Lead (249 ppm) was found at concentrations exceeding DCC Tier I level in sample L6030, collected in a light stain emanating from a barrel in Area B of the eastern half of the site (Photograph V-30).

Of the five plant samples collected, only one was analyzed for inorganic contaminants. All analytes detected were present at less than twice the mean background concentration for each element.

Both water samples collected from drainage originating in the North 40 Dump were analyzed for inorganic contaminants. The concentrations of all analytes were below the limits of detection.

Only two soil samples collected in the North 40 Dump contained inorganic elements at concentrations exceeding the DCC. The concentration of copper in L6004 exceeded Tier II, and the lead concentration in the stained soil sampled at L6030 exceeded Tier I.

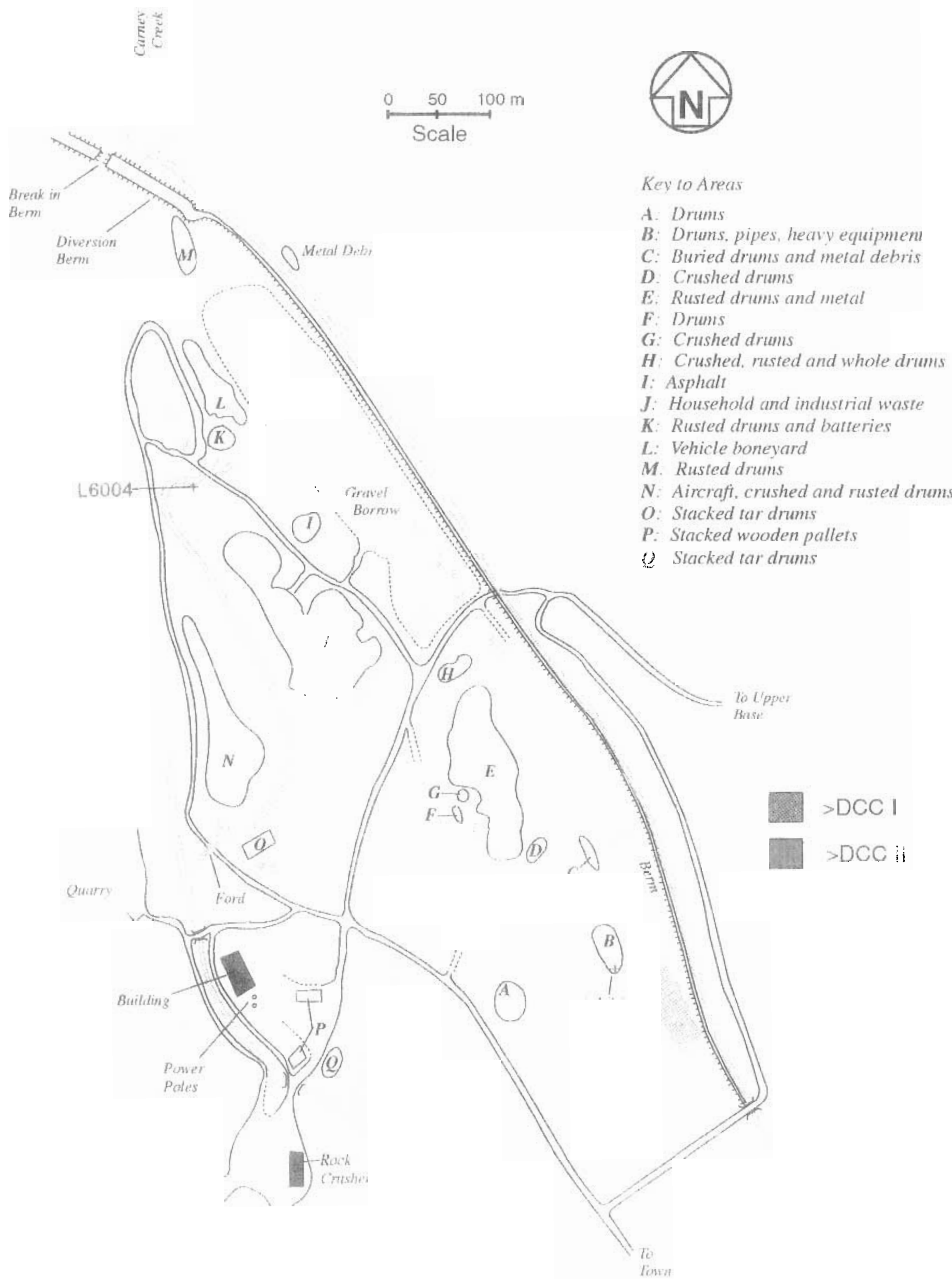
ii. Polychlorinated Biphenyls (PCBs)

Twenty-four of the 42 soil samples collected in the North 40 Dump were analyzed for PCBs. Although the mean concentration of PCBs in soils collected at the dump were 24 times greater than the mean background concentration, none of the soils contained levels which were above the DCC. The maximum concentration of PCBs in soils collected in the North 40 dump (0.29 ppm) did not approach DCC Tier I (1 ppm).

One of the five plant samples collected in the North 40 Dump was analyzed for PCBs. The concentration of PCBs in the vegetation (0.0012 ppm) was 41 times the mean background concentration (0.00059 ppm).

One of the two water samples collected in drainage from the North 40 Dump was analyzed for PCBs. The concentration of PCBs in WF6000 was below the limit of detection.

Map V-15: Samples Exceeding the Cleanup Criteria, North 40 Dump



In summary, concentrations of PCBs in soils collected in the North 40 Dump did not exceed the DCC and were only slightly elevated above background soil concentrations. However, influence on the local biota of disposal of PCB-containing materials in the dump was apparent in the plant sample analyzed for PCBs.

iii. Other Organic Contaminants

One soil sample (L6032) from the North 40 Dump was analyzed for pesticides. The total concentration of pesticides (0.010 ppm) detected did not exceed the BC (2 ppm), Québec (2 ppm) or Netherlands (3 ppm) Level B remediation criteria. Seven of the 22 pesticide analytes were detected, but none of these were present at concentrations which exceeded the Netherlands criteria for individual pesticides.

One soil sample (L6029), collected in a stain located at the southeastern corner of the site, was analyzed for the ABN suite of chemicals. There were no analytes above the limits of detection.

Five soil samples collected at the North 40 Dump were analyzed for PAHs. Although many of the PAHs are included in the ABN suite of analyses, the specificity of the targeted analyses increases the accuracy of the reported results. In this case, PAHs were detectable in the targeted analyses but not in the ABN analyses. Concentrations of compounds for which a surrogate standard was used were corrected for percent recovery before comparison to the criteria was made. None of the samples contained any of the PAH analytes at levels exceeding the CCME R/P or BCMOE Level B remediation criteria.

Alkylated PAH data is presented in the tabulated results (Chapter V of the Appendices) and includes mono- through penta-alkylated isomers of naphthalene, phenanthrene and anthracene combined (e.g., C1 phen,anth), and fluoranthene and pyrenes combined (e.g., C1 fluor,pyrenes). No criteria currently exist which address the environmental impact of the alkylated forms of PAHs, and the debate surrounding the bioavailability of the various isomers is ongoing. This data does however form part of a signature (i.e. the ratios of the various isomers) from which information regarding the source of the contaminants can be discerned. In this case, the signature is that of common petroleum products, as would be expected for the stained soils which make up these samples. Furthermore, impact can be assessed by comparing the reported levels of these compounds to those expected under background conditions. The concentrations of alkylated PAHs in samples L6029 and L6030, and to a lesser extent L6021 and L6034, were generally elevated. No background soils were analyzed for PAHs, but this was not considered necessary since PAHs are only expected to be found in areas impacted to some extent by the use of petroleum products; hence their presence reflects the impact of wastes contained within the dump site.

In summary, none of the samples collected in the North 40 Dump contained concentrations of the other organic contaminants in excess of the applicable criteria.

iv. Barrels

Tables 21 and 22 in Chapter V of the Appendices list the identities of the contents of the barrels, and the concentrations of four inorganic analytes and PCBs. Most of the 537 barrels sampled were full and contained mixtures of fuel and lubricating oil, or glycol and water. None contained PCBs at concentrations over 2 ppm, in contrast with the Avati report (1993a) which reported that the contents of both analyzed barrels contained PCBs. Approximately half of the barrels containing organic materials were also found to contain inorganic elements at concentrations high enough to preclude incineration of the contents. Lead was present in 173 of the samples, chlorine in 82, cadmium in 44 and chromium in seven; several of the samples contained more than one contaminant. Chlorine was present as dichloromethane in some cases, but the form of the chlorine in others could not be determined. Four samples contained a product of unknown composition.

In summary, 238 barrels in the North 40 Dump should be sent South for disposal, because they contain one or more contaminants at concentrations precluding their incineration. The contents of 282 barrels meet the requirements for on-site incineration, as outlined in the DLCU Barrel Protocol, 49 can be poured onto oil absorbent pads as they contain mainly water, and one was empty.

5. Cleanup Recommendations

The location of the North 40 Dump - within a river valley which receives a considerable volume of water throughout the thaw period - has resulted in a corresponding leachate production problem within the dump. The pattern of drainage throughout the site has also created a direct path for the migration of contaminants in water passing through the site to Koojesse Inlet in the south. Although no evidence of contaminants was found in water collected in the current investigation, they have been detected previously in water collected from the site (Avati 1993a). Once contaminants have entered the system of drainage ditches in the site, the likelihood of their being carried to the inlet waters is great. In addition, the removal of gravel and sand from the area introduces the possibility that contaminated soils will be incorporated into fill for transport off-site, and used in various construction activities within the town. This was particularly evident in the southeastern portion of the site where soils heavily contaminated with petroleum products leaking from barrels were directly adjacent to the sand extraction site. The DLCU Protocol specifically addresses the migration of contaminants away from an area of higher concentration as requiring mitigation.

In accordance with the DLCU Protocol, soils exceeding DCC Tier II level must be removed from contact with the Arctic ecosystem. Therefore soils in the vicinity of sample location L6004 containing copper at concentrations in excess of Tier II require excavation and shipment off-site. The stained soil in Area B which contains lead at concentrations in excess of DCC Tier I should be excavated and placed in a properly engineered landfill with sufficient fill placed over it to effectively seal the contaminants into the permafrost layer (see Implementation, Chapter II). Heavily oiled soils such as those present in the southeastern end of the North 40 have the potential to be incorporated into sands being extracted for fill material; these soils should therefore be treated in a manner similar to Tier I soils and removed to an engineered landfill. Materials within the dump require sorting into hazardous and non-hazardous components. All hazardous materials should be shipped South for disposal. Non-hazardous wastes can be further divided into metal and non-metal categories. Scrap metal could be shredded and then, if economically feasible, should be shipped South on returning barges and cargo ships for recycling. Non-metal wastes should be disposed of in an engineered landfill on-site (see Implementation section for further detail).

Barrels and their contents should be disposed of as outlined in the DLCU Barrel Protocol. Of the 570 barrels examined, 282 contained material suitable for incineration and 238 require southern disposal. The materials which meet the requirements for burning include 15 barrels containing water contaminated with glycol at concentrations greater than 2 ppm. Twenty barrels contained materials with lead concentrations between 100 and 150 ppm; the contents of these barrels could be incinerated under updated GNWT regulations regarding incineration of lead-contaminated waste oil, currently under consideration. A total of 49 barrels contained only water or water with a trace of petroleum products, and these can be emptied according to the barrel protocol. One barrel was empty. Disposal options for each barrel are indicated in the final column of Table 22 in Chapter V of the Appendices. **It is strongly recommended that use of the North 40 area for the disposal of wastes be discontinued following cleanup of the dump.**

Photograph V-29: Soil sample L6004 contained elevated levels of copper.

Photograph V-30: Soil sample L6030, collected in a stain amongst the barrels in Area B, contained elevated levels of lead.

D. Dump Site #1: Sylvia Grinnell Park Dump

1. General

Dump Site #1 is situated on the side of a large boulder outcrop in Sylvia Grinnell Park 1.7 km southwest of the town of Iqaluit (Map V-1). The dump overlooks Sylvia Grinnell River and can be accessed from an unmaintained dirt road which runs southwest from the end of the old gravel runway in the West 40. The toe of the slope is not easily accessible by vehicle.

Prior to 1958 sewage and domestic waste produced by the military were trucked to a beach near Dump Site #1 and dumped on the intertidal flats to be removed at the next high tide (RCAF 1958). Aerial photographs date the establishment of the dump at some time between 1958 and 1969, which coincides with USAF withdrawal from the area (Haertling 1988). Also, the nature of debris at the dump supports the theory that USAF was responsible for depositing much of the waste at this site. Following the departure of USAF, community wastes from Frobisher Bay residences continued to be incorporated into the dump. During site operations, granular material was added to the slope as waste was deposited. This is indicated by the presence of fill on top of much of the debris, and an absence of a significant amount of slumping within the dump. Vehicles and some electrical equipment were dumped in a drainage channel east of the main dump. No fill was added to this area of the dump. Municipal-type wastes such as tin cans, wooden pallets, electrical consoles, water heaters, kitchen appliances and non-military vehicles are evident in the main area of the dump. The dump was abandoned as the municipal waste disposal site in the early 1970's in favour of the Apex Dump (Dump Site #5). Upon closure granular material was added to the face of the slope to cover much of the debris.

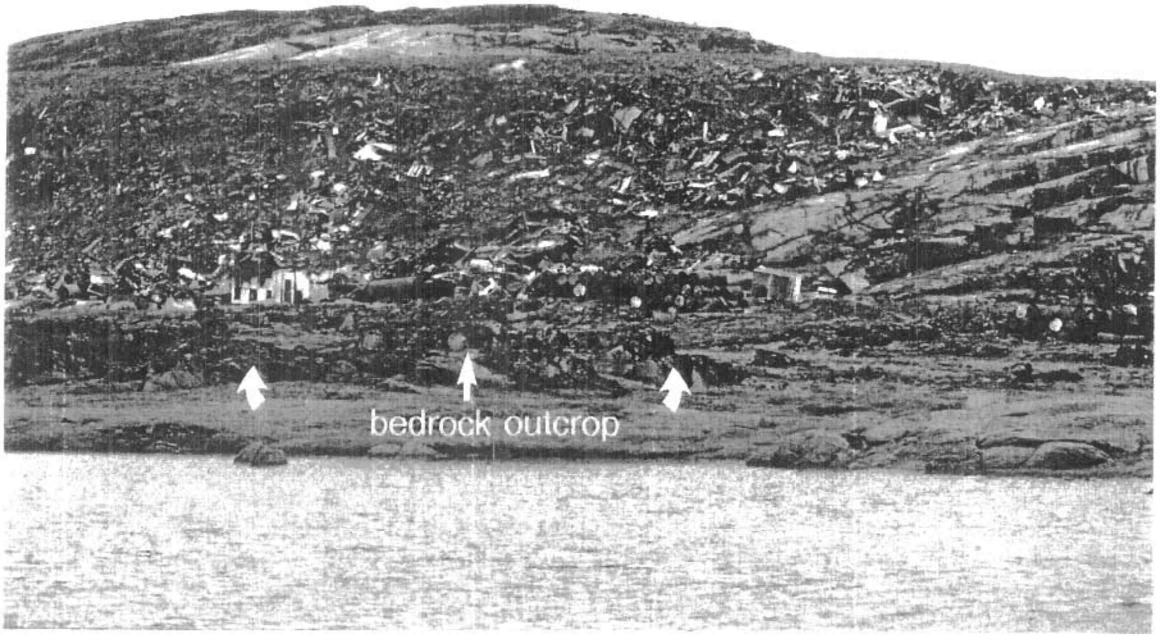
Some cleanup of the site was initiated by DIAND in October 1986 and included the removal of electrical equipment likely to contain PCBs. A total of 41 pieces of equipment including transformers, capacitors and a condenser were collected, and 18 were identified as likely to contain PCBs (DIAND File# B5565-2). Further work at the site was completed in the summer of 1990 when DIAND funded a work project employing inmates from the Baffin Correctional Centre to collect and pile barrels from within and around various dump sites in Iqaluit (UMA 1994). The barrel piles located along the south toe of the dump are the result of that project.

Dump Site #1 has recently become part of the newly designated Sylvia Grinnell Park situated along the north bank of the river.

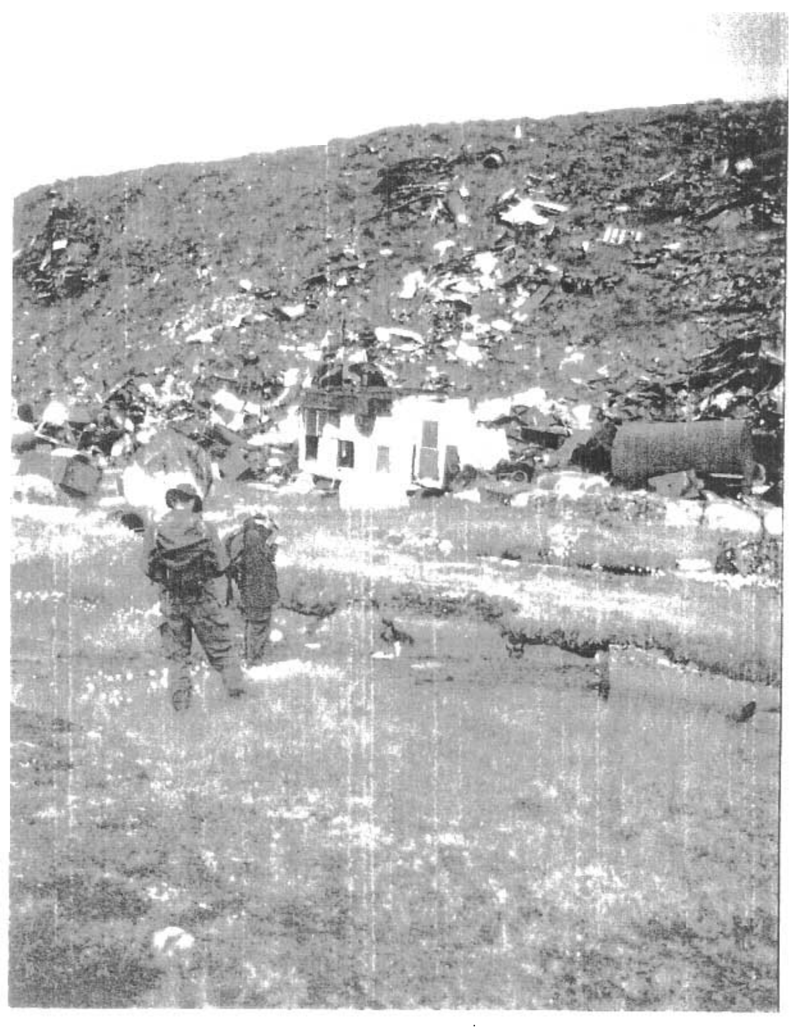
Different disposal methods have produced two distinct areas within Dump Site #1. The pile of vehicles to which no fill was added occupies an area of approximately 0.6 hectares east of the main area of the dump (UMA 1994). The vehicles are visible both from the top of the slope and the river valley. They occupy a small but active drainage channel which flows south into a series of ponds and ultimately into Sylvia Grinnell River. The stability of this haphazard heap of vehicle bodies is questionable due to the lack of any supporting fill within the pile.

The main area of the dump covers approximately 1 hectare on a steep slope approximately 150 m above the river (Photograph V-31). Waste in this portion of the site is not readily visible from the top of the slope. Vegetation is extensive on top of the slope and consists primarily of early successional grass species. The slope itself is made up of pockets of waste surrounded by granular material. Debris on the slope is composed principally of metals and wood. It was estimated that more than 60% of the slope face is covered with fill. Vegetative cover in filled areas is extensive and also consists primarily of early successional grass species. The west end of the slope is characterized by a steep cliff overlooking a pond. During the current sampling program, field workers observed some barrels in the pond.

Other areas within Dump Site #1 include the toe of the main slope into which a considerable amount of large metal waste has fallen (Photograph V-32), and four barrel piles located on a flat area just beyond the toe (Photograph V-33). Some staining is present around the barrel piles. The substrate at the base of the slope consists of a thin sandy soil layer over bedrock and supports a thin covering of vegetation. A border of protruding bedrock just beyond the stacked barrels runs parallel to the slope-face. This bedrock outcrop is reported to be an effective barrier to the migration of leachate south towards the river (Haertling 1988). Obvious drainage through the site appears to be limited primarily to the drainage channel running through the vehicle pile on the east side of the site. Stagnant pools of water are common just south of the dump. Vegetation in these areas consists in large part of sedges and cottongrass.



Photograph V-31: Dump Site #1 as viewed from the south bank of the Sylvia Grinnell River. Note the bedrock outcrop running parallel to the dump face.



Photograph V-32: View of the toe of Dump Site #1, showing the accumulated debris at the base of the slope

Photograph V-33: View to the west from within Dump Site #1. Note the steep angle of the slope and the piles of barrels stacked along the toe of the dump.

2. Results of Previous Studies

The 1983 report "Evaluation of Solid Waste Disposal - Town of Frobisher Bay" by Oliver, Mangione, McCalla and Associates did not consider Dump Site #1 beyond its aesthetic impact due to "its age, ... remoteness .... and origin."

Soils collected in 1985 by the Environmental Protection Service from the drainage channel passing through the vehicle pile exceeded the DCC Tier I level for PCBs (2.24 and 2.11 ppm, Haertling 1988). However, considering the poor detection limits of the analyses (1 ppm), these results may not be significant; concentrations of PCBs reported to be present in samples collected from the same general area in 1987 were found to be much lower (0.5 ppm, Haertling 1988).

A detailed analysis of contaminant migration within Dump Site #1 was the subject of a 1988 master's thesis by Joachim Haertling, a Queen's University geography student. Inorganic element and PCB concentrations in soil, sediment and water samples collected in the area around the dump are included in this report. Haertling found soils at the base of the slope to contain levels of arsenic (44.2 ppm), and zinc (22000 ppm) that exceeded DCC Tier II values. The report does not, however, include comparisons of the results to environmental criteria of any sort. Concentrations of PCBs reported to be present in the soils around the site were below the DCC, ranging from 0.02 to 0.5 ppm. The highest concentrations of PCBs were detected in the drainage below the vehicle pile. Haertling's thesis included additional PCB results from the soil samples collected in 1985 by EPS (see above). The Haertling thesis also presents results for a water sample collected in a "little pool of oil rich water below one of the capacitors"; this sample contained 11.1 ppb PCBs. Although this "water" result is significantly elevated above the CCME FAL Remediation Criterion of 1 ppt, the nature of the sample (a puddle of oil rather than freshwater) was such that application of the freshwater criterion would not be appropriate.

Based on results of contaminant analyses Haertling (1988) concludes that transport of contaminants away from the main area of the dump "is inhibited by the northwest-southeast aligned bedrock outcrops just downslope of [it]". Additional comments made in a letter to J.M.A. Theriault of DIAND (1988) suggest that "it is ...highly unlikely that PCB containing fluids from [the main area of the dump] would migrate to the Sylvia Grinnell river", although later in the same communication it is suggested that PCB contamination from the vehicle pile may have reached the river.

The Public Works Canada literature review (1992) summarizes in part various characteristics of Dump Site #1, including its location and the history of waste disposal in the area. The document also reviews work carried out at the site and summarizes the results of previous studies. Much of the material summarizing aspects of the Haertling thesis (1988) is, however, inaccurate. The Public Works Canada review misquotes the level of PCBs reported in an oily pool as 11.1 ppm rather than 11.1 ppb. It is suggested in the PWC review that Haertling detected PCB levels in soils that exceeded CCME guidelines. The highest level of PCBs in soil (0.5 ppm) detected by Haertling was well below the CCME R/P Remediation Criteria (5 ppm).

Dump Site #1 was part of the focus of the environmental assessment conducted in 1993 by Avati Ltd. The Environmental Site Assessment volume (1993a) of the report contains results of the analyses of a total of 14 soil and four water samples collected from around Dump Site #1. Of eleven soil samples analyzed for inorganic elements, none were reported to have concentrations exceeding the CCME R/P Remediation Criteria. Three of the five water samples analyzed for inorganic elements contained at least one element at a concentration that exceeded the CCME FAL Remediation Criteria. Copper (9 ppb) and zinc (78 ppb) concentrations were elevated above the criteria in a water sample from a pool on the west edge of the site, while lead (2 ppb) and boron (630 ppb) concentrations in the same sample fell within the range of the criteria (1 - 7 ppb and 500 - 6000 ppb, respectively). Copper (73 ppb) and nickel (160 ppb) were detected at concentrations exceeding the CCME FAL Remediation Criteria in a water sample from the drainage channel which runs through the vehicle pile. The elevated boron, lead and nickel concentrations were not reported in the results and discussion sections of the Environmental Site Assessment volume of the report (Avati 1993a). The Remediation

Options volume (Avati 1993b) did not address any of the elevated concentrations of inorganic elements.

PCB concentrations, reported for three soil samples from Dump Site #1, did not exceed the DCC or CCME R/P Remediation Criteria. PCBs were detected in only one of the samples, at a concentration of 0.05 ppm. The detection limit of the analysis of one of the samples, in which PCBs were undetectable, were too high (0.3 ppm) to provide much insight into the actual state of PCB contamination in that sample. Total petroleum hydrocarbons (TPH) were detected at low concentrations in one of five soil samples analyzed as part of the Avati study (1993a). TPH was not detected in the duplicate for this sample. The only two compounds detected in analysis for the Acid/Base/Neutral (ABN) suite of chemicals, in a water sample from Dump Site #1, were present at levels comparable to those reported for the background water sample and are common laboratory contaminants. Dichloromethane (5.1 ppm) was detected in excess of the CCME R/P Remediation Criteria (5 ppm) in a soil sample, however this level was also comparable to that found in the background sample (4.8 ppm).

The statement in the Discussion section (Chapter 4) of the Environmental Site Assessment volume of the Avati report (1993a) that "only one exceedence [sic] of CCME remediation criteria was found in [Dump Site #1]" is incorrect. Copper and zinc concentrations in water reported in the Results section as exceeding the CCME FAL Remediation Criteria are omitted. There is no discussion of the elevated concentration of nickel or of boron, lead and nickel levels exceeding the lower range of the criteria. Dump Site #1 was designated as having a Class 1 high risk potential based on the NCSCS score it received (75) in the discussion section. Dump Site #1 was given a higher contaminant characteristic score than the Upper Base, and thereby received a greater overall NCSCS score (Upper Base = 73).

As was the case for most of the other sites examined in the Avati study (1993), recommendations made in this volume included excavating all the wastes from the site, sorting them, and shipping South, either all materials (Alternative 7 in their report) or hazardous materials only, and burying the remaining waste in a landfill in Iqaluit (Alternative 6).

A 1994 summary of the state of solid waste disposal in Iqaluit by C. Finley of the University of Toronto reviews some of the information contained in the Avati reports (1993a,b,c) and the 1992 PWC report. Finley's report does not contain any unique information regarding Dump Site #1 in particular. It does, however, address the issue surrounding land ownership with respect to all of the waste disposal sites around Iqaluit.

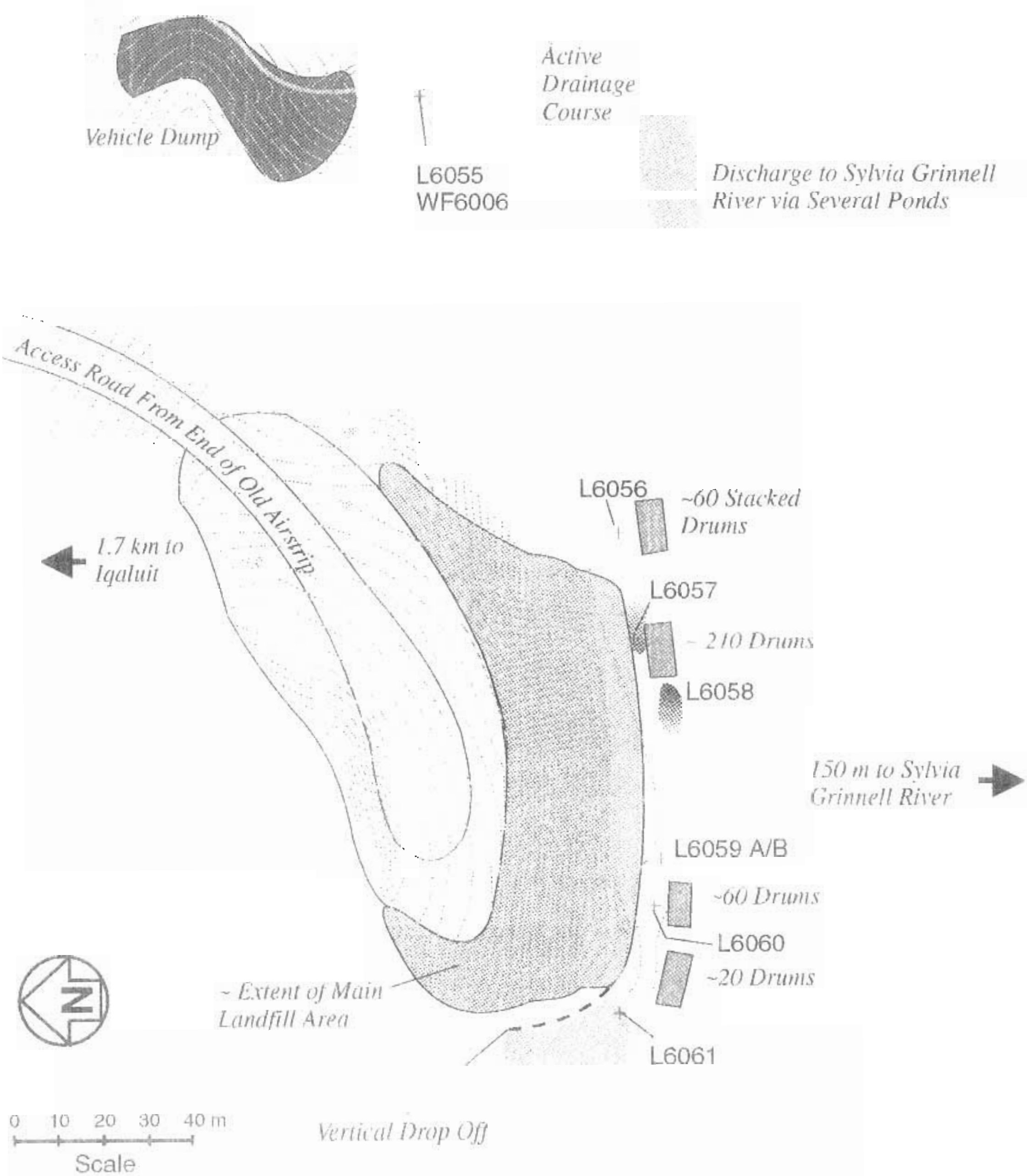
The 1994 UMA Engineering Ltd. preliminary report on the cleanup of Dump Sites #1 through 5 details the aesthetic and physical characteristics of the site including the local topography, surface and subsurface drainage and geotechnical stability of the dump. Several recommendations for cleanup of the site are presented in the report and include the following: (1) removal of all loose debris without compromising stability of the slope including vehicles piled to the east of the main waste area and barrels to the south; (2) the construction of a swale along the edge of the top of the site in order to redirect any drainage which would run down the exposed face of the dump; (3) a geotechnical evaluation of the slope of the dump followed by stabilization as required; (4) the reseeding of any areas undergoing alteration, to enhance stability of the disturbed areas; and (5) confirmatory sampling following cleanup. The recommendations included in the UMA report (1994) were based on visual inspection of the site only.

3. Current Sampling Program

The ESG undertook field sampling at Dump Site #1, as part of the current investigation, on August 15th, 1995. The potential for contaminant migration out of the dump and south towards Sylvia Grinnell River made the collection of samples at the toe of the dump the primary focus of the sampling program. As obvious sites of potential contamination, stained areas formed a second focus of the sampling program. A total of eight soil samples, including one field duplicate, were collected in Dump Site #1; one in the drainage channel flowing through the vehicle pile east of the main area of the dump, and seven from the toe of the main slope of the dump, including two from stained areas next to the barrel piles (Map V-16). One sample of vegetation was collected from each of three locations in which soil was also sampled. A single water sample was obtained from the active drainage channel passing through the vehicle pile east of the main area of the dump. Detailed descriptions of individual sampling locations and vegetation collected and surveyed are provided in Section D, Chapter IV of the Appendices.

As part of the concurrently conducted Historical Ocean Disposal study, three sediment samples were collected from Sylvia Grinnell River in the vicinity of the dump (SG004-006, Bright et al. 1995).

Map V-16: Sample Locations at Dump Site #1, the Sylvia Grinnell Park Dump



Map adapted from the Preliminary Report on Cleanup of Waste Disposal Sites Near the Town of Iqaluit, NWT, Prepared by UMA Engineering Ltd., April 1994

4. Analytical Results

The analytical results for this and all other sites can be found in Chapter V of the Appendices. Four of the seven samples analyzed contained inorganic elements at levels exceeding the DCC (Map V-17).

i. Inorganic Elements

Seven of the eight soil samples collected at Dump Site #1 were analyzed for inorganic elements. The mean concentration of lead (293 ppm) and zinc (2020 ppm) in soils from this site exceeded the DCC (see Figure V-11). Mean and maxima for all other analytes were below the DCC.

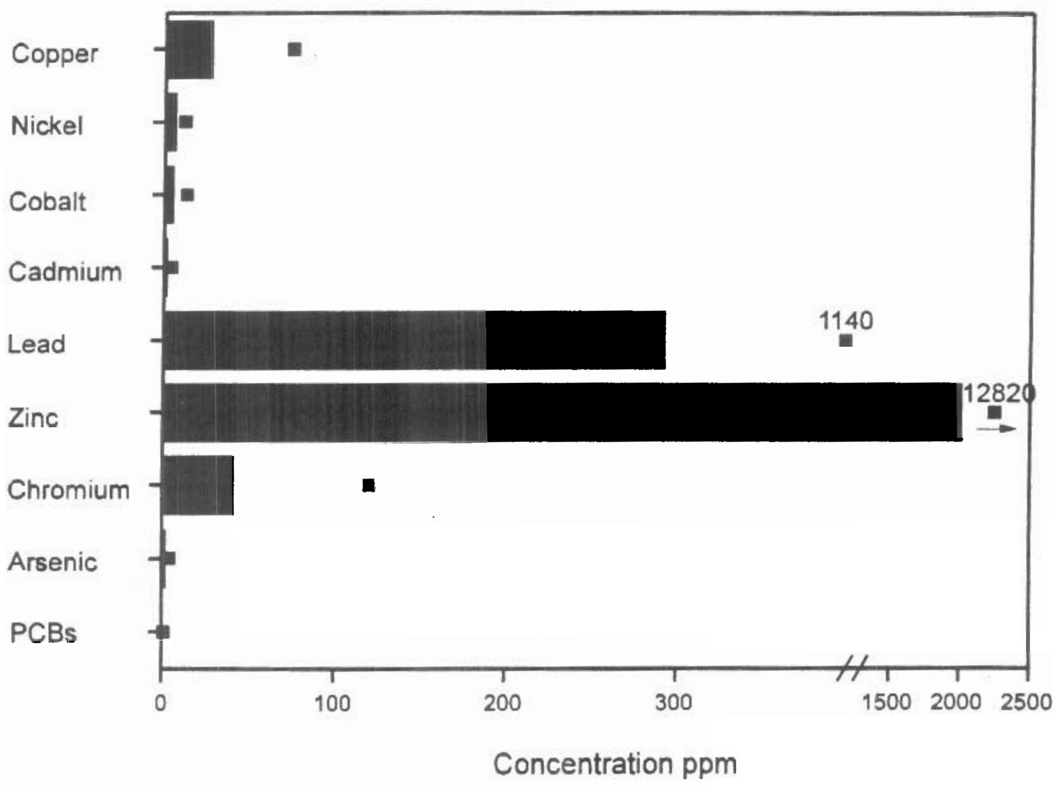


Figure V-11: Mean and Maximum Inorganic Element and PCB Concentrations in Soils Collected at Dump Site #1.

The concentrations of lead in two soil samples were higher than the DCC Tier I level. L6055, collected from within the drainage channel passing through the vehicle pile, contained 409 ppm lead (Photograph V-34). The second soil, L6056, was collected in a stain beside the easternmost barrel pile at the toe of the main area of the dump, and contained 414 ppm lead. Lead (1140 ppm) and zinc (720 ppm) were found in excess of DCC Tier II in a soil sample (L6057) collected at the toe of the dump beside the second barrel pile from the eastern end of the row (Photograph V-35). Finally, sample L6058, collected in a black, burned stain contained zinc (12820 ppm) at levels greatly exceeding the DCC (Photograph V-36).

One plant sample collected from Dump Site #1 was analyzed for inorganic contaminants. Although the concentration of zinc (219 ppm) in L6055P (*Salix glauca*) was elevated compared to levels in soil from the same location, these were not elevated above the average concentration of zinc calculated for background plants (252 ppm).

There were no inorganic analytes above the detection limit in the sample of water obtained from the drainage channel passing through the vehicle pile (WF6006).

All three sediment samples from Sylvia Grinnell River were analyzed for inorganic contaminants (Bright et al. 1995). One of the samples (SG006) contained chromium (38 ppm) at a concentration in excess of the Environment Canada Interim Freshwater Sediment Quality guidelines. Elevated levels of chromium in background sediments suggests that the higher levels in the samples may be naturally occurring. All other analytes were either below the limit of detection or present at concentrations below the sediment quality guidelines.

Lead and zinc are elevated in soils at the toe of the Sylvia Grinnell Park Dump. Plants have been unaffected by localized elevated concentrations of inorganic elements. Sediments from Sylvia Grinnell River do not contain inorganic elements at levels significantly elevated above concentrations in background sediments. Overall, these results suggest that migration of inorganic elements from the dump is not resulting in loading of the river sediments.