the 1989 evaluations done by Gordon Allison. All 4 sub-sites did not show any obvious signs of contamination other than oil or diesel fuel as identified clearly in pictures and confirmed by soil analysis at site CA-35 under the caterpillar (Plate 14 {sub-site CA35, photo 1). Also at site CA-35, explosives were discovered in the tool shed (approximately 15 sticks of dynamite). The condition of this explosive was noted to be suspect due to the leaching or sweating of the glycerine component through the paper jackets. INAC was informed of the presence of this material formally on November 8, 1996. A copy of the letter is included in Appendix 5. It is our understanding that this matter would be referred to the RCMP and we are unaware of the current disposition of these explosives.

One other item worth noting is that site CA-32 may be in use once again as a mining camp. This was evidenced by newspapers at the site from May of 1996. A general note which can be made about all sites is that the majority of the barrels on site were empty. There were very few that appeared to contain any liquids. Any barrels with liquid in them were assumed to have either water in them or diesel/aviation fuel/motor oil in them as clearly identified by labels on the barrels. Everything was generally labeled except for the crushed drums and cans.

4.2 Site Inventory

The purpose of this section is to identify the material at each site that is on the surface and either is or may in the future pose a threat to the environment, or is or may be a physical threat to wildlife and humans.

4.2.1 Site 19 - Cracker Creek

This site has been subjected to an extensive cleanup and/or burial of surface material since the last investigations. As a result, no hazardous materials were found at any of the sub-sites at Cracker Creek that warranted inventorying. As note above, however, some surface debris remains at one site (sub-site 19H) consisting of wooden crates, tin cans and some broken glass, that could be buried or removed for aesthetic reasons (see Plate 5).

4.2.2 Site 20 - Canyon Creek

Like Cracker Creek, this site has obviously been extensively cleaned up, at least superficially, over the last decade. As a result, the surface debris that remains is relatively minor. Site 20A, CANOL Pumping Station C has one area of building debris which is largely overgrown and otherwise only the concrete foundations of the main buildings remain. These foundations are possibly of historical interest and pose no real danger to humans or animals and in our opinion are not a concern (see Plates 8 and 9).

The main area of surface debris occurs in sub-site 20B on the south side of the Highway. As noted above numerous occurrences of wooden crates and wooden construction material, tin cans and other metal material including some automotive parts and miscellaneous debris occur here. The material shown in Plates 10 through 13 are typical of this area. These are considered to be aesthetic concerns only.

4.2.3 Site 42 - Hayes Creek Noranda Camp

A lot of material was found at each of the four sub-sites; consequently, the inventory will be listed separately for each one.

4.2.3.1 *Site Inventory - CA-35*

(See plates 14 through 17)

- -diesel fuel barrels (empty)
    - -14 blue - Chevron H. Diesel, Aug. 84, May 85
    - -17 red - Esso (Imperial Oil)
    - -1 small red (no label)
    - -1 green - Isopropyl Alcohol
- -old log cabin


Plate 13

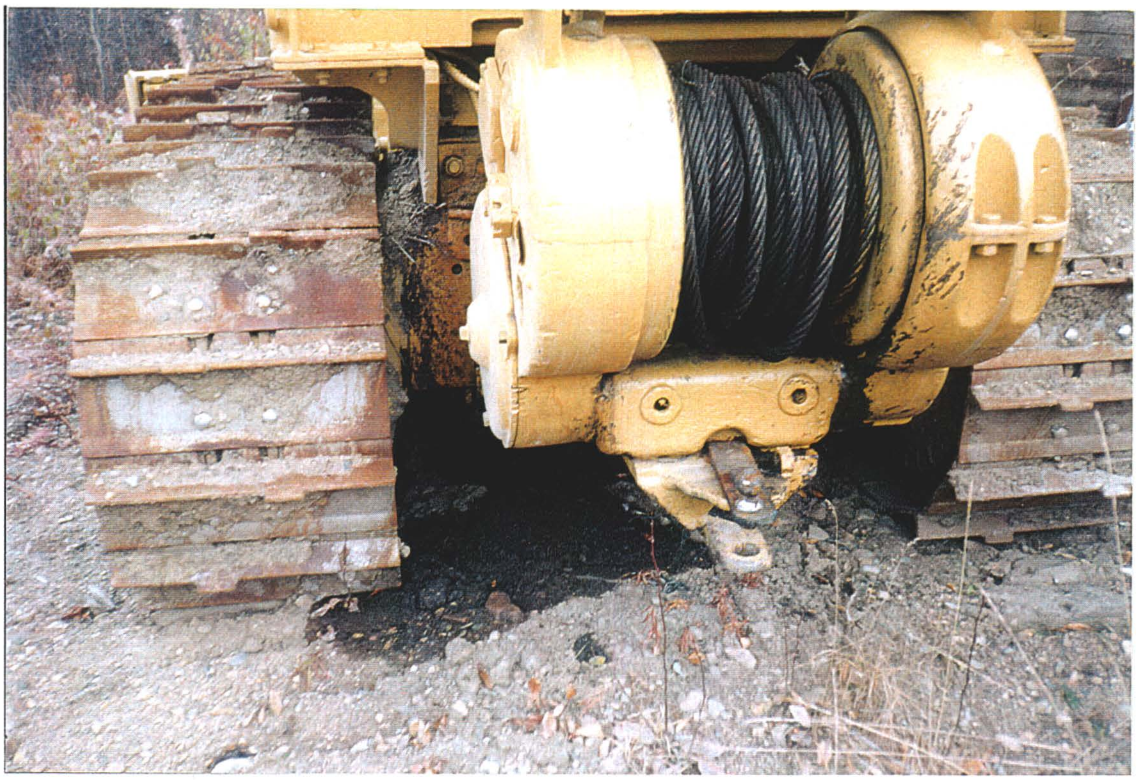
Plate 14



Plate 15

Plate 16


- 2 shacks (bunkhouse and tool shed)
- 2 caterpillars
- 20 L motor oil barrels - plastic (Gulf/Chevron) (empty)
- Crushed cans and barrels (numbers are approximate as they are scattered)
    - 20 L naphtha (approx. 12 total)
    - 1 hydraulic oil
    - 1 chain bar oil
    - 1 gear lubricant

-8 large propane cylinders/1 small propane cylinder
-pipes
-metal debris (miscellaneous) - washing machine, bar, plate, caterpillar parts, chains
-wood pile
-old sled

4.2.3.2 *Site Inventory - CA-33*

(See Plates 18 through 20)

-propane tank
-diesel fuel tanker
-approximately 28 barrels labelled diesel fuel (empty)
-tractor tires
-high flotation tires (Exact origin unknown)
-metal debris
-old wood stove

4.2.3.3 *Site Inventory - CA-34 (Kline's Gulch Airstrip)*

(See Plates 21 through 25)

-caterpillar tracks
-51 diesel fuel barrels, aviation fuel (empty), motor oil cans by drums (empty)
-there were approximately 70 barrels total (most of them are empty, a couple are full - this may be water/diesel (we couldn't open any but they were all labeled diesel)
-kitchen, freezer and kitchen utensils
-tires
-5 large propane cylinders
-beds
-6-10 small oil barrels (20 L)
-Coleman fuel can, motor oil
-old cans, pipes, wheel parts, filters
-trenching all around the site
-3 or 4 tents

4.2.3.4 *Site Inventory - CA-32*

(See Plates 26 and 27)

-6 shacks on site/1 outhouse
-approximately 4-5 old rusted diesel barrels (empty)
-2 big racks of cores; 1 other rack of cores now scattered widely
-trenches or lines behind camp site along creek

4.3 Site Surface Conditions

4.3.1 Surface Water Sampling

Surface water samples were collected in 250 ml Wheaton bottles and transported to MDA Environmental in Brantford in a cooler with ice packs via air-freight. After a review of the investigation results for the three sites, including the field screening results, specific samples were sent to Zenon Environmental Laboratories in Burlington, Ontario for chemical analysis. Sample selection was made following the process identified in the PRESIS.

Sample collections were made where there appeared to be evidence of possible contamination, where contamination was suspected or to provide background levels of surface water in the area, as follows:

- Site 19 - Cracker Creek — - no water samples taken as there was no surface water in the area and Cracker Creek is approximately 1 km from the site
- Site 20 - Canyon Creek — - groundwater was collected from 8 pits excavated at the base of the military dump (see Figure 14 for locations)
  - surface water was collected on the Aishihik River upstream and downstream of the military dump
- Site 42 - Hayes Creek Noranda Camp
  - one sample was collected 200 m below the sluice between sites CA34 and CA33
  - at site CA32, samples were collected upstream of the camp (50 m before the bend) and downstream, 50 m below the last cabin (see Figure 15 for locations)

4.3.2 Surface Soils

The nature of surface soils is important with respect to the infiltration and subsurface transport of water and contaminants. Consequently, soil samples were collected at Sites 19 and 20 to assess this potential. These data are presented in Appendix 6. In general, Site 19 can be described as having fine sand soils with a silty/clay matrix. Much of the coarser material in these samples was actually clumped fines which upon continued sieving were dis-aggregated to silts and clays. As a result of this fine texture, these soils would tend to be much less conductive than the soils of Site 20. The Military Dump area of Site 20 (sub-site 20D) (samples were collected on the face of the dump and thus these samples represent cover material, not internal fill material) consists of a sandy gravel. To the west of Aishihik River at sub-site 20B-16, the soil can be described generally as a silty fine sand. Although this soil has a greater percentage of silt and clay then those of Site 19, the soils at site 20B-16 do not have the fine clays present and are considerably better sorted. These soils are likely river bed sediments deposited during deglaciation of the area. As illustrated in Plates 28 and 29, this area geomorphologically contains interbedded sediments ranging from gravels to sandy gravels to thin silty clay beds which are the result of annual flow cycles. Consequently, the fine silty sand at the surface of this are may be underlain by highly variable and very permeable beds of sediment.

The CANOL Pumping Station site was also sampled in the vicinity of the disposal area to the east of the actual remains of the pumping station. While this was surface material, it is likely indicative of the material used to bury whatever debris was disposed of here. This is again a silty sand much like sub-site 20B-16, although at various places there was evidence of gravels which could merely be the fill material placed under and about the construction site to provide a firm base.

Soil samples for grain size analysis were not collected at the Hayes Creek site due to the heterogeneity of the surface material at the site which would have required extensive sampling to make any general assessment. This was not feasible due to the helicopter access to these sites. In general, the surficial material at Hayes Creek can be described as coarse to fine gravels with a sand matrix. (See Plate 30)

4.3.3 Soil and Groundwater Sampling

Soils samples were collected in polyethylene containers or whirl-pack bags for field pre-screening and transported to MDA Environmental in Brantford in a cooler with ice packs via air-freight. Due to the high detection limits utilized in the assessment, such containers were appropriate and avoided the risk of breakage usually associated with glass containers. After a review of the investigation results for the three sites, including the field screening results, specific samples were sent to Zenon Environmental Laboratories in Burlington, Ontario for chemical analysis. Sample selection was made following the process identified in the PRESIS.

Surface soils were sampled from the sites as listed in Table 1. Locations of the soil samples are provided in the appropriate site plans for each sub-site.

Site 19 - Cracker Creek

At Site 19, both soil and liquid samples were acquired, either near or directly from exposed steel drums. One soil sample (Sample 8) was acquired at Sub-site 19-F from a shallow hole downslope of a partially exposed metal drum. Broken glass, which tended to be ubiquitous at burial sites here and other refuse were encountered during excavation. Additionally, a small (10 ml) liquid sample (Sample 29) was acquired from an exposed metal drum at Sub-site 19-E.

Site 20 - Canyon Creek

Soil samples only were acquired in the western portion of Site 20B, while both soil and groundwater samples were obtained from the former military dump-site farther to the east (sub-site 20D). Groundwater samples at the Military Dump were obtained from a series of 0.5 m deep pits excavated at the toe of the dump in an area having a shallow water table. Subsurface seepage water was sampled directly from each pit with 250 ml amber glass jars. Soil samples obtained from Site 20 were sealed in both high density polyethylene (HDPE) containers and whirlpaks. Both soil and groundwater samples were stored in a closed cooler.

The military dump-site section of Site 20 (sub-site 20D) was an area of relatively intense soil and groundwater sampling. A total of 12 sampling pits were excavated at this site, from which 11 soil

Plate 17

Plate 18

Plate 19

Plate 20

Plate 21

Plate 22

Plate 23

Plate 24

Plate 25

Plate 26

Plate 27

Plate 28

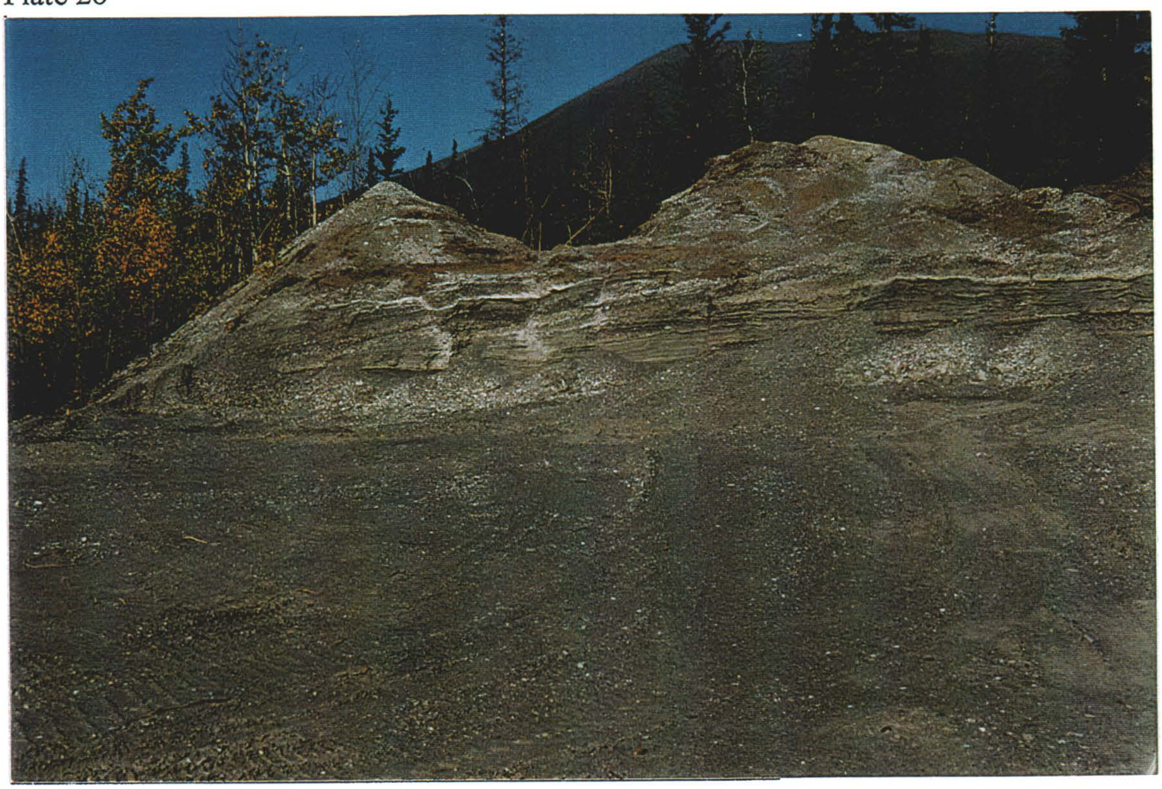


Plate 29

Plate 30

samples and 8 groundwater samples were acquired (see Figure 14). Soil Sample 23 (pit 1), Sample 22 (pit 2) and Sample 17 (pit 3) were sandy samples acquired along the top of the dump's embankment, proximal to subsurface magnetic anomalies and prone to possible off-site contaminant migration during runoff events.

Nine additional pits (4 to 12) (see Figure 14 for locations) were excavated at 8 m intervals in the fine sediments along the base of the dump-site's embankment. Eight soil samples were obtained from these pits; Sample 25 (pit 4), Sample 15 (pit 5), Sample 13 (pit 6), Sample 19 (pit 7), Sample 16 (pit 8), Sample 18 (pit 9), Sample 14 (pit 10) and Sample 21 (pit 11). No soil samples were acquired from the northernmost pit, number 12.

Eight groundwater samples were acquired from pits along the base of the embankment; Sample 30 (pit 4), Sample 31 (pit 5), Sample 32 (pit 6), Sample 33 (pit 8), Sample 34 (pit 9), Sample 35 (pit 10), Sample 36 (pit 11) and Sample 37 (pit 12). Water seepage into pit 7 was inadequate for sampling purposes.

Within the western portion of Site 20 (sub-site 20B), samples were obtained from sub-sites 20B-8 and 20B-15. At each of these sub-sites, shallow pits were excavated and samples were acquired from both the near-surface and subsurface. Sample 24 (surface) and Sample 27 (subsurface) were taken at sub-site 20B-8, while Sample 16 (surface) and Sample 20 (subsurface) were obtained at sub-site 20B-15.

Table 1: Locations of soil samples from Cracker Creek, Canyon Creek and the Hayes Creek Noranda Camp

Sample Designation	Sample Material	Sampling Date	Sample Location	Container Type	Description
sample 1	soil	02-Oct-96	Site 34	polyethylene	Label: "Site 34-Stained surface soil 2 m in front of barrel off airstrip"
sample 3	soil	01-Oct-96	Site 35	polyethylene	Label: "Site 35-Pit below crest of mound near cat. (Shawn's Pit)"
sample 4	soil	01-Oct-96	Site 35	polyethylene	Label: "Site 35-5 m right of log cabin, 30 cm deep"
sample 5	soil	01-Oct-96	Site 35	polyethylene	Label: "Site 35-Pit by wood pile-sediment"
sample 6	soil	01-Oct-96	Site 35	polyethylene	Label: "Site 35-Soil under caterpillar-likely motor oil/deisel fuel"
sample 8	soil	30-Sep-96	Site 19-F	polyethylene	Label: "Soil site-19-E Near partially exposed drum" (actually subsite 19-F)
sample 9	soil	01-Oct-96	Site 33	whirlpak	Label: "Site 33- rust-stained soil 25 metres from tank"
sample 10	soil	01-Oct-96	Site 33	whirlpak	Label: "Site 33- Discoloured near-surface soil by orange drum dump"
sample 11	soil	01-Oct-96	Site 33	whirlpak	Label: "Site 33- Soil beside excavated orange drum"
sample 12	soil	01-Oct-96	Site 33	whirlpak	Label: "Site 33- Oil-stained soil near big wheels"
sample 13	sediment	29-Sep-96	Military Dump	whirlpak	Label: "S-6": fine sediment from base of escarpment
sample 14	sediment	29-Sep-96	Military Dump	whirlpak	Label: "S-10": fine sediment from base of escarpment
sample 15	sediment	29-Sep-96	Military Dump	whirlpak	Label: "S-5": fine sediment from base of escarpment
sample 16	soil	26-Sep-96	Site 20-B-15	whirlpak	Label: "20-B-15S" surface soil in large burn area
sample 17	soil	29-Sep-96	Military Dump	whirlpak	Label: "Military dump S-3": sand, top of escarpment. near metal target
sample 18	sediment	29-Sep-96	Military Dump	whirlpak	Label: "S-9": fine sediment from base of escarpment
sample 19	sediment	29-Sep-96	Military Dump	whirlpak	Label: "S-7": fine sediment from base of escarpment
sample 20	soil	26-Sep-96	Site 20-B-15	whirlpak	Label: "20-B-15SS" subsurface soil in large burn area
sample 21	sediment	29-Sep-96	Military Dump	whirlpak	Label: "S-11": fine sediment from base of escarpment
sample 22	soil	29-Sep-96	Military Dump	whirlpak	Label: "Military dump S-2": sand, top of escarpment. near metal target
sample 23	soil	29-Sep-96	Military Dump	whirlpak	Label: "Military dump S-1": sand, top of escarpment. near crushed drum
sample 24	soil	26-Sep-96	Site 20-B-8	whirlpak	Label: "20-B-8S" surface soil in burial area
sample 25	sediment	29-Sep-96	Military Dump	whirlpak	Label: "S-4": fine sediment from base of escarpment
sample 26	sediment	29-Sep-96	Military Dump	whirlpak	Label: "S-8": fine sediment from base of escarpment
sample 27	soil	26-Sep-96	Site 20-B-8	whirlpak	Label: "20-B-8SS" subsurface soil in burial area
sample 28	soil	01-Oct-96	Site 35	polyethylene	Label: "Site 35-front right corner (old log cabin)"

sample 29	liquid	26-Sep-96	Site 19-E	polyethylene	Label: "Contents of drum at 19-E": Muddy liquid
sample 30	water	29-Sep-96	Military Dump	amber glass	Cap Label: "W-4": Water from pit adjacent to sed sample S-4
sample 31	water	29-Sep-96	Military Dump	amber glass	Cap Label: "W-5": Water from pit adjacent to sed sample S-5
sample 32	water	29-Sep-96	Military Dump	amber glass	Cap Label: "W-6": Water from pit adjacent to sed sample S-6
sample 33	water	29-Sep-96	Military Dump	amber glass	Cap Label: "W-8": Water from pit adjacent to sed sample S-8
sample 34	water	29-Sep-96	Military Dump	amber glass	Cap Label: "W-9": Water from pit adjacent to sed sample S-9
sample 35	water	29-Sep-96	Military Dump	amber glass	Cap Label: "W-10": Water from pit adjacent to sed sample S-10
sample 36	water	29-Sep-96	Military Dump	amber glass	Cap Label: "W-11": Water from pit adjacent to sed sample S-11
sample 37	water	29-Sep-96	Military Dump	amber glass	Cap Label: "W-12": Water from pit 12, base of escarpment
sample 38	water	01-Oct-96	Site 35	amber glass	Cap Label: "35-W - 200 m below sluice"
sample 39	water	02-Oct-96	Site 32	amber glass	Cap Label: "Site 32 downstream of camp 50 m below last cabin"
sample 40	water	02-Oct-96	Site 32	amber glass	Cap Label: "Site 32 upstream 50 m before bend"
sample 41	water	29-Sep-96	Lower Aishihik River	amber glass	Cap Label: "2R"
sample 42	water	29-Sep-96	Upper Aishihik River	amber glass	Cap Label "1R"

Table 1(cont'd.): Locations of soil samples from Cracker Creek, Canyon Creek and the Hayes Creek Noranda Camp

Site 42 - Hayes Creek

A total of 10 soil samples were aquired from the various subsites composing Site 42 following the established sampling protocol previously applied at sites 19 and 20. Four soil samples were obtained from Subsite CA-33, one sample was obtained from Subsite CA-34, and five samples were obtained from Subsite CA-35.

Soil samples 9, 10, 11, and 12 consisted of sandy gravels obtained from Sub-site CA-33. Both samples 9 and 10 were surface samples obtained from rust-discoloured areas observed at the site. Sample 11 was a shallow (0.25 m) subsurface soil taken from beside an excavated orange metal drum. Sample 12 was a surface sample acquired from a small patch of oil-stained ground located proximal to a set of large rubber tires (Plate 20).

Soil sample 1 was acquired at Sub-site CA-34. The sample consisted of a coarse-grained stained surface soil located proximal to a metal drum located at the western end of the site's airstrip.

Soil samples 3, 4, 5, 6, and 28 consisted of sandy gravels obtained from Sub-site CA-35. Sample 3 was a subsurface soil obtained from a shallow pit located downslope of a refuse burial mound at the northern end of the site. Samples 4 and 28 were surface soils obtained near a dilapidated log cabin located at the southern end of the site in an area having stained surface soil and an unidentified magnetic anomaly (Plate 15). Excavation of the area near these sampling points revealed ubiquitous broken glass and other miscellaneous debris. Sample 5 was a subsurface soil obtained beside an excavated blue metal drum located beneath a wood pile at the northern end of the site. Sample 6 was a dark-stained surface soil obtained from beneath a bulldozer also located at the northern end of the site (Plate 14).

4.3.4 Biological Survey

The aquatic biological site assessment consisted of a preliminary biological evaluation of macro-invertebrates in the Aishihik River below the military dump at site 20. Site 20 was the only site where a biological assessment was performed. None of the other sites were close enough to a water body or had potential signs of contamination to warrant investigation. An upstream site about 20 m below the highway bridge as well as a downstream site about 800 m below the highway bridge were sampled. The site 800 m from the highway was called the downstream site as it was downstream of the military dump. Copies of site field notes are attached as Appendix 7. A sampling effort of approximately 2 to 2.5 hours was undertaken at both the upstream and downstream sites.

In addition to current speed estimates, substrate types and water depth, pH, specific conductance and temperature of the water were measured at each sampling site. Biota were collected via kick and grab samples. A Benthos tube was used to collect samples, however the rocky nature of the bottom made it easier to kick samples directly into the screen as well as by turning over rocks. Samples were composited and sorted using a 500 μm sieve. Macroinvertebrates found in the sieve were placed in specimen bottles and preserved using a 50% solution of alcohol. Identifications were performed using a dissecting microscope and confirmed through the use of biological field guides and keys. Classification of the aquatic insects were made to Order and in some cases to Family.

The terrestrial survey was undertaken for each site to check for avoidance of the burial sites by burrowing animals . At all dry sites in Sites 19 and 20, evidence of active burrows were apparent, often right in the area where surface debris and the geomagnetic survey indicated the presence of greatest buried waste material. Clearly, there was no sign of avoidance at these sites, including along the face of the sub-site 20D, the military dump. As non of these animals were seen, the actual species were not determined. As noted above, vegetation was often a clear indication of burial sites due to the slow rate of re-vegetation. As well, in sub-site 20B, areas that apparently had been subjected to waste burning, showed extremely slow rates of recolonization by local species possibly as a result of the loss of organic matter from the sandy soils.

4.4 Site Sub-surface Conditions

Where it was warranted based upon physical evidence, intensive and in some cases reconnaissance level geophysical surveys were undertaken to investigate the nature of the subsurface material without intrusive excavations. This was useful in that all previous records (for Sites 19 and 20) had indicated that burial was shallow (1 - 2 m) and thus based on the results of the geophysical survey, shallow test pits could be made at target sites and the contents of the site quickly determined. Each site will be discussed in turn.

4.4.1 Site 19 - Cracker Creek

Systematic geophysical investigations were undertaken at sub-sites 19B, 19C, 19D, 19E, and 19F. Sub-site 19I was scanned but nothing was detected using the EM31.

Sub-site 19B (drawing no. 705-104 in Appendix 2) shows two zones of slightly increased conductivity. These two zones coincided with surface metallic debris and indicate that this continues at depth. The in-phase plot confirms the presence of buried metal debris. There is no evidence of any plumes extending from the targets to suggest liquid contaminant sources.

Site 19C (drawing 705-105) is a large area showing numerous targets. Again most of these coincided with surface metal debris frequently of vehicular origin and the presence of metallic debris is confirmed by the in-phase plot. Again for this site there is no evidence of transport plumes away from the targets.

Site 19D (drawing 705-106) was a large cleared area with no surface evidence of disposal. This tends to be confirmed for the site by the conductivity which showed only one strong target in the northwest extremity of the sub-site. The in-phase plot did not indicate that this was a strong metallic signal and the absence of surface debris suggested that excavation was not warranted to determine the cause of the high conductivity.

Site 19E (drawing 705-107) shows three targets with high conductivities. Two of these were determined to be buried wastes including cans and other metallic material. The third one in the centre of the drawing was identified to contain crushed drums. Both soils samples and contents samples from one of the drums that was exposed were sampled here and field screened with no indication of ionizable contaminants or hydrocarbons at the levels of detection. This site was close to the water table, which may have been perched at this location, and there is no evidence for a contaminant plume away from this site. Consequently, while there is clearly material buried here, it is thought to consist largely of metallic debris with little to no contamination concerns.

Site 19F (drawing 705-108) is interesting. A target was identified consistent with the debris that was visible on the surface. It seemed to consist of at least one drum and heavy vehicle parts. The in-phase signal indicated that this was an area of metallic debris. At first appearance, there appears to be a subsurface plume of greater conductivity extending from this site basically to the north. Visual inspection of the soils and subsurface water in this area confirmed that this is a topographical effect with water at or near the surface along a depression resulting in increased conductivity. As a result, further investigation was not considered to be warranted.

4.4.2 Site 20 - Canyon Creek

Sub-site 20A of the Canyon Creek site had clearly identifiable burial sites as noted in Figure 12. Nevertheless, the conductivity map of this site (drawing 705-110) indicated the absence of targets and the pattern appears to be primarily a topographic effect reflecting probably increased water content in low lying areas at the edge of the fill. The in-phase plot showed two relatively weak metal targets in the east burial site but these do not suggest any immediate concern. This site had been excavated in one spot to a depth of approximately 1.5 m and aside from the one section of 3" pipe (from the CANOL pipeline) that was exposed, there was no evidence of wastes at this site. Based upon the physical information, and this geophysical data, it is possible that the large so-called disposal or burial site to the east of the remains of the pumping station is nothing more than surficial material that was relocated as part of the construction activities at this site and that there are no actual wastes buried here.

Three waste disposal areas in sub-site 20B were investigated in detail using the EM31. All other sites were checked only with a hend held metal detector and shallow pits and as a result it was determined that there was not extensive burial of metallic wastes at any of these sites. Sub-site 20B-5 was scanned (drawing 705-113) and it was determined that there was one area of buried metal debris in the middle of the site. This site was sandy and represented a slight geographic rise above the surrounding land so it is well drained. This is indicated by the conductivity plot which does not show any variation except in the central burial site indicating that there is no evidence of an contamination plume from this site.

Sub-site 20B-11 is a large site in the southwest corner with lots of evidence of surface soil and vegetation removal and some partially buried surface debris. Again this is a sandy, dry site as indicated by the general lack of conductivity gradient across the site except in the central target area. The in-phase signal confirmed that this target is metallic and quite dense. This signal also indicates that there is other buried debris in this site with a signal but these are small compared to the major target area. It is our conclusion that while buried material exists here, it is likely to be metallic vehicular parts and other metal debris with no real evidence of a major concern for environmental contamination.

Sub-site 20B-15 and 15A represent a large area extending to the east of the trail. There is clearly one target area here with a metal signal as shown by both the conductivity and in-phase signal. One other burial site is indicated in sub-site 20B-15A, basically behind the first site. Again these results together with the evidence of near surface debris indicate that this is a metal material burial site with little to no likelihood of contamination of the subsurface.

Sub-site 20D is the military and local dump area. This site, as noted above, has been extensively cleaned up relative to the early reports on the site and the only visible waste is now presently along the steep face of the dump down toward the meander of Aishihik River. It was not possible to electromagnetically survey the face of the dump in sufficient resolution to prepare drawings of the face so the only drawings prepared are for the top of the dump. These drawings show one particularly strong metal signal at the south end of the site and to the west of the roadway (i.e. toward the face of the dump). At least three other areas of buried metal debris are located along the top of the dump over a distance of approximately 150 m. This information provided the basis for positioning test pits and soil sampling sites on the face of the dump in order to identify contents and the possibility of site contamination.

4.4.3 Site 42 - Hayes Creek Noranda Camp

Based upon the surface inspection, a number of sites were inspected using the EM31 in a reconnaissance fashion but there was no evidence of contaminant plumes or buried targets as part of any of these investigations. Consequently, no drawings have been made for any of these sites and no further comments will be made regarding the results from the subsurface investigation.

5. SITE CONTAMINATION CONSIDERATIONS

5.1 Field Screening Results

The results of the field screening for chlorinated compounds and volatile organic compounds (VOCs) (generally associated with hydrocarbon contamination) within the soil samples collected at all three sites are provided in Table 2. IONSCAN plasmagrams are provided for reference in Appendix 8. A characteristic IONSCAN plasmagram for a soil sample confirmed by GC/ECD analyses to have a high concentration of PCBs (> 90 µg/g) is illustrated in Figure 14 for comparison.

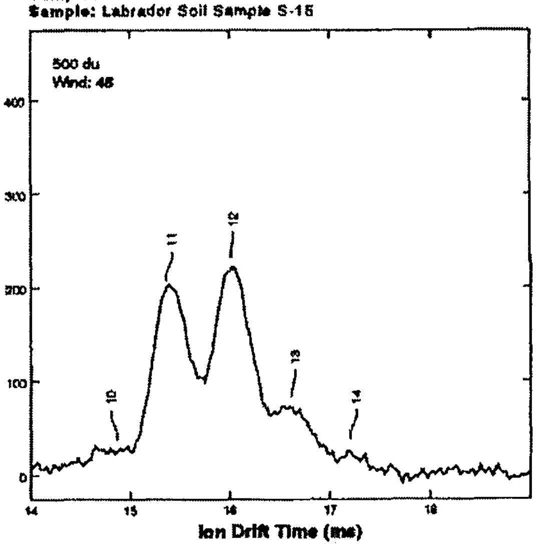
Figure 14: Characteristic IONSCAN plasmagram for a soil sample with a concentration of PCBs of approximately 90 µg/g

BARRINGER

IONSCAN™ Explosives Plasmagram

SampID: S-15 Cls: PCB WTime: 19.80 - 20.24 s
Sample: Labrador Soil Sample S-15

Pk1	PeakID	K_o	DTime	
9	Cal	[illegible]	[illegible]	
10	PENTA-CB	1.1777 *	14.673	*
11	HEXA-CB	[illegible]	[illegible]	*
12	HEPTA-CB	[illegible]	16.014	*
13	OCTA-CB	[illegible]	16.622	*
14	NONA-CB	1.0179 *	17.205	*



Wnds: 45 Scans: 20 Pts: 856 Per: 25µs T: 22ms Alg: 1 Time: 15:46:32 05/13/96
Desc: Model 250-8307 Neg Mode; 118,299,297 degC; 351,300,863 cc/min;

RESULTS OF IONSCAN ANALYSIS *** FAIL *** No. of IONSCAN windows: 45

HEXA-CB ALARM! Substances found: HEXA-CB
HEPTA-CB ALARM! Substances found: HEPTA-CB
OCTA-CB ALARM! Substances found: OCTA-CB

Chn	ChanID	Ko	DTime (µs)	Max Amp	Delta (µs)	# of Hits	Detected Substances (Partly) Dependent upon this Channel
0	Cal	1.6540	10590	277	N/A	N/A	
11	HEXA-CB	1.1405	15404	119	+46	15	HEXA-CB
12	HEPTA-CB	1.0938	16024	153	+11	21	HEPTA-CB
13	OCTA-CB	1.0538	16643	36	+22	8	OCTA-CB

Directory Pathname: c:\ism\pcb\pcb_samp
IONSCAN Model No: 250 Serial No: 8307
Comments:
Soil Sample S-15, oven dried approximately 15 minutes at 200 deg. C.
Results of 10th desorbtion.
Monday, May 13th, 1996.

5.1.1 Site 19 - Cracker Creek

Sample 8 soil, acquired downslope of a partially exposed drum at subsite 19-D, showed an absence of PCB-characteristic peaks during IONSCAN screening. The sample was observed to generate a peak having an approximate drift time of 12.2 ms. However, analytical analysis would be required to determine what this peak represents and this was not possible with the limited sample available and within the current budget. Photovac screening of Sample 8 indicated VOCs at 3 ppm.

5.1.2 Site 20- Canyon Creek

Soil samples acquired from sub-sites 20B-8 and 20B-15 in the western section of Site 20 showed an absence of any significant peaks indicative of PCB's or other ionizable substances during IONSCAN screening. Photovac screening of the same samples indicated VOC concentrations ranging from 6.5 to 9.9 ppm.

Sand and sediment samples acquired from pits 1, 3, 4, 7, 8, 9, 10, and 11 of the military dumpsite showed an absence of any significant peaks indicative of PCB's or other ionizable substances during IONSCAN screening. Sample 13 (pit 6), Sample 15 (pit 5) and Sample 22 (pit 2) each generated peaks having an approximate drift time of 11.4 ms. Samples 15 and 22 also generated an additional peak having an approximate drift time of 12.2 ms. These observed peaks are not characteristic of PCB contamination. Photovac screening of these dumpsite samples indicated the presence of VOCs in the range of 10 to 20 ppm at most fine sand sites along the base or toe of the dump except for samples 19 and 26. The samples from higher up on the exposed face of the dump ranged from 8.8 ppm (sample 23) to 10.0 and 17.8 ppm for samples 22 and 17, respectively. Samples 22 and 23 were located close to a metal drum whereas sample 17 was located near an un-excavated metal target.

Table 2: Summary of IONSCAN and Photovac field screening for chlorinated compounds and total volatile organic hydrocarbons for Yukon soil samples

Sample Designation	Sample Material	Sample Location	IONSCAN Peaks (ms)	Volatile organic Hydrocarbons		
				Maximum (ppm)	Back-ground (ppm)	Comment
Sample 1	soil	Site 34	12.2, 13.0, 18.8	2.6	0.7	
Sample 3	soil	Site 35	12.2	1.5	0.7	
Sample 4	soil	Site 35	11.4, 12.2, 12.9, 13.6	2.4	0.5	
Sample 5	soil	Site 35	12.2	1.8	0.3	
Sample 6	soil	Site 35	12.2, 12.9	46.1	0.7	
Sample 8	soil	Site 19-E	12.2	3.0	1.1	
Sample 9	soil	Site 33		9.9	3.3	
Sample 10	soil	Site 33		8.2	3.0	
Sample 11	soil	Site 33	12.2	18.7	3.0	
Sample 12	soil	Site 33	12.2, 13.2, 13.9, 14.7, 15.3, 16.2, 16.7, 18.8	21.6	3.2	moist
Sample 13	sediment	Military Dump	11.4	13.3	0.2	moist
Sample 14	sediment	Military Dump		17.9	2.0	moist
Sample 15	sediment	Military Dump	11.4, 12.2	10.4	2.0	moist
Sample 16	soil	Site 20-B-15		8.8	0.2	
Sample 17	soil	Military Dump		17.8	1.8	
Sample 18	sediment	Military Dump		13.6	2.0	moist
Sample 19	sediment	Military Dump		6.2	2.9	moist
Sample 20	soil	Site 20-B-15		6.5	2.6	
Sample 21	sediment	Military Dump		19.2	2.3	moist
Sample 22	soil	Military Dump	11.4, 12.2	10.0	2.6	
Sample 23	soil	Military Dump		8.8	2.6	
Sample 24	soil	Site 20-B-8		9.9	2.5	
Sample 25	sediment	Military Dump		18.4	2.7	
Sample 26	sediment	Military Dump		8.0	0.3	moist
Sample 27	soil	Site 20-B-8		8.5	2.6	
Sample 28	soil	Site 35	19	21.1	0.7	
Sample 29	liquid	Site 19-E		insufficient sample		
*Note: In moist samples, erroneously high readings may result as water vapour may contain mineral salts which carry a charge. The water vapour becomes an electrolytic solution which becomes ionized when it enters the detector.						

5.1.3 Site 42 - Hayes Creek Noranda Camp

Soil samples 9 and 10 acquired from Subsite CA-33 showed an absence of any significant peaks indicative of PCB's or other ionizable substances during IONSCAN screening. Sample 11, also from sub-site 33 was observed to generate an IONSCAN peak having an approximate drift time 12.2 ms, while sample 12 was observed to generate at least 8 peaks having drift times ranging from 12.2 ms to 18.8 ms. Althought a single PCB alarm (Penta-CB) was triggered during screening of this sample, the absence of other congeners contained in commercial PCB distillations makes PCB contamination of this sample unlikely. Photovac screening of the soil samples from Sub-site CA-33 indicated total VOC concentrations of 9.9, 8.2, 18.7 and 21.6 ppm for samples 9, 10, 11 and 12, respectively. This combination of results is indicative of hydrocarbon contamination, such as oils and fuels, at this site with little or no evidence of the contaminants being characteristic of chlorinated hydrocarbons.

Soil sample 1 from Sub-site CA-34 showed an absence of any significant peaks indicative of PCB's. The sample was, however, observed to generate 3 distinct peaks having approximate drift times 12.2 ms, 13.0 ms, and 18.8 ms. Photovac screening of the Subsite CA-34 sample indicated low VOC concentrations of 2.6 ppm indicative of minor contamination of hydrocarbons.

During IONSCAN screening, none of the soils acquired from Sub-site CA-35 showed any significant peaks indicative of PCB contamination. Sample 3 was observed to generate one peak having an approximate drift time 12.2 ms while sample 4 produced 4 peaks having approximate drift times of 11.4 ms, 12.2 ms, 12.9 ms 13.6 ms. Sample 5, generated one peak having an approximate drift time of 12.2 ms. Sample 6 generated 2 peaks having approximate drift times of 12.2 ms and 12.9 ms. Sample 28 was observed to generate several muted peaks, including one wide peak having an approximate drift time of 19 ms. Photovac screening of Sub-site CA-35 samples indicated VOC concentrations of <3 ppm for samples 3,4 and 5 but 46 ppm for sample 6 directly under the caterpillar indicative of some type of oil spill probably with the IONSCAN peaks resulting from impurities or additives to the oil.

5.2 Laboratory Analyses

5.2.1 Soil Samples

Based on the results of the pre-screening of the soil samples, a subset (Samples 1, 6, 12, 15, 22 and 28) was submitted to Zenon Laboratories of Burlington, Ontario for quantitative analyses of selected organochlorines (except samples 1 and 6) and hydrocarbons. These data are presented in Appendix 9. These samples were selected as representative of those samples displaying IONSCAN peaks as well as VOC concentrations from Sites 20 - Canyon Creek and Site 42 - Hayes Creek Noranda Camp. No samples from Site 19 - Cracker Creek had pre-screening results suggesting the need for follow-up laboratory analysis. In all cases, the samples showed no detectable concentrations of organochlorines including PCB. Consequently, no additional samples were submitted. Although the IONSCAN was detecting something, it does not appear to be a chlorinated compound of concern. Based upon the surrogate recovery for 2,4,5,6-Tetrachloro-m-xylene (102 to 122 %), it is reasonable to assume that analytical procedure recovered the target analytes and confidence can be placed in these results.

Six soil samples were analysed for hydrocarbons. Note that the detection limits varied depending on the dilution of the extract. In these samples, a total of 3 surrogates were used with percent recoveries that ranged from 23 to 107%. In general this range can be considered acceptable although the recoveries for Sample 15 are noticeably low. All of the surrogates in Sample 6 could not be quantified due to the high concentration of some of the target compounds. Of these samples, only Sample 6, which was a clearly oil stained patch of soil directly under a caterpillar had quantifiable concentrations of hydrocarbons including 1-methylnaphthalene, acenaphthalene, fluorene, phenanthrene and pyrene. Phenanthrene exceeded the Ontario soil quality guideline (MOEE, 1994). There is no guideline for 1-methylnaphthalene although the guideline for 2 -methylnaphthalene in soil for parkland and recreation in an area where the groundwater is considered to be potable is only 0.29 mg/Kg. The concentration of 1-methylnaphthalene, if the guidelines are in fact comparable, could be a concern at a concentration of 55 mg/Kg although the extent of this contaminated area is small and thus does not pose a major concern.

5.2.2 Water Samples

Field pre-screening techniques used in this study were not suitable for water samples although the results for the soils were used to suggest possible contamination of water. Water samples were not analysed for organochlorines and hydrocarbons as the low water solubility of most of these compounds would mean that they would not be present at detectable concentrations except through the use of large volume samples to lower the detection limit. This level of investigation is not normally required in a site assessment and was not indicated as being required based upon the soil sample results. The detailed analytical results for the water samples also are provided in Appendix 9.

One sample from Hayes Creek (site 42, sub-site 35) was analysed from about 200 m downstream of the sluice. This sample which had elevated concentrations of nitrate (1.1 mg/L) relative to the other samples and high concentrations of sulphate (340 mg/L) and sulphur (Canadian Water Quality Guideline for water supply for SO_4 is 500 mg/L) is likely indicative of groundwater in this area and consequently these results do not suggest a concern due to contamination.

The other water samples were collected from the area of the military dump at Site 20 -Canyon Creek. This dump was a particular concern as its contents are totally unknown although its period of use was relatively restricted as noted above. Samples 31 and 32 represented groundwater collected from shallow pits at the toe of the dump whereas Samples 41 and 42 were from the Aishihik River, upstream and downstream of the general area of the dump. Not surprisingly, the concentrations for most analytes were higher in the groundwater than in the surface water samples. Chromium, copper, iron and manganese all exceeded either the surface water quality guideline for the protection of aquatic life and/or the raw water supply for drinking water (CCME, 1987). It should also be noted that the concentrations of aluminum and silicon are also high and the abundance of these in the earth's crusts suggests that these elevated concentrations may all be typical of groundwater in the area. Additional work using stable isotopes would be required to further determine the nature of these groundwaters, including their approximate age, and this was beyond the scope of the current work. While some of the water chemistry data may be higher than guidelines, there is no clear evidence that these groundwaters are being contaminated by passage through the landfill site. This could only be confirmed through a more intensive investigation at this site including the installation of a test well upstream of the landfill. However, based upon the water quality data of the Aishihik River and other data from this investigation we do not think that this work has merit at this time. An ongoing watch of water quality at the toe of the dump, including some analyses of large volume water samples might be warranted to determine the possible presence of chlorinated organic compounds and hydrocarbons in the water. This should be a minimal program conducted every few years at most with several samples collected at the toe of the dump during the summer season.

5.3 Biological Survey Results - Site 20 - Canyon Creek

Both the upstream and downstream site had stoneflies, mayflies and blackflies. The presence of all of these aquatic insects are indicative of a healthy environment. Furthermore, the downstream site contained one chironomid (midge/blood worm). Chironomid larvae are found in almost all types of aquatic habitats. Some can withstand low oxygen levels and can live in the oxygen-poor substrata of deep lakes and below sewage outfalls (Clifford, 1991). The upstream site contained a snipe fly. It also contained a large number of black flies relative to the downstream site. This was likely sampling bias as there was one rock in particular at this site that contained a very large amount of black fly larvae. Some blackfly larvae are filter feeders while those without cephalic fans are collectors of organic debris around their attachment sites. (Merritt and Cummins, 1978).

As this was only a preliminary investigation, samples were considered to be indicators rather than being indicative of statistical significance. Clearly a more detailed evaluation could be performed. However, the presence of the species identified were indicative of a healthy ecosystem. As identified by Clifford (1991), Ephemeroptera (Mayfly) larvae are found in unpolluted waters of both standing and running waters. The greatest species diversity occurs in rocky bottomed second and third order streams. Most mayfly nymphs are collectors or scrapers and they feed on a variety of detrital and plant food eating substantial amounts of algae, especially diatoms (Clifford. 1991) and some animal material with a few of them being true carnivores (Merritt and Cummins, 1978). They achieve their greatest diversity in streams and can be an important food item for fish. Furthermore, most stonefly larvae are sensitive to a lack of dissolved oxygen, and their absence from streams can be an indication of organic pollution (not organic contaminants). In other words, stoneflies are primarily associated with clean and cool running waters (Merritt and Cummins, 1978).

Water samples collected at both the upstream and downstream sites were virtually identical and represented normal background levels for the area. These results further supported the conclusion that the Aishihik River is not currently being seriously impacted by leachate from the military dump or other waste sites in the vicinity. As this was a low flow sampling season (fall, 1996), it is likely that any leachate reaching the river in significant quantities would not be excessively diluted. Nevertheless, the cut off meander that now forms a floodplain wetland at the base of the military dump is probably a good buffer for the Aishihik River for any contaminants that may be released from this site.

Table 3: Results of the macro-invertebrate survey of Aishihik River above and below the military dump site

Species	Count
Site #1 - Downstream	
Phylum Arthropoda Class Insecta Order Plecoptera (Stone Flies)	13
Phylum Arthropoda Class Insecta Order Ephemeroptera (Mayflies)	10
Phylum Arthropoda Class Insecta Order Diptera Family Simuliidae (Black Flies)	25
Phylum Arthropoda Class Insecta Order Diptera Family Chironomidae (Midges, blood worms)	1
Site #2 - Upstream	
Phylum Arthropoda Class Insecta Order Plecoptera (Stone Flies)	7
Phylum Arthropoda Class Insecta Order Ephemeroptera (Mayflies)	8
Phylum Arthropoda Class Insecta Order Diptera Family Simuliidae (Black Flies)	203
Phylum Arthropoda Class Insecta Order Diptera Family Rhagionidae (Snipe Flies)	1

6. PRELIMINARY ENVIRONMENTAL RISK ASSESSMENT

6.1 Introduction

Human Health Risk Assessment (HHRA) refers to the technical, scientific assessment of the nature and magnitude of risk and uses a factual base to define the health effects of exposure of individuals or populations to hazardous contaminants and situations. In general, risk is defined as the probability of an adverse event. In the case of HHRA the health endpoints, both cancer and non-cancer, must be assessed. Li-Muller and Marsh (1994) indicate that for situations where uncertainty is so high that the assessment fails to provide a meaningful risk estimate, quantitative risk assessment would not be the tool of choice. This level of assessment is not appropriate for these sites due to the absence of detailed information and the relatively low level of human contact with the sites.

By comparison, Ecological Risk Assessment (ERAs) is a process which attempts to estimate and where possible, quantify risk posed to the environment and its non-human inhabitants by a given condition. This condition is generally the presence of a chemical or compound at concentrations higher than that of uncontaminated background levels. ERA is the technical, scientific assessment of the nature and magnitude of the risk attributable to the contaminant and the situation. It involves three levels of assessment, the first being a Screening Level Assessment (SLA), the second being a Preliminary Quantitative Risk Assessment (PQRA) and lastly a Detailed Quantitative Risk Assessment (DQRA). For the purposes of this evaluation, we have performed only a SLA using the available data. Only if this first level of assessment indicated a risk, would the second level (PQRA) be warranted.

The SLA, as defined by Li-Muller and Marsh (1994) is primarily a qualitative assessment of the potential environmental risk to specific ecological receptors that have been determined to be of major importance. These are often called valued ecosystem components (VECs). The SLA is based primarily on data from literature reviews and from previous or preliminary studies at the site. It should provide sufficient information to determine that remediation is or is not required, or it may provide a basis for determining what level of ERA is required and for focussing more detailed investigations of potential effects.

Within the scope of our ecological risk assessment, four major elements are involved. These include: receptor characterization, exposure assessment, hazard assessment and risk characterization. Receptor characterization will identify the ecosystem components of concern and the effects and the pathways by which the components come into contact with the contaminants (Li-Muller and Marsh, 1994). Exposure assessment will evaluate the potential exposure of the ecosystem components to substances determined to be of potential concern. Hazard assessment will determine the potential for specified contaminants to cause adverse effects in exposed individuals or populations, and of estimating the relationship between extent of exposure and severity of effects. The final element is the risk characterization. This integrates information derived from the 3 other elements and gives an estimate of the degree of risk present (Li-Muller and Marsh, 1994).

In general, for the SLAs undertaken here, it has been assumed that the surface aquatic environment is the most sensitive and the VECs are the aquatic food chain including fish. It can be argued that for all of these sites, the terrestrial food chain is most directly affected. However, due to the relatively small area affected, even for all three of the sub-sites, it is difficult to imagine how the terrestrial food chain would be impacted and so the aquatic food chain, for which a lot more information is available, has been utilized.

6.2 Site 19 - Cracker Creek

Site 19 - Cracker Creek is the location of extensive buried debris and some limited surface debris. This was confirmed through non-intrusive geophysical surveys and the excavation of shallow test pits. Nevertheless, there was no indication of chemical contamination of the soils here, based upon the results of the field screening techniques for PCBs and other ionizable contaminants and for VOCs, probably because much of the debris is discarded metallic kitchen waste and vehicle parts as well as maintenance material including oil and anti-freeze cans. The one location where crushed drums were uncovered did not give rise too any indications of contamination of liquids leaking from these containers. Moreover, the silty nature of the soils at this site, would tend to limit subsurface migration of any contaminants off site or downwards to an aquifer. Cracker Creek, the local surface water is generally >500 m from the nearest burial site and migration of material from a burial site is not expected to be a concern to the surface water quality. Previous work has done a great deal to bury unsightly wastes, which from our evidence appear to be environmentally benign. Using this information in a qualitative way for the SLA, **we conclude that there is no need for remediation at this site.**

Greater contamination, especially from hydrocarbons, may be evident in and about the old buildings of the maintenance camp but as these are now on private property (that of Mr. Boland) this area was outside of the purview of this investigation. **Also, although it is not considered a risk, we would recommend that the previously excavated portion of sub-site 19A be filled. We would further recommend that the work at sub-site 19A be done manually to minimize further disturbance of the vegetation. The debris at sub-site 19E should be removed and disposed of at an approved landfill.**

6.3 Site 20 - Canyon Creek

Site 20 - Canyon Creek is a large and complex site. It consists of numerous burial and surface disposal sites most of which are located a considerable distance (> 1 km) from the local surface water, Aishihik River. In contrast to Site 19, the soils in the vicinity of Site 20 tend to be coarser and generally lack the fine silty/clay matrix. Consequently, the potential for off-site migration and subsurface contamination is increased. Nevertheless, of the waste sites away from the river (specifically the CANOL Pumping Station C {sub-site 20A}), the triangular area on the south side of the Alaska Highway referred to here as sub-site 20B), it is our conclusion that these sites primarily contain metallic and other debris based upon the electro-magnetic surveys. Based upon the field screening of soil samples, we were unable to identify any contaminants at concentrations that would suggest a concern at these sites. **We therefore conclude that remediation is not required at these two sub-sites.**

Nevertheless, several parts of sub-site 20B contain quantities of surface debris which could be removed to an approved landfill for aesthetic reasons. This, however, is not an environmental concern of consequence. We also note that re-vegetation about this site is generally slow especially in areas where burning has occurred. This may be due to the loss of the organic matter from the burn layer. **We would therefore caution against site burning as a means of eliminating unsightly surface flammable wastes at this site.**

Sub-sites 20C and 20E represent two distinct areas that were investigated as part of this study. Sub-site 20C is an area close to the current Alaska Highway along a former right of way that clearly exhibits multiple dumping sites. The geophysical survey of this site was negative with respect to the presence of metallic debris suggesting that this material is primarily strip material from one of the highway reconstruction works. **Sub-site 20C is not considered to be an environmental hazard and poses no foreseeable risk and is best left to continue the revegetation process.**

Sub-site 20E, the site of the old Highway Lodge, is still evident and is receiving minor quantities of modern wastes (e.g. tricycles, other metal debris). Without a detailed survey of the lot containing the commercial business operated by Mr. Beecher, we could not establish unequivocably whether or not this lot is on private property. Without this clarification we were unable to proceed with a site specific survey; nevertheless, the visual inspection of this site indicated that it is more likely to be an aesthetic concern than to pose an environmental risk. **Any subsurface risk is further mitigated by the distance of this site (> 1 km) from Aishihik River, the nearest surface water, and thus our SLA suggests no need for remediation. We do however recommend that the ownership of this site be defined and the owner (we suspect it is now privately owned) encouraged to remove the debris and re-vegetate the site.**

Two areas in site 20 are located close to the Aishihik River. The first, referred to here as the Military Dump (sub-site 20D) was expected to be a potential problem; however the soil field screening for PCBs, other ionizable substances and VOCs as well as the analytical laboratory analysis of selected soil and water samples, did not indicate an obvious and immediate concern.

Groundwater collected from shallow pits at the toe of the dump had concentrations for most analytes higher than in the surface water samples from Aishihik River. Chromium, copper, iron and manganese all exceeded either the surface water quality guideline for the protection of aquatic life and/or the raw water supply for drinking water (CCME, 1987). It should also be noted that the concentrations of aluminum and silicon are also high and the abundance of these in alumino-silicate minerals, suggests that these elevated concentrations may all be typical of groundwater in the area.

Additional work using stable isotopes would be required to further determine the nature of these groundwaters, including their approximate age, and this was beyond the scope of the current work. While some of the water chemistry data may be higher than guidelines, there is no clear evidence that these groundwaters are being contaminated by passage through the landfill site. This could only be confirmed through a more intensive investigation at this site including the installation of test well upstream of the landfill. However, based upon the water quality data of the Aishihik River and other data from this investigation, it is our opinion that this work is not warranted at this time. Ongoing monitoring of water quality at the toe of the dump, including analyses of large volume water samples (to provide detection limits below the solubility limit) would determine the presence of chlorinated organic compounds and hydrocarbons in the water. A minimal program conducted every few years with several samples collected at the toe of the dump during the summer season is recommended. **Based upon this information, the SLA for this site does not indicate the need for remediation of this site.**

The priority of a monitoring program for sub-site 20D should be evaluated relative to other Yukon sites and in the context of INAC's budget to determine if this site is of sufficient priority to undertake such a monitoring program. This site, even in the context of this study alone, is not considered a high priority for monitoring.

Two other sub-sites are worthy of mention here as they can be considered new sites. The first, sub-site 20B-18 is a clearing between the roadway and the other waste sites in sub-site 20B. This site was not inspected as there was no obvious access to it. However, it is suspect only because of the tendency to find other waste disposal sites in natural or man-made clearings. **This is the largest clearing in the area and we recommend that the site be visually inspected to determine if it is a natural clearing with no debris.**

Another site at Canyon Creek, upstream of the military dump and on the north side of the Alaska

Highway appears to have been extensively disturbed over a long period of time based upon the air photo study undertaken. Unfortunately, MDA staff could not find access to this site without crossing clearly posted private property and thus the site was not inspected and surveyed. Access would appear to be possible, at least on foot, along the electrical power corridor. This new site inspection is considered a priority as sub-site 20D was apparently not used until sometime after 1964 and consequently there must be an additional, as yet unexplored waste disposal site near this camp. We consider sub-site 20B to be too far away and too small for 20 years of refuse from a significant camp.

On a positive note, the biological assessment of the Aishihik River, of which the upstream sampling site was adjacent to or downstream of this un-investigated area, was characterized by species indicative of clean water, thus indicating that the concern is not immediate, if there are any significant impacts at all. Ownership and access rights to this property would have to be clearly established prior to undertaking any work on this site. Ownership is complicated by the fact that the lot in question is indicated to be subject to a land claim but there is also a large building on part of the property. **The length of time that this site was worked (early 1940s through to at least the mid-1960s), its proximity to the base and its proximity to the Aishihik River, leads us to strongly recommend that an intensive follow-up investigation be undertaken of this new site prior to making a final decision on the results of the SLA status of Site 20 - Canyon Creek.**

The findings from this new site investigation would also be relevant to the importance placed in a monitoring program on the military dump (sub-site 20D) as discussed above. If this new site is a major disposal area, it is possibly of greater concern than the military dump site (sub-site 20D).

6.4 Site 42 - Hayes Creek Noranda Camp

The sub-sites of Site 42 - Hayes Creek Noranda Camp are a little more complex due to the site physiography and the fact that at least certain parts of the site are apparently still in active use. Of the three sites investigated in this assessment, this site requires the greatest attention with respect to removal and cleanup of surface debris provided that the site is no longer subject to a mineral claim and is no longer in use. Due to the access difficulties to this site, however, this is not a trivial task.

This debris could pose both an environmental quality hazard as well as possible physical danger to wildlife and humans (although it is a remote site). This is exclusive of the explosives found on the site which to our understanding have been or will be removed. As well, responsibility for the cleanup is not likely an INAC responsibility due to the ongoing mineral claim on this site and the clear ownership trail to this equipment and debris. The company responsible for the present conditions should be required to undertake the clean-up. As a result we do not provide Class "C" cost estimates for this site. We would be pleased to do so if requested by INAC.

While extensive surface debris is present, the extent of contamination apparently from hydrocarbons and waste oils is quite restricted spatially. Contaminated soils in the vicinity of a bull dozer at sub-site CA35 are the most noteworthy. This is the only instance of contamination that was indicated by the field screening techniques and verified by the laboratory analyses. This soil had concentrations of Phenanthrene that exceed the Ontario Surface Soil Criteria for this compound as well as the CCME Interim Criteria for Soil. The compound 1-methylnaphthalene was also high but there are no guidelines for this compound. These guidelines are intended to protect potable groundwater and thus are not directly applicable to an SLA using aquatic populations as the VEC. Our observations indicate that the volume of contaminated soil is small, possibly of the order of one cubic metre or less and thus this mass of contaminant would be very quickly diluted if it reached surface waters. **We suggest that the removal of this soil is not a priority; however, we recommend that it would be advisable to remove the contaminated soil at the time the site is cleaned up, as the equipment is there to do so and we anticipate the additional associated costs will be minimal.**

The greatest environmental impact on this site is likely the physical disturbance of the creek bed from placer mining and access via tracked vehicles. Nevertheless, there is very little that can be done about this now and in the overall context of the watershed, the disturbed site represents only a small area and the effect on aquatic habitat is small due to the low base flow.

7. RECOMMENDATIONS AND CLASS "C" COST ESTIMATES

7.1 Recommendations

Based upon the historical information search, inspection of air photos, site investigations, field screening of soils for contaminants and the detailed laboratory analyses of soil and water samples for contaminants, we offer the following recommendations for sites 19 - Cracker Creek, 20 - Canyon Creek and 42- Noranda Hayes Creek Camp of the INAC, Action on Waste site inventory.

1. Using the available information in a qualitative way for the Screening Level Assessment, we recommend that there is **no need for remediation at** Site 19 - Cracker Creek.

2. Although it is not considered a risk, we further recommend that the previously excavated portion of sub-site 19A be filled. It is suggested that the work at sub-site 19A be done manually to minimize further disturbance of the vegetation. The surface debris at sub-site 19E should be removed and disposed of at an appropriate landfill.

3. Our Screening Level Assessment, allows us to suggest that **remediation is not required** at sub-sites 20A and 20B of the Canyon Creek site. However, we recommend that the exploratory excavation that had been undertaken at some time in the past at the CANOL C pumping station be filled in as it is considered to be a physical hazard for both humans and wildlife.

4 Several parts of sub-site 20B contain quantities of surface debris which could be removed to an approved landfill for aesthetic reasons. We also note that re-vegetation about this site is generally slow especially in areas where burning has occurred and we therefore caution against on-site burning as a means to eliminate combustable surface debris at this sub-site.

5. Sub-site 20C, a disposal area apparently consisting of road reconstruction strip material, is not an environmental hazard, poses no foreseeable risk and is best left to continue the revegetation process.

6. Sub-site 20E, the site of the old Highway Lodge, is still evident and is receiving minor quantities of modern wastes (e.g. tricycles, other metal debris). The visual inspection of this site indicated that it is more of an aesthetic concern than an environmental risk. Any subsurface risk is further mitigated by the distance of this site (> 1 km) from Aishihik River, the nearest surface water and thus our SLA suggests no need for remediation of sub-site 20E. We do however recommend that the ownership of this site be defined and the owner (we suspect it is now privately owned) encouraged to remove the debris and re-vegetate the site.

7. The Military Dump (sub-site 20D) was expected to be a potential problem; however, based upon the results of our study and the Screening Level Assessment for this site, it is our assessment that **no remediation is required** at this site.

8. The proximity of the Military Dump at sub-site 20D to the Aishihik River suggests the need of a monitoring program for this site. This would have to be evaluated relative to other Yukon sites and in the context of INAC's budget to determine if there was sufficient cause to undertake such a monitoring program. **We do not consider this site**, even in the context of this study alone, **a high priority for ongoing monitoring.**

9. Sub-site 20B-18 is a clearing between the roadway and the other waste sites in sub-site 20B. This site was not inspected as there was no obvious path or track to it. However, this is the largest clearing in the area and we recommend that the site be visually inspected to confirm that it is a natural clearing with no debris.

10. An additional site at Canyon Creek, upstream of the military dump and on the north side of the Alaska Highway appears to have been extensively disturbed over a long period of time based upon the air photo study undertaken. Unfortunately, MDA staff could not find access to this site without crossing clearly posted private property and thus the site was not inspected and surveyed. The length of time that this site was active (early 1940s through to at least the mid-1960s), its proximity to the military and highway maintenance base and its proximity to the Aishihik River, leads us to strongly recommend that an intensive follow-up

investigation be undertaken of this new site prior to making a final decision on the results of the Screening Level Assessment status of Site 20 - Canyon Creek, in its entirety.

11. While extensive surface debris is present at all sub-sites of Site 42 - Hayes Creek Noranda Camp, the extent of contamination apparently from hydrocarbons and waste oils is quite restricted spatially. Contaminated soils in the vicinity of a bulldozer (sub-site CA35) are the most noteworthy. This soil had concentrations of Phenanthrene that exceed the Ontario Surface Soil Criteria for this compound as well as the CCME Interim Criteria for Soil. The compound 1-methylnaphthalene was also high but there are no guidelines for this compound. These guidelines are intended to protect potable groundwater and thus are not directly applicable to a Screening Level Assessment using aquatic populations as the valued ecosystem component. It is anticipated that the volume of contaminated soil is small, possibly of the order of one cubic metre, and thus this mass of contaminant would be very quickly diluted if it reached surface waters. While we recognize that the removal of this soil is not a priority, we recommend that it would be advisable to remove the contaminated soil at the time the site is cleaned up as the equipment is there to do so and the additional costs will be minimal.

7.2 Cost Estimates by Recommendation

Approximate cost estimates have been developed for the recommendations related to each of the waste sites investigated as part of this study. Local labour costs are estimated at $50.00 per hour. Local vehicle costs (4 wheel drive vehicle) are estimated at the rate of $50.00 per day plus $0.42 per kilometre. This may be low in light of the fact that in some cases a truck with a dump box may be required. Further, costs savings will be realized at Sites 19 and 20 by having the work at these two sites done by the same local contractor. Professional fees are estimated using the same daily rate as per the present contract between MDA Environmental and INAC and have been calculated as a blended hourly rate for the staff. All estimates are exclusive of applicable taxes.

1. Site 19 - Cracker Creek (local labour only required)
   - filling in excavation at sub-site 19A
   - cleanup of surface debris at sub-site 19E
   - travel time to/from Haines Junction
     - total time for one crew (consisting of 1 foreman @ $35/hr and 2 labourers @ $25/hr each) is 8.5 hours @ $680/day (blended rate for crew)

Labour (1 crew day)	$680.00
Travel (daily + 250 km)	$150.00
Expense - tipping fee	$150.00
Estimated total	$980.00

2. Site 20 - Canyon Creek (clean-up)
   - fill in of excavation at sub-site 20A
   - Cleanup of surface debris at various disposal sites throughout sub-site 20B
   - travel time to/from Haines Junction

Labour (2 crew days)	$1360.00
Travel (daily + 500 km)	$ 310.00
Expense - tipping fee	$ 300.00
Estimated total	$1970.00

3. Site 20 - Canyon Creek
   - exploratory survey of the open clearing in sub-site 20B (identified as 20B-18)
   - on-site hours (2 people at 2 hours each)
   - travel time to/from Whitehorse for MDA local staff (6 hours for 2 people)

Labour (16 hrs. @ $52.50)	$ 840.00
Travel (daily + 500 km for 1 day)	$ 225.00
Expenses - incidentals, gas	$ 110.00
Report preparation	$ 500.00
Estimated total	$1675.00

Note: a blended hourly rate has been used here for MDA's Whitehorse based personnel.

Please note that we have not costed clean-up of sub-site 20E as we believe that this is now on private property and any cleanup therefore should be negotiated with the landowner. Nor have we budgeted the cost of the groundwater monitoring program for sub-site 20D as we do not expect that it is a priority for the Yukon. Nevertheless, if INAC wishes, MDA is prepared to design a detailed routine monitoring program for this site, to initiate the project and to provide a monitoring plan to the Department.

4. Site 20 - Canyon Creek - detailed site investigation of new site

MDA is concerned that there remains a previously unidentified and unexplored waste disposal site in the vicinity of the Aishihik River on the northwest side of the Alaska Highway river crossing. The questions of ownership and property boundaries have to be defined prior to commencing this work. This will require the cooperation of the current land owners. This needs to be approached carefully and lead by INAC or some other responsible body due to the concern expressed to us by other land owners in the area that any discussion regarding buried wastes in an area can be quickly seen as a potential financial windfall by any opportunistic local land owners. For example, either it will be an opportunity to insist on a cash settlement as the land was presumed clean when purchased or there will be a perceived opportunity to financially benefit from extensive clean up work that may be insisted upon regardless of the relative risk. For this reason, MDA was extremely careful in discussing this site while in the field to avoid undue concern and excessive pressure for investigation.

Nevertheless, this site must be investigated and assuming the above concerns can be addressed, we propose the following budget for investigation of this site. Due to our current knowledge of the area, we propose an advanced preliminary environmental investigation complete with mapping, geophysical surveys, soil screening for PCBs and ionizable compounds and VOCs, groundwater sampling for contaminants, and laboratory analysis of soils and water based on field screening results.

On-site labour
- detailed site survey (2 people @ 8 hours each)
- detailed geophysical survey and interpretaion of results (2 people @ 10 hours each)
- sampling and field screening of soils (2 people at 8 hours)

Total estimated hours on-site for staff	52 hours
Blended hourly rate for professional And technical staff ($60.31)	
Subtotal estimated labour	$3136.25

Subcontracts

- contract for excavation of target sites (equipment and operator, 1 day @ $1000)
- laboratory analysis

- water	- anions (5 @ $43)	$ 215.00
	Heavy metals & Hg (5@ $63)	$ 315.00
- soils	- PAH (5 @ $300)	$1500.00
	- chlorinated hydrocarbons (5 @ $580)	$2900.00
	Subtotal	$4930.00.

Travel and living expenses

- air transportation to/from Whitehorse (2 people)	$1900.00
- vehicle rental (3 days plus 1000 km)	$ 500.00
- accommodation and meals (3 nights)	$1920.00
- miscellaneous	$ 100.00
Subtotal	$4420.00

Miscellaneous technical expenses (Note that these costs are minimums and could be distributed over other projects if undertaken simultaneously)

- soil vapour analyser (lease)	$ 750.00
- total station survey system (lease)	$ 250.00
- electro-magnetic equipment (lease)	$ 680.00
- ENVIROSCAN (lease)	$1350.00
- field conductivity and pH metre (lease)	$ 150.00
- freight charges	$ 500.00
- office supplies and support	$ 300.00
Subtotal	$3980.00

In-office professional services

- preparation of detailed site maps (2 days @ $340)	$ 680.00
- preparation of conductivity maps (2 days @ $340)	$ 680.00
- preparation of final report (6 days @ $375)	$2250.00
- preparation of final report, correspondence, and project management (3 days @ $750)	$2250.00
Subtotal	$5860.00
Total estimated costs (exclusive of taxes)	**$22,326.25**

Please note that cost savings will be realized by combining this work with investigations of other sites.

5. Site 42 - Hayes Creek Noranda Camp

Costs estimates have not been provided for this site on the basis that clean-up of this site likely rests with the company(ies) that brought the material to the site and are believed to be still holding mineral claims on at least some of the sub-sites. These companies could undertake this cleanup in a very cost effective way when they abandon the site using their on-site equipment to remove the waste material. If this should not be the case, MDA is fully prepared to cost the clean-up of this site if requested by INAC.

REFERENCES

Barringer Instruments, 1993. IONSCAN Model 250 Operator's Manual. Barringer Instruments Limited, Mississauga.

Bostock, H.S., 1936. "Carmacks District, Yukon."
Geological Survey of Canada Memoir 189, Bureau of Economic Geology, Canada Department of Mines, Ottawa, 1936, 67pp.

CCME, 1997. Interim CCME environmental quality criteria for contaminated sites - final draft. Unpublished. (Obtained from CCME WWW site)

CCME, 1987. Canadian water quality guidelines. Prepared by the Task Force on water Quality Guidelines, Canadian Council of Resource and Environment Ministers, Water Quality Objectives Division, Water Qulaity Branch, Inland Waters Directorate, Ottawa, ON, (various page numbers)

Clifford, Hugh F., 1991. Aquatic Invertebrates of Alberta. The University of Alberta Press, Edmonton, Alberta, 583 pp.

Ecoregions Working Group, 1989. Ecoclimatic Regions of Canada - first approximation. Ecoregions Working Group of the Canada Committee on Ecological Land Classification, Ecological Land Classification Series no. 23., Sustainable Development Branch, Canadian Wildlife Service, Conservatiuon and Protection, Environment Canada, Environment Canada, Ottawa, ON., 119 pp plus map

Kearey, P. and Brooks, M., 1984. An Introduction to Geophysical Exploration. Blackwell Scientific Publications, Oxford.

Laberge Environmental Services, 1993. Use, disposal and transportation of selected contaminants in Yukon. Prepared for: Committee on Contaminants in Northern Ecosystems and Native Diets. Indian and Northern Affairs Canada, Ottawa. 50 pp. + appendices.

Li-Muller, A. and Marsh, M., 1994. Proposed draft guidelines for the use of risk assessment in site clean-up in Ontario. MOEE, Toronto, May 1994., 14 pp.

Ministry of Environment and Energy (MOEE), 1994. Proposed guidelines for the cleanup of contaminated sites in Ontario. Queen's Printer for Ontario, Toronto, Ontario, 74 pp.

Photovac Incorporated, 1995 (pamphlet)

LIST OF APPENDICES (single copy only provided under separate cover)

Appendix 1: Copies of land ownership maps obtained from the Yukon Territorial Government, Fall, 1996

Appendix 2: Complete set of site drawings prepared for this project

Appendix 3: Complete set of appropriate photographs of sites taken as part of this study

Appendix 4: Airphotos for sites 19 - Cracker Creek and 20 - Canyon Creek purchased from the National Airphoto Library as part of the background work for this study

Appendix 5: Copy of letter provided by MDA to INAC - Whithorse advising Mr. B. Hartshorne of the presence of explosives at Site 42, sub-site CA35

Appendix 6: Complete results of soil particle size analysis for Sites 19 - Cracker Creek and site 20 - Canyon Creek

Appendix 7: Field notes for macroinvertebrate survey, Aishihik River at Alaska Highway, Yukon Territory

Appendix 8: IONSCAN plasmagrams for all soil samples pre-screened as part of the site assessment

Appendix 9: Analytical laboratory analyses of soil samples and water samples submitted to Zenon Laboratories, 5555 North Service Road, Burlington, ON., L7L 5H7