1.0 INTRODUCTION

1.1 BACKGROUND AND OBJECTIVES

UMA Engineering Limited (UMA) in association with Hardy BBT Ltd. (HBT) and Jacques Whitford and Associates Limited (JWA) was commissioned in the spring of 1990 by the Canadian Commercial Corporation (CCC) on behalf of the United States Air Force (USAF) to carry out an environmental clean-up study of 21 Distant Early Warning (DEW) Stations in Canada.

The overall purpose of this study is to identify and investigate areas of the 21 DEW Stations as they have been affected by past waste disposal and spills. In addition, the objective of the study is to determine and evaluate decommissioning alternatives for waste disposal and spill areas, and facility demolition debris (including associated hazardous or toxic materials). Details of the overall study objectives are provided in Volume 2 (Section 1.3)

The study consisted of four phases generally following the National Guidelines for Decommissioning Industrial Sites (Monenco, 1989). These include:

(1) Phase I - a literature review of baseline environmental conditions and existing data on waste materials, spills and facilities at each site.
(2) Phase II/III - a combined field reconnaissance, field sample collection, and sample analysis for each site.
(3) Phase IV - an evaluation of the environmental impacts including a baseline risk assessment for each station and the identification of decommissioning options. A detailed decommissioning plan was not developed.

Details of these phases are provided in Volume 2 (Section 1.3). The final report for this study is provided in 24 volumes as follows:

(1) Volume 1 - Executive Summary.
(2) Volume 2 - General Information.
(3) Volumes 3-23 - Specific DEW Station Reports.
(4) Volume 24 - Quality Assurance and Quality Control.

This Volume (Volume 17) is a specific DEW Station report that presents all four phases pertaining to CAM-5), MacKar Inlet. An overview of the site based on a review of existing literature is presented in Section 2.0. Section 3.0 provides a description of the biophysical environment, including heritage resources and land use. Section 4.0 describes the site infrastructure. Sections 5.0 and 6.0 present the observations and results of the onsite investigation. In Section 5.0, the asbestos, paint and PCB findings are detailed. Section 6.0 summarizes the soil and water sampling program for each of the facilities and features investigated. Facility decommissioning and clean-up alternatives are provided in Section 7.0. In Section 8.0, the costs of decommissioning are summarized. References cited are listed in Volume 2.

1.2 FIELDWORK, SAMPLING AND ANALYSES

Field work at CAM-5 took place between July 23 and July 26, 1990. A brief reconnaissance was completed initially. This was followed by sampling in selected areas.

Data showing the number of soil, water, paint, asbestos, and PCB oil samples taken at CAM-5 are provided in Table 1.1. Sample site descriptions are presented in Appendix B.

Table 1.1

CAM-5, MACKAR INLET: NUMBER OF SAMPLES TAKEN AND NUMBER OF SAMPLES ANALYZED

Sample Type	Samples Taken*	Samples Analyzed*	Samples Not* Analyzed
Soil	53	25	28
Water	7	6	1
Paint	5	5	0
Asbestos	7	7	0
Transformer Oil	1	1	0

* Does not include duplicates or replicates.

The general approach to field survey and laboratory analysis are described in Volume 2 Section 3.2. Quality assurance and quality control measures are described in Volume 24.

1.3 DATA ASSESSMENT CRITERIA

An assessment of the indicator chemicals was made using the Contaminated Sites Rehabilitation Policy from the Province of Quebec (Quebec Soil Guidelines) (1988) and the Guidelines for Canadian Drinking Water Quality (1987). The Quebec guidelines recommend three levels, A, B and C, for the evaluation of the degree of contamination.

Level A represents background for metals which occur naturally in the environment. For organic chemicals, Level A is the analytical detection limit. The implications of Level A are that minimal environmental impact has occurred and land use should generally be unrestricted. In this study, if the concentration of metals was greater than 50 percent of the Level A guideline, or if organic compounds were detected, the results were used in the baseline risk assessment.

Level B is defined as a point at which thorough investigation of the source and extent of contamination is warranted. The implications of Level B are that contaminants are present above background levels and that land use restrictions or mitigation may be required. For the DEW line stations, concentrations exceeding Level B were identified as potential areas requiring remediation and/or further evaluation where:

- the areal extent was expected to be large
- the compound had a significant impact on the risk assessment
- a point source was not readily definable, or;
- a sample was obtained from a location downgradient of an area which may contain higher concentrations.

Level C constitutes a significant environmental impact as health and safety risks may be present and where prompt remedial action may be required. The DEW Line sites were evaluated as industrial sites; therefore, Level C would be the threshold concentration at which remediation would be required.

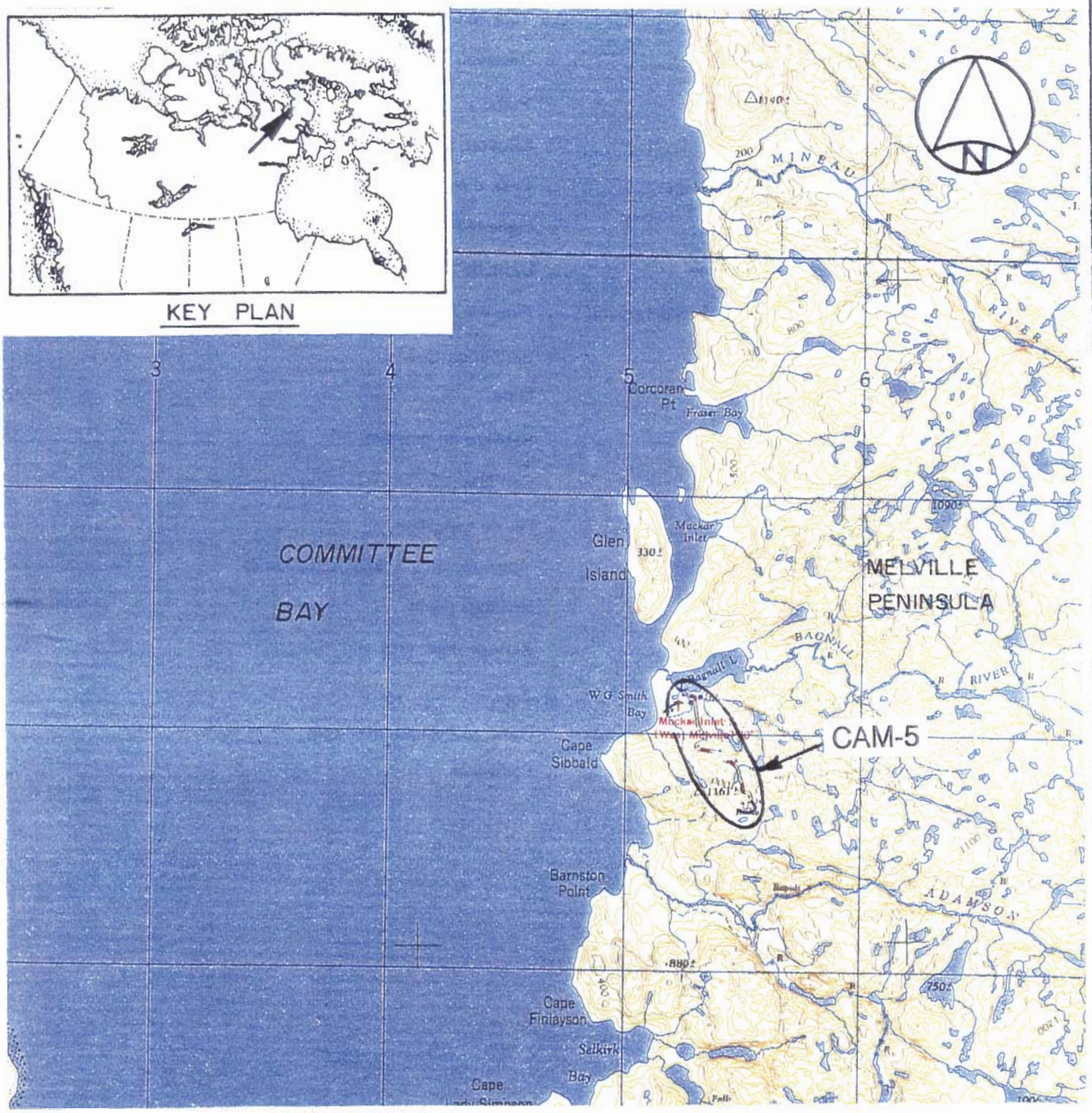
The evaluation of chemical constituents in water samples was based on the Maximum Allowable Concentrations (MAC) indicated in the Guidelines for Canadian Drinking Water Quality (1987). Where the allowable concentration was expressed as a range, the most stringent value was applied.

The rationale of this evaluation method was given in Section 3.2.3.1 of Volume 2.

2.0 SITE OVERVIEW

CAM-5 MacKar Inlet is located on the western shore of Melville Peninsula at 68° 17' 49" north latitude and 85° 07' 30" west longitude on Melville Peninsula in the Committee Bay area of the Northwest Territories. The station is located about 7 km inland from the west side of the peninsula. The nearest community with charter aircraft and a full range of commercial and public services available is Hall Beach, 180 km to the northeast. Access to the site is limited to charter aircraft. The site cannot be accessed by water as the harbour is ice-bound year round. Airlift operations occur in late winter with Hercules aircraft landing on a winter ice strip on the lake east of the airstrip. Figure 2.1 shows the general location of the station in the area and Plate 1 provides an aerial view of the site. The land use of the area is summarized in Section 3.7.

The site is still part of the DEW Station system but is scheduled for decommissioning in the period 1992 to 1994. The site will be restored under the Department of National Defence/Department of Indian Affairs and Northern Development (DND/DIAND) 1989 Memorandum of Understanding for Restoration of Distant Early Warning and North Warning System Sites, as discussed in Volume 2, Section 1.0.



STATION DATA

LATITUDE: 68° 17' 49" N
LONGITUDE: 85° 07' 30" W
ELEVATION: 400 m
MEAN RAINFALL: 82 mm
MEAN SNOWFALL: 97 cm
ACCESS: AIR - CHARTER
WATER - NONE

CAM-5 MACKAR INLET

LOCATION PLAN

SCALE - 1:250,000

FIGURE 2.1

3.0 BIOPHYSICAL ENVIRONMENT

3.1 CLIMATE

MacKar Inlet site is situated on the west side of Melville Peninsula, approximately 399 m asl. Climate data are presented in Table 3.1.

3.1.1 PRECIPITATION

Mean total annual precipitation is 179 mm, of which 81.7 mm occurs as rain and 97.0 cm as snow. The mean number of days a year with measurable precipitation is 63, 20 with rain and 46 with snow. Snow and rainfall from May to October accounts for the majority of annual precipitation.

3.1.2 TEMPERATURE

Mean annual temperature is -14.8 °C while mean monthly temperature ranges from 6.0 °C in July to -31.7 °C in February. Extreme temperatures of 21.7 °C in July and -50.0 °C in January have been recorded.

3.1.3 WIND AND FOG

The mean annual wind speed is 12.2 km/hr. Winds are fairly steady throughout the year. Cloud cover ranges from approximately 30 percent in January to over 90 percent in September. The frequency of cloud cover peaks in spring and fall, as does the occurrence of fog and ice fog, which range from 12 to 47 percent from January to September.

3.2 GEOLOGY

3.2.1 OVERVIEW

The landscape is comprised of a glacially scoured bedrock terrain characterized by rugged hills separated by narrow elongate valleys. Numerous small lakes irregular in outline and typically interconnected by poorly defined runways and drainage channels are scattered throughout the landscape. A single large lake emptying into the ocean and the penultimate catchment basin of the region occurs along the northern perimeter of the study area.

Parts of the landscape are mantled by a gently rolling till blanket and others by raised marine sequences. The extent of the raised marine sequences suggests relative sea level drop of at least 160 m since deglaciation.

Periglacial and frost processes have modified the landscape and imparted distinct patterned ground features within the unconsolidated sediments. Exposed bedrock is typically frost-shattered.

Elevations range from sea level along the coastal zone to approximately 450 m asl within the uplands.

Three general kinds of surface material occur within the landscape. These include bedrock/felsemeer/grass, till and raised marine (glacio-marine). Fluvial materials are present but constitute a comparatively small proportion of the surface materials, particularly at higher elevations.

TABLE 3.1: CLIMATE NORMALS FOR CAM-5, MACKAR INLET

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Precipitation													
Mean Rainfall	0.0	0.0	0.0	0.0	T	6.2	32.0	33.3	9.3	0.9	0.0	0.0	81.7
Mean Snowfall	1.9	2.6	3.0	7.7	16.0	5.8	1.6	3.9	21.7	22.1	8.3	2.4	97.0
Mean Total	1.9	2.6	3.0	7.7	16.0	12.0	33.7	37.2	31.2	23.0	8.3	2.4	179.0
1 No. Days w/meas rain	0	0	0	0	*	2	7	8	3	*	0	0	20
No. Days w/meas snow	2	1	2	4	7	4	1	2	9	9	3	2	46
No. Days w/meas precip	2	1	2	4	7	5	8	9	11	9	3	2	63
Greatest rain in 24 hrs	0.0	0.0	0.0	T	0.8	13.5	42.2	23.1	18.8	10.2	0.0	0.0	42.2
Greatest snow in 24 hrs	6.2	12.7	9.5	7.9	17.8	6.4	3.8	6.1	12.6	25.7	16.0	5.1	25.7
Greatest precip in 24 hrs	6.2	12.7	9.5	7.9	17.8	13.5	42.2	23.1	18.8	25.7	16.0	5.1	42.2
Temperature (C)													
Mean Daily Max	-28.1	-28.5	-25.5	-17.1	-6.7	1.8	9.2	7.2	-1.5	-9.5	-18.8	-24.2	-11.8
Mean Daily Min	-34.3	-35.1	-32.3	-23.8	-12.4	-3.3	2.7	1.5	-5.6	-14.9	-25.3	-30.5	-17.8
Mean Daily	-31.3	-31.7	-28.9	-20.5	-9.6	-0.8	6.0	4.4	-3.6	-12.2	-22.1	-27.3	-14.8
Extreme Max	-2.8	-5.6	-4.5	4.4	6.1	18.3	21.1	21.7	12.8	1.7	3.3	1.1	21.7
Extreme Min	-50.0	-49.5	-46.7	-39.4	-27.8	-16.1	-5.0	-7.8	-17.2	-34.0	-42.2	-45.0	-50.0
Wind													
Mean Wind Speed (km/hr)	12.2	10.5	9.8	12.2	12.4	11.6	10.3	11.4	15.0	15.6	13.8	11.3	12.2
and prevailing direction	M	M	M	M	M	M	M	M	M	M	M	M	M
Mean Vector Speed (km/hr)	M	M	M	M	M	M	M	M	M	M	M	M	M
and direction	M	M	M	M	M	M	M	M	M	M	M	M	M

1. measurable rain > 0.2 mm — rainfall in mm
measurable snow >0.2 cm — snowfall in cm
measurable precipitation >0.2 mm water equivalent — total precip in mm water equivalent

T = trace

M = missing data

* less than 0.5 greater than 0.0

The bedrock within the study area consists mostly of massive or foliated granitoid rocks of Precambrian age. The bedrock is typically jointed and two distinct trends, east-west and north-south, are evident. The jointing is best developed below 180 m elevation. At elevations greater than 180 m the joints are typically incised and widened by erosion with fluvial and talus material collecting within the bottoms.

Quartz and feldspar are dominant components of the mineral assemblage comprising the bedrock. Weathered surfaces are rusty brown or drab grey and typically lichen-covered.

Till deposits blanket the bedrock within parts of the upland areas. The tills are bouldery with little cobble-, gravel-, and sand-sized material. Frost action and water has crudely sorted the tills and a distinct meshed or netted pattern has developed within the tills throughout the landscape.

Raised marine sediments occur along the northern perimeter of the map area. The sediments are wedge-like in outline, broadest nearest sea level gradually tapering to a point several kilometres inland. The surface materials consist mostly of cobble-, gravel-, and sand-sized sediments. Remnant strandlines and broad, shallow, poorly defined drainage courses occur throughout.

General considerations for development of a landfill in permafrost areas were summarized in Section 6.3.3 of Volume 2. The availability of the capping materials required to insulate the landfill contents, and prevent frost heaving of debris from the landfill is discussed in Section 3.2.3 of this volume.

3.2.2 TERRAIN UNITS

The terrain units in the vicinity of the facilities are provided in Figure 3.1. Eight terrain units are described in the following sections.

3.2.2.1 Terrain Unit 1

Terrain Unit 1 encompasses most of the area surrounding the upper base facilities. The unit, which lies approximately 350 to 400 m asl, is comprised of a till (ground moraine) which blankets underlying bedrock. Surface materials are typically coarse-grained and boulders cover the landscape.

The surface is gently rolling. Frost processes and water have crudely sorted the surface materials and have imparted a netted pattern throughout the landscape. Slopes are variable throughout, ranging from long and gentle to comparatively short and steep.

Surface materials drain rapidly and drainage is predominantly below the boulder cover. Drainage patterns are not well defined.

Two subunits designated 1a and 1b are delineated.

Subunit 1a consists of an inclined disturbed terrain. Warehouse storage and POL facilities are sited within this unit. Surface materials typically consist of sands and gravels. Drainage is generally parallel to direction of the slope. Drainage ditches have improved drainage from the area.

Subunit 1b comprises the undisturbed terrain.

3.2.2.2 Terrain Unit 2

Terrain Unit 2 ranged from 350 to 2300 m asl and consists of a bouldery till distributed in a discontinuous veneer throughout the landscape. Three terrain subunits designated 2a, 2b and 2c (Figure 3.1) are delineated within Terrain Unit 2.

The surface expression ranges from predominantly ridged in parts to predominantly rolling in others. Slopes are typically long and gentle along ridge tops to short and steep, perpendicular to ridges. Terrain Unit 2 is similar to Terrain Unit 1 in that frost processes and frost sorting have modified the landscape, producing patterned ground and frost induced ridge movement.

Surface materials are highly pervious. Drainage channels are comparatively well developed in this terrain. Flow is generally northward.

Subunit 2a consists of a flat-topped knoll on which the module train is sited. Within undisturbed parts of subunit 2a, surface materials are typically coarse textured and occupy interstices between boulders. Drainage radiates from the hill crest flowing in poorly defined channels down the steeply inclined slopes.

Subunit 2b consists of comparatively flat terrain gently inclined toward the northwest. Surface materials are relatively fine-grained. Sewage outfall from the upper base flows along poorly defined drainage paths within the subunit.

Subunit 2c comprises the remaining terrain which is largely removed from the influence of base activity with exception of land activity adjacent to the road leading to the lower base area (Figure 3.1).

3.2.2.3 Terrain Unit 3

Terrain Unit 3, approximately 370 m asl, consists of a talus covered bedrock scarp. The terrain is steeply inclined toward the north. Drainage is parallel to the slope direction.

3.2.2.4 Terrain Unit 4

Terrain Unit 4 is comprised of a raised glacio-marine succession. Elevations range from a few metres asl to approximately 180 m asl. This Terrain Unit can be subdivided into six distinct subunits which have been designated subunits 4a, 4b, 4c, 4d, 4e and 4f.

Subunit 4a consists of undulating to nearly flat-lying terrain, gently inclined toward the north, dissected by poorly defined drainage channels. The surface consists of a layer of fine-grained, organic-rich material overlying coarser grained sediments. The terrain is imperfectly drained.

Surface materials comprising subnit 4b consist of cobbles, gravels, and sands distributed across gently inclined terrain. Well-developed marine strand lines are prominent within the landscape and have imparted a gently undulating surface expression. Surface materials are highly permeable and drainage channels are not well developed in the landscape.

Subunit 4c consists of coarse material, predominantly gravels and cobbles distributed in a belt oriented east to west. The terrain is moderately inclined toward the north. Movement of the surface materials is evident by a succession of closely spaced, elongate steps perpendicular to regional slope. Surface materials are highly permeable. Several comparatively well defined drainage channels have developed parallel to the regional slope.

Subunit 4d is comprised of a low lying, poorly drained terrain. Surface materials consist of a wet or water saturated organic-rich silt or sand layer several centimetres thick, overlying coarser grained sands and gravels. Surface materials are moderately to highly permeable; however, shallow, subcircular ponds are common throughout the landscape. The terrain is slowly drained by poorly defined channels. Drainage is toward a large lake adjacent the lower base facilities.

Subunit 4e consists of a narrow, gently curved ridge comprised of gravels overlying bedrock. Surface materials are highly permeable and the landscape is well drained. Gravel has been excavated along its southern end.

Subunit 4f consists of terrain that is extensively altered by excavation and landfilling activities. The terrain is comparatively well drained, aided by improvements to the natural drainage channels.

3.2.2.5 Terrain Unit 5

Terrain subunits 5a and 5b are comprised of a fluvially dominated terrain. Northwesterly - southeasterly elevations range from sea level to 75 to 100 m asl. Subunit 5a consists of comparatively narrow, northwesterly - southeasterly trending V-shaped channels which cut the raised marine succession (Terrain Unit 4) near its eastern perimeter.

Subunit 5b consists of low lying terrain and includes a small deltaic build-up at the mouth of the channel. Surface materials are partly comprised of thin (less than 20 cm thick) organic-rich sediments overlying coarser grained materials. The terrain is undulating and is gently inclined toward the northwest. The drainage is imperfect or poor with standing water common on both sides of the channels which cut through the unit.

Water erosion along the steep embankments of landfill has partly exposed the contents underlying the surface materials. Continued downcutting and erosion could potentially expose more debris.

The remaining terrain units fall outside the area of primary interest. These include Terrain Units 6, 7, and 8.

3.2.2.6 Terrain Unit 6

Terrain Unit 6 is gently inclined toward the sea and is characterized by successive marine strandlines along its length. The unit is comprised of recent exposed marine reworked material.

3.2.2.7 Terrain Unit 7

Terrain Unit 7 is comprised of the predominantly granitic rock outcrops within the map area. The terrain is typically ridged and rolling with extensive jointing and possible faulting throughout.

3.2.2.8 Terrain Unit 8

Terrain Unit 8 includes raised deltaic sediments along the mouth of a river which drains the uplands.

3.2.3 POTENTIAL BORROW SOURCES

Seven existing borrow areas were identified at CAM-5, MacKar Inlet. All were located in the vicinity of the lower base and are associated primarily with Terrain Unit 4. The aggregate works at this site are quite extensive. Generally, the materials are coarse-grained and consist of boulders, gravels and sands.

The potential for additional gravel sources is high. No sources of fine grained materials were identified.

3.3 HYDROLOGY

Site drainage and topography of the CAM-5 site and surrounding area can be seen in Figure 3.1. The CAM-5 Module Train is located on top one of the topographical high points at an approximate elevation of 400 m, while the lower site and airstrip are located between Bagnall Lake and Committee Bay near sea level.

Surface drainage from the Module Train area to the lower site occurs generally in a northwesterly direction through two narrow elongated valleys. The two valleys run approximately parallel to each other. Several lakes connected by streams flow through the rough bouldery terrain on the valley floor. There is a lake in the more westerly valley downgradient of the upper site which partitions its discharge between the two valleys by way of a brief interconnecting valley. The two valleys join a second time before discharging immediately east of the vehicle and equipment storage pad at Bagnall Lake. Significant flow discharges at the mouth of this stream occur as a result of the large drainage area encompassed by the two valleys.

Drainage from the upper site flows primarily to the north and east as determined by local topography. Drainage east of the POL storage area is controlled by natural topographic contours which direct the drainage to the head of the more easterly valley. However, some runoff from the warehouse and garage building area flows to the south toward the water supply lake.

The water supply lake is located approximately 280 m south of the Module Train in a natural depression in the bedrock surface surrounded by boulder covered terrain. It is 18 m deep and has an approximate area of 0.8 ha. There are no streams or lakes which recharge or drain from the water supply lake.

The sewage outfall discharges to the steep slope immediately north of the Module Train. The effluent travels through the steeply graded boulder covered slope to a grassy, sediment rich deltaic area leading to a lake. This lake is located adjacent to the roadway approximately 1100 m from the upper site and discharges to a stream which continues through the more easterly valley described previously.

Surface drainage south of the airstrip is collected by streams and lakes at higher elevations which eventually discharge to Committee Bay, approximately 80 m south of the northwest end of the airstrip.

The active landfill for CAM-5 drains north and east along established gullies. Landfill C drains into Landfill B which flows north into Bagnall Lake.

Runoff in the immediate vicinity of the airstrip is channelled through a shallow ditch parallel to the runway on its south side. The ditch slopes to the northeast and eventually discharges to Bagnall Lake. Drainage on the north side of the runway is collected by small catchments which discharge to Bagnall Lake as well.

3.4 FLORA

The landscape at the camp is characterized by barren bedrock outcrops and knolls sparsely vegetated by mosses and lichens. Vascular plant cover is generally less than 15 percent, including purple saxifrage (*Saxifraga oppositifolia*), mountain avens (*Dryas spp.*), willow (*Salix spp.*), alpine foxtail (*Alopecurus alpinus*), wood rush (*Luzula* spp.) and other saxifrages (*Saxifraga* spp.). In lowland areas including slopes down to waterbodies, where more soil materials are present, plant cover may range from 40 to 60 percent. Where soil moisture is abundant these areas are completely covered by sedge (*Carex* spp.), cotton grass (*Eriophorum* spp.), saxifrage and mosses, providing excellent grazing for caribou.

3.5 FAUNA

3.5.1 LARGE MAMMALS

It is believed that no more than a few muskoxen (*Ovibos moschatus*) ever inhabited Melville Peninsula and it has been suggested that the species no longer exists there (Urquhart 1982). Archaeological studies during the site survey at FOX-M located east of CAM-5 discovered bones of muskox which may have come from the Hall Beach area.

MacKar Inlet is located approximately 60 km north of the Northeastern Keewatin caribou calving ground which is an 11000 km^2 area of special interest to the Government of the Northwest Territories (Ferguson 1987). Barren-ground caribou (*Rangifer tarandus groenlandicus*) in this region belong to the Melville Herd which was estimated at over 40000 in 1983 (Heard *et al.* 1986). This spring survey indicated that approximately 2500 animals were on the northern half of Melville Peninsula at that time. Calving usually occurs during the first half of June after which cows and calves apparently move north (Ferguson 1987). Approximately 20 caribou were observed near the landfill during the site visit in July. Station personnel reported that caribou are commonly seen at the site during the summer.

Polar bears (*Ursus maritimus*) in this area are within Management Zone C which may support one of the largest polar bear populations in the Canadian Arctic (Urquhart and Schweinsburg 1984). Wager Bay, Southhampton Island, and an area immediately south of Hall Beach are important summer retreats for bears of Foxe Basin which is largely ice-free during that season (Urquhart and Schweinsburg 1984). Polar bears have been reported at this station and one was observed at the airstrip during the site visit. Stenhouse *et al.* (1988) found that 71 percent of the problem polar bears killed in the Northwest Territories occurred in the Baffin region.

3.5.2 OTHER TERRESTRIAL MAMMALS

Arctic fox (*Alopex lagopus*) were not observed at the station but are probably present in the area. This species is usually attracted by artificial food sources (landfill and litter), foraging around construction camps is common (Eberhardt *et al.* 1982). Home range size with territories overlapping petroleum development facilities have been reported as 20.8 km^2 and 3.7 km^2, for adults and juveniles respectively (Eberhardt *et al.* 1982).

A wolf (*Canis lupus*) was observed at this site walking along a road. This was unusual as no other individuals were sighted during the 21 site surveys in 1990 and station personnel report their occurrence at these sites as rare. Observations of other terrestrial furbearers at this station were not recorded although the short-tailed weasel (*Mustela erminea*) is known to occur on Melville Peninsula (Carbyn 1987; Fagerstone 1987).

An arctic ground squirrel (*Spermophilus parryii*) was found at the site where it had made a den beneath a pile of rocks. Other mammals which probably occur in the area include arctic hare (*Lepus arcticus arcticus*), collared lemming (*Dicrostonyx torquatus lentus*) and brown lemming (*Lemmus sibiricus*) (Banfield 1974).

3.5.3 MARINE MAMMALS

Beluga (*Delphinapterus leucas)* and narwhal (*Monodon monoceros*) whales migrate westward through Lancaster Sound into Parry Channel from Baffin Bay after ice-break-up in the spring (June-July)(Read and Stephansson 1976). At this time, most marine mammals concentrate in the main channel of Lancaster Sound with smaller numbers migrating to Barrow Strait and few or none penetrating into Viscount Melville Sound. Some whales do enter the Gulf of Boothia by moving south along the east coast of Somerset Island. Narwhals have a similar summer migration route although they may enter Lancaster Sound somewhat later in the spring (Sergeant and Hay 1978).

Preferred summer habitats and areas of major concentrations of beluga and narwhal are northwest of the study area at Brentford Bay near Bellot Strait. Station personnel reported that narwhal are occasionally seen in the bay at MacKar Inlet during summer.

The endangered bowhead whale (*Balaena mysticetus*) migrates into Lancaster Sound in June and July. It is unlikely to be encountered in the study area, preferring, like the narwhal, the fiords of northern Baffin Island during the summer (Arctic Pilot Project 1979).

During the open water season (summer) walrus (*Odobenus rosmarus*) concentrate in Lancaster Sound in the vicinity of southwest Devon Island in numbers of less than 400 animals (Sergeant and Hay, 1978). Walrus enter the Gulf of Boothia along the east coast of Sommerset Island as far south as Lord Mayor Bay. Walrus are unlikely to be seen in and around MacKar Inlet since only periodic migrations are made south of Somerset Island (Read and Stephansson 1976).

Due to annual ice conditions in the central arctic, most marine mammals either do not penetrate into or migrate from Lancaster Sound prior to winter freeze-up (September). An exception are the seals which occur year-round in the region although, depending on the species, there are shifts in distribution in relation to preferred ice habitats. The two most common seal species, bearded (*Erignathus barbatus*) and ringed (*Phoca hispida*) seals, extend southward into Pelly Bay and Committee Bay (Read and Stephannson, 1976). No marine mammals were observed at MacKar Inlet during the site visit.

3.5.4 RAPTORS

No raptors were reported or observed during the site visit although Snowy Owls (*Nyctea scandiaca*), Peregrine Falcon (*Falco peregrinus*), Gyrfalcon (*Falco rusticolus*), and Rough-legged Hawk (*Buteo lagopus*) are known to occur in this region.

3.5.5 OTHER AVIFAUNA

Intensive field surveys at Scarpa Lake, approximately 120 km east of MacKar Inlet, in 1981-1982 located 40 species of birds (Montgomerie *et al.* 1983). Species observed and their relative abundance in this area may be comparable to what exists at MacKar Inlet. Detailed observations of avifauna were not recorded at this station other than a sighting of three Tundra Swans (*Cygnus columbianus*).

3.5.6 FISH

MacKar Inlet is located on Committee Bay, which has a small commercial harvest of Arctic char (*Salvelinus alpinus*). Station personnel also fish recreationally for Arctic char.

3.6 HERITAGE RESOURCES

Three archaeological localities were identified through information supplied by station personnel. The Bagnall Lake 1 locality contains 21 features in four concentrations. The features are represented by a hunting blind, nine caches, two shelters, three tent rings, a possible grave, and five unidentified structures which may have been used for multiple functions. The age of the features appear to range from relatively recent (post-dating construction of the station) to perhaps several centuries. Considerable disturbance to the site features has occurred through road construction, gravel extraction, and natural erosion. Some structures have been totally disturbed.

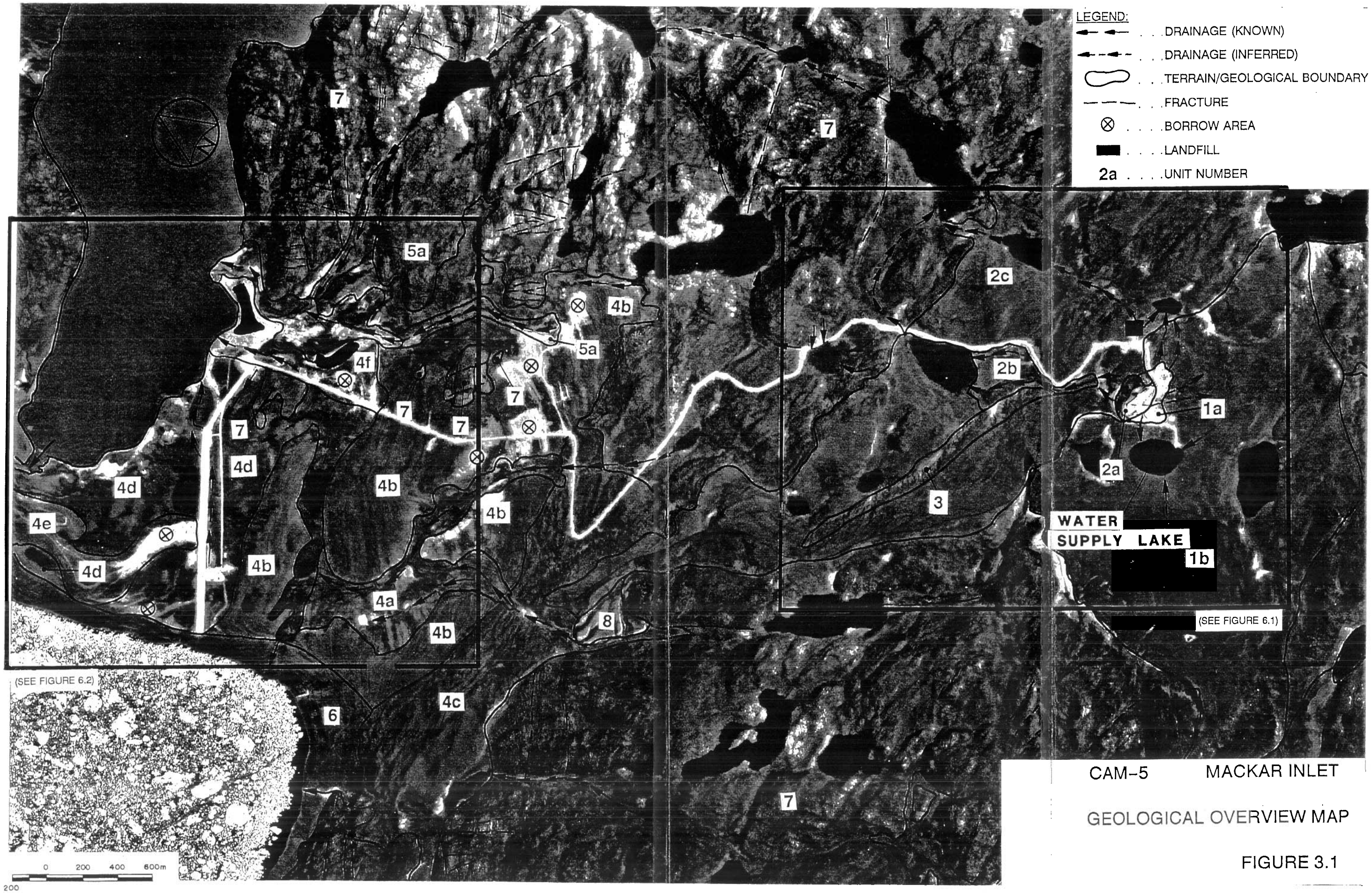
The Bagnall Lake 2 locality contains two concentrations of features. The first consists of a complete tent ring and a partial tent ring which is presently eroding into the river. These features appear to pre-date the construction of the station. The second concentration consists of an *inuksuk*, an associated cache and a tent ring. This locality appears to be prehistoric in age. To the west of the runway is a large Inuit site containing 22 features including tent rings, partial tent rings, caches, and hearths. Although the precise age of the site can not be determined it is thought to represent occupation from perhaps 100 to 200 years ago. This site may be affected by continued gravel extraction.

Substantial disturbance has already occurred at the Bagnall Lake 1 site. Additional disturbance may result from continued gravel mining and road construction, as well as station decommissioning. It is recommended that a full archaeological assessment program, including detailed survey, mapping, and test excavation be conducted at the identified sites. All site areas are to be avoided until this program has been completed. In addition, it is recommended that an archaeological assessment program be conducted prior to the occurrence of any potential disturbance on the north side of the river.

A separate report documenting the heritage resources study on the site has been filed with the Prince of Wales Northern Heritage Centre with copies to USAF and DND (Fedirchuk et al, 1990).

3.7 LAND USE

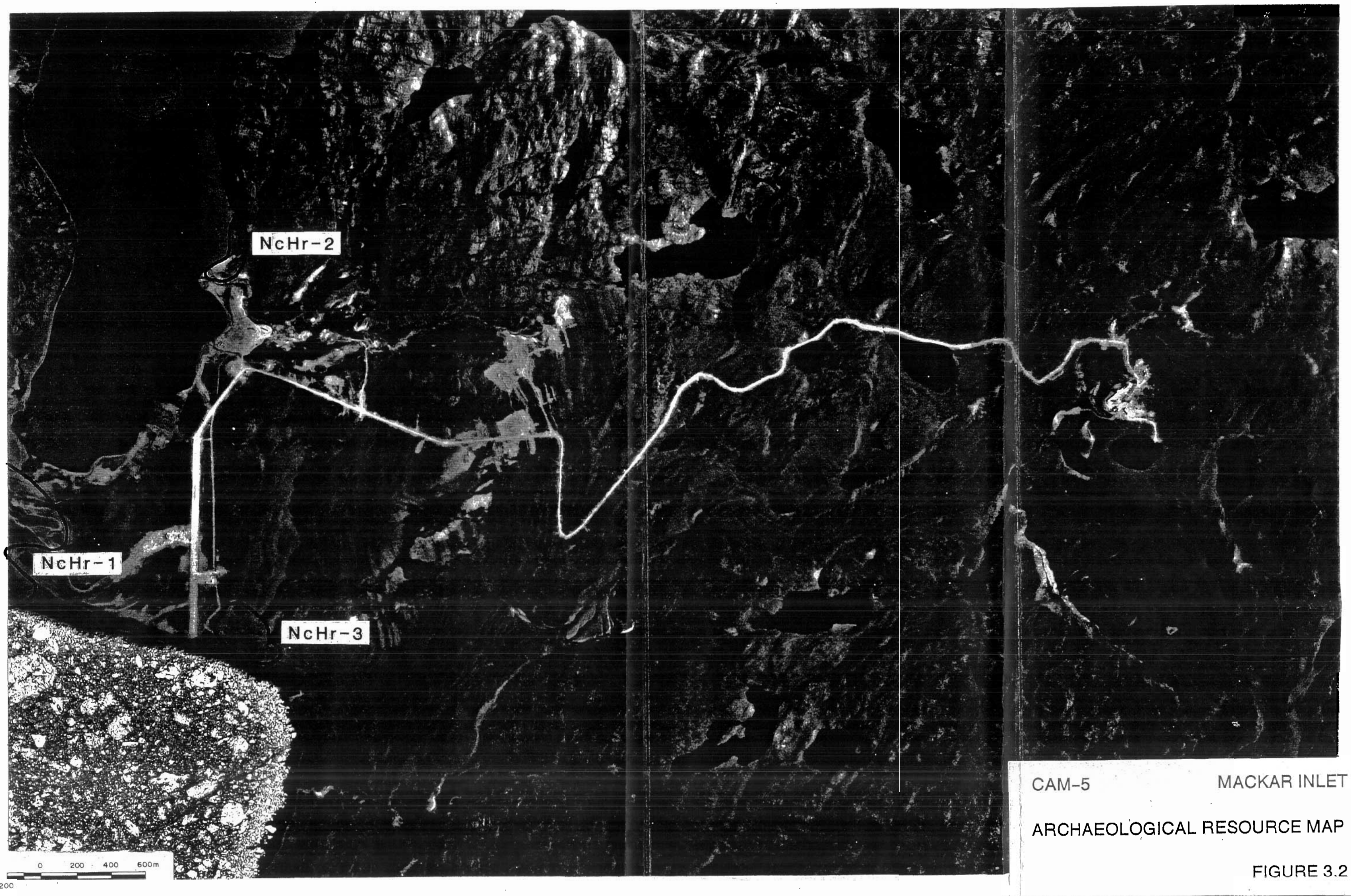
No ecological sites are designated in this area. Occasional hunting for polar bear occurs in the area by hunters from Igloolik and Hall Bay communities located on the eastern shore of the Melville Peninsula.



CAM-5 MACKAR INLET

GEOLOGICAL OVERVIEW MAP

FIGURE 3.1



CAM-5 MACKAR INLET

ARCHAEOLOGICAL RESOURCE MAP

FIGURE 3.2

4.0 SITE INFRASTRUCTURE

4.1 BUILDINGS

The facilities on CAM-5 MacKar Inlet are described in detail in the Base Civil Engineering data which appear as Appendix A. Figure 4.1 illustrates the location of the facilities. Facilities and features are labelled as per the BCE facility index. An aerial view of the site is shown in Plate 1.

4.2 FUEL STORAGE AND DISTRIBUTION

Fuel storage facilities at CAM-5 MacKar Inlet are summarized in Table 4.1.

Table 4.1

CAM-5, MacKar Inlet: Fuel Storage Facilities

1.	Diesel Oil: Total Capacity	384 m^3
	a) Airstrip area (2 steel tanks) (69 m^3 ea.):	138 m^3
	b) Building site area (1 steel tank):	246 m^3
2.	Mogas: Total Capacity	46 m^3
	a) Airstrip area (one steel tank):	23 m^3
	b) Building site area (one steel tank):	23 m^3

1 m^3 = 264 US Gal.

Product is delivered by airlift for off-loading into receiving tanks. Mogas is trucked to the site. Diesel fuel is transferred via a 50 mm pipeline to the building site tanks. The diesel fuel is distributed to the module train, garage and warehouse via the pumphouse and pipeline. The total length of the pipeline including building feeder lines is about 6800 m. Drum stocks are transferred using portable pump units or tank vehicles as required.

4.3 WASTE TREATMENT

Wastewater and liquid sewage is collected in internal storage tanks within the module train, the only building with sanitary facilities. The wastewaters only undergo partial primary treatment within the storage tanks prior to periodic discharge to the outfall area. The outfall area is located northeast of the building compound as shown in Plate 2.

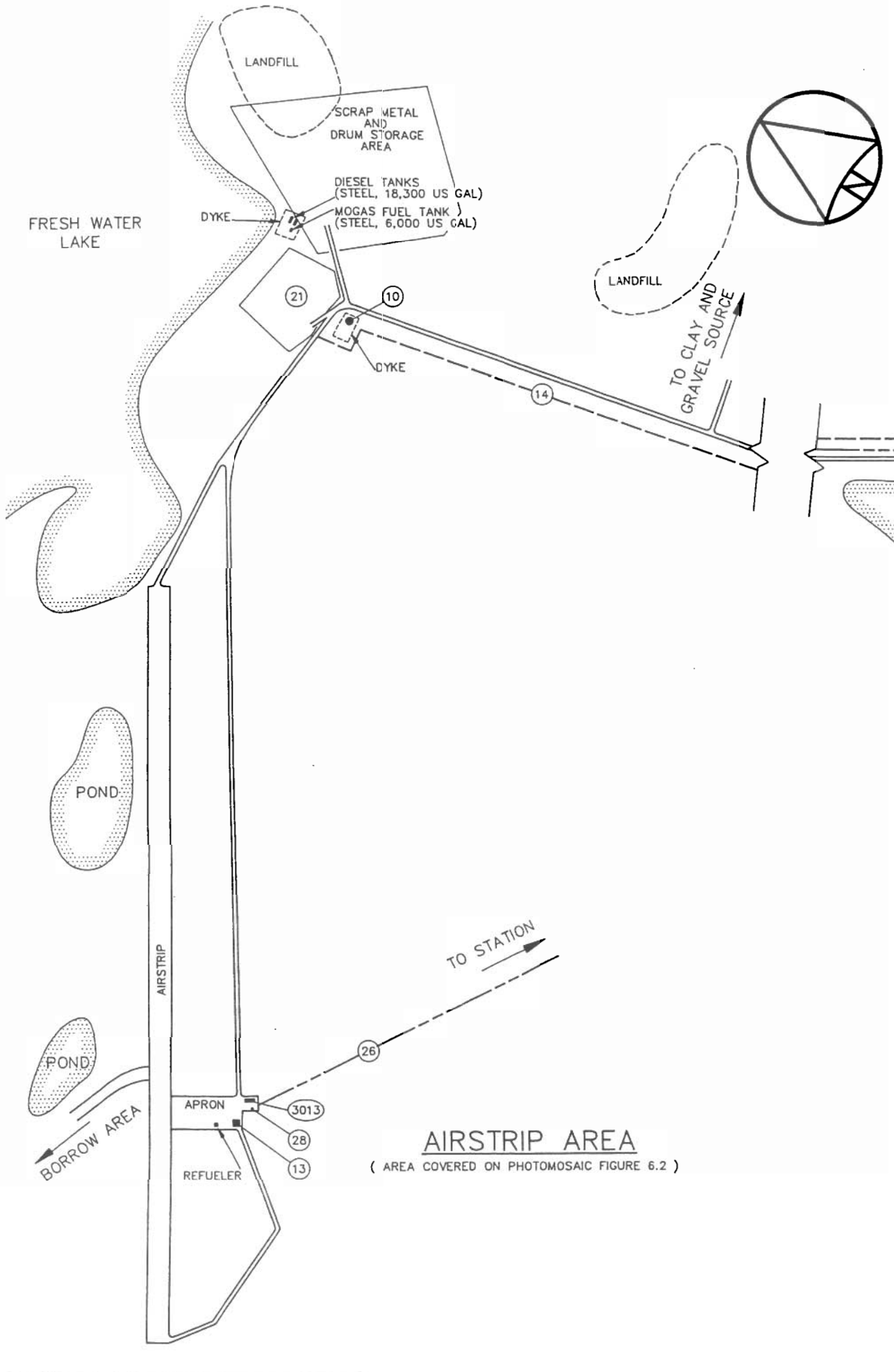
The module train is also equipped with emergency dry head toilets. When full, the waste is transferred to steel drums and transported to disposal areas.

4.4 HAZARDOUS MATERIAL SURVEY

A comprehensive hazardous material inventory was not available for CAM-5. Based on retrograde plans (4700 OSS LGTT, 1989 and 1990), it is expected that the following hazardous goods may be encountered on site.

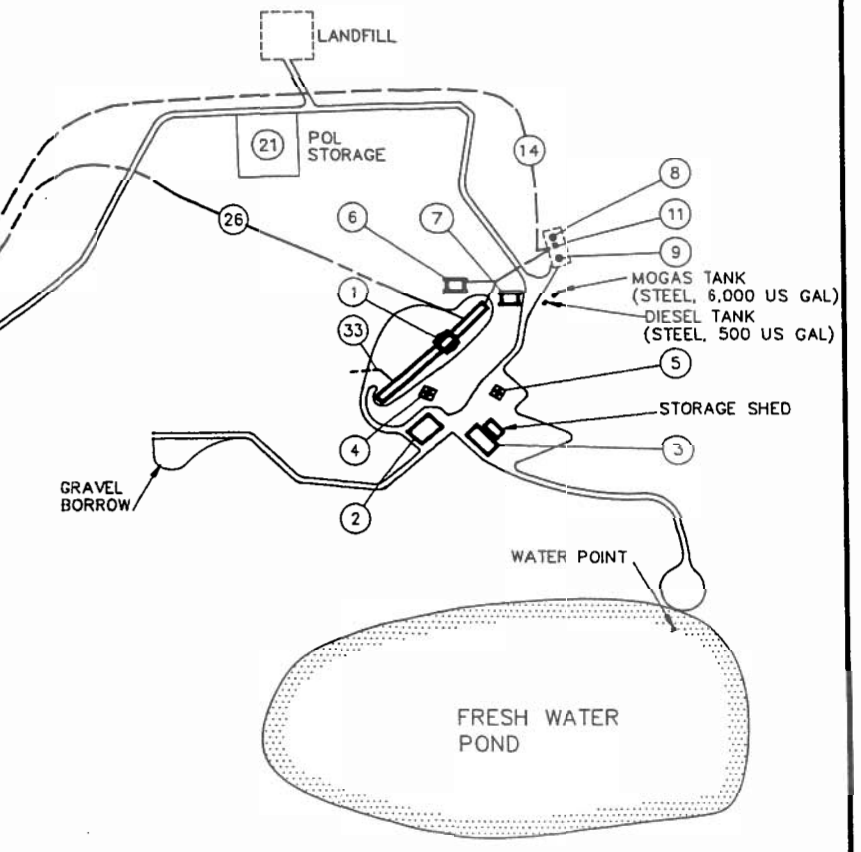
FACILITIES INDEX:

(1)	MODULE TRAIN	(7)	COMMUNICATION "BILLBOARD"	(21)	OPEN STORAGE AREA
(2)	GARAGE	(8)	DIESEL FUEL TANK (STEEL, 65,000 US GAL)	(26)	PRIMARY POWER CABLE
(3)	WAREHOUSE	(9)	DIESEL FUEL TANK (STEEL, 65,000 US GAL)	(28)	BEACON LIGHT
(4)	COMMUNICATION "DISH"	(10)	DIESEL FUEL TANK (STEEL, 65,000 US GAL)	(33)	SEWAGE LINE
(5)	COMMUNICATION "DISH"	(11)	POL PUMPHOUSE	(3009)	SHELTER HUT (NOT SHOWN)
(6)	COMMUNICATION "BILLBOARD"	(13)	UNHEATED VEHICLE STORAGE	(3010)	EMERGENCY SHELTER
		(14)	POL LINE	(3013)	AIRSTRIP HUT



AIRSTRIP AREA

(AREA COVERED ON PHOTOMOSAIC FIGURE 6.2)



STATION AREA

(AREA COVERED ON PHOTOMOSAIC FIGURE 6.1)

NOTE:

1. FOR OVERALL SITE PHOTOMOSAIC COVERAGE SEE FIGURE 3.1.
2. THE FACILITIES SHOWN ARE TAKEN FROM THE AVAILABLE AS-BUILT SITE DRAWINGS AND THE CURRENT BCE DATA (1990), AND AS VERIFIED ON SITE.
3. NUMBERED FACILITIES ARE AS GIVEN IN THE FACILITIES INDEX IN THE BCE DATA.

0 80 160 240 m

80

CAM-5 MACKAR INLET

SITE PLAN

FIGURE 4.1

- Class 2 compressed gases including acetylene, mapp gas and oxygen.
- Class 3 flammable liquids.
- Solvents and antifreeze.
- Class 8 corrosives including batteries.
- Oil, grease, lubricants and hydraulic fluids.

The status of hazardous materials should be verified prior to decommissioning. As specified in Volume 2, Section 6.2, the USAF removes all identifiable and recoverable hazardous materials as part of the standard site shut-down procedure.

4.5 SPILL HISTORY

One fuel spill was described in the spill report records for CAM-5 (Frontec/Felec Spill Reports, 1990).

The spill occurred on March 29, 1988 approximately 65 m south of the POL pumphouse (Fac 1013). Physical evidence suggests that approximately 180 L of diesel fuel was lost when a pipeline was broken, although estimates put this number as high as 1000 L. Contaminated soil was to be collected and retrograded. Corrective measures to the pipeline were completed on March 30, 1988.

5.0 ASBESTOS, PAINT, AND PCB RESULTS

5.1 ASBESTOS

5.1.1 RECORD REVIEW

The March 31, 1990 asbestos survey (DEW Surveys, 1990) conducted at the site indicated the presence of asbestos, in sheet and pipe forms. Table 5.1 summarizes the location, form, and quantity of asbestos present at the site from this survey.

Table 5.1

CAM-5, MACKAR INLET: ASBESTOS INVENTORY

Location	Form	Quantity
Module Train	Pipe Sheet	1 260 m 74 m^2
Garage	Pipe Sheet	9 m 0.4 m^2
Warehouse	Pipe Sheet	5 m 20 m^2

Note: Pipe insulation measured in lineal metres.

5.1.2 FIELD SURVEY

Five samples of insulating material were obtained during the 1990 site sampling trip. Two samples of floor tile were obtained from the module train. A third sample from the module train was taken from a hot water pipe. One sample was collected from the mechanical room in the warehouse. All samples were taken from encapsulated materials. Insulating material found at the landfill area was also tested.

5.1.3 ANALYTICAL RESULTS

Analytical results are presented in Table 5.2. Asbestos content was determined by polarized light microscopy according to NIOSH Method 9002.

Samples C5A-001 and C5A-005 from refuse in the active landfill and the Warehouse Mechanical Room (respectively), contained 70 percent chrysotile asbestos. The floor tile samples from the Module Train did not contain asbestos. The remaining sample from the hot water pipe also did not contain asbestos. According to Regulation 7/82, Alberta Occupational Health and Safety Guidelines, material with an asbestos content of greater than 1 percent is considered a hazardous good.

Table 5.2

CAM-5, MACKAR INLET: ASBESTOS SAMPLE SITES AND ANALYTICAL RESULTS

Location	Area	Sample No.	Percent Asbestos Present	Type of Asbestos
Active Landfill	Refuse	C5A-001	70%	Chrysotile
Module Train	Laundry Room Floor Tile	C5A-002	Not Detected	
Module Train	Tank Room Floor Tile	C5A-003	Not Detected	
Module Train	Washroom Hot Water Pipe	C5A-004	Not Detected	
Warehouse	Mechanical Room	C5A-005	70%	Chrysotile

5.2 PAINT

5.2.1 FIELD SURVEY

Five paint samples were obtained from representative areas in the interior and on the exterior of the CAM-5 facilities in July of 1990. Sample locations included the interior and exterior of the emergency shelter hut, the exterior of a mogas tank, and the interior of the Module Train. The fifth sample was collected from a paint spill location. Specific areas are described in Table 5.3.

Table 5.3

CAM-5, MACKAR INLET: PAINT SAMPLE SITES AND ANALYTICAL RESULTS

Location	Emergency Shelter (FAC 3013)	Lake Shore POL	Lake Shore POL	Emergency Shelter (FAC 3009)	Module Train (FAC 01)
Sample Area	Interior	Paint Spill	Mogas Tank Exterior	Exterior	Storage Room Interior
Sample No.	C5P-001	C5P-002	C5P-003	C5P-004	C5P-005
Metals Present (mg/kg)					
Arsenic	170	1	0.5	0.7	38
Selenium	6.3	<0.5	<0.5	<0.5	2.2
Mercury	49	<0.5	0.22	2.9	14
Barium	120	13000	9900	55	48
Beryllium	<1	<1	<1	<1	<1
Cadmium	15	38	40	<1	11
Chromium	210	7	5	22	64
Lead	3300	210	40	52	1100
Nickel	42	<5	<5	<5	15
Silver	<5	<5	<5	<5	<5

5.2.2 ANALYTICAL RESULTS

The results of the metal analyses of the paint samples are presented in Table 5.3. All analyses determined the total concentration of specific metals. Test methods for the various chemicals are given in Appendix C.3.

Lead concentrations ranged from 40 to 3300 mg/kg in the specific samples tested, with the highest concentration detected in the sample taken from the exterior of the emergency shelter (C5P-001). Elevated concentrations of arsenic (170 mg/kg) and mercury (49 mg/kg) were also detected in this sample. Sample C5P-005, taken from the interior of the module train, showed moderately high levels of arsenic and mercury as well (38 mg/kg and 14 mg/kg, respectively).

High levels of barium were detected Samples C5P-002 and C5P-003 (13000 and 9900 mg/kg, respectively) taken from the lake shore POL facility. Generally, high metal concentrations are typical of industrial oil-based paints.

5.3 PCB

5.3.1 RECORD REVIEW

The most recent PCB inventory is dated January 25, 1990 (DEW Surveys 1990). A list of the equipment suspected of containing PCBs in use as of January 25, 1990 is summarized in Table 5.4.

5.3.2 FIELD SURVEY

A runway lighting regulator located at the airstrip, suspected of containing PCB oil, was sampled. The remaining units listed in the inventory were not tested as they were either sealed or in use at the time of the site visit.

Table 5.4

CAM-5, MACKAR INLET: PCB INVENTORY

Area	Transformer Units	Capacitor Units	Misc. Units	Suspected Total PCBs (kg)
Building 32	1	--	--	172.12
Airstrip	1	--	--	172.12
Receiver Room	556	38	506	131.6
Radar Room	86	574	328	94.08
Lateral Communication Room	12	24	--	36.56
Surveillance Room	20	68	13	36.56
Emergency Radio Room	1	1	1	2.50

5.3.3 ANALYTICAL RESULTS

The sample tested did not contain PCB oil above the detection limit. These results do not preclude the presence of PCBs in other units which were not available for sampling.

6.0 SITE ASSESSMENT

The study was designed to satisfy the requirements of the base line risk assessment and available environmental clean-up criteria (UMA 1990a). A full suite of chemical analyses of soil and water samples consisted of the following: metals by ICP scan EPA Method 6010; arsenic EPA Method 7061; lead and cadmium EPA Method 7420 and 7130; mercury EPA Method 7471; PCB and TPH EPA Method 8080; volatiles EPA Method 8270; and semi-volatiles EPA Method 8260.

The full suite of analyses was conducted on water and leachate samples. Representative soil samples from each of the facilities/features investigated, as well as the background samples were analyzed for all requested parameters. Analysis of additional samples were targeted at specific compounds based on the results of the full suite of analysis. The results of all soil and water analyses are presented in Appendix C.

The evaluation of the indicator chemical concentrations found at specific locations at this station is based on the site assessment strategy outlined in Volume 2. The strategy consisted of:

(1) Comparison of laboratory data to background soil and water and identification of results with values greater than 50 percent of Quebec Level A Guidelines or detection of organic chemicals.

(2) Comparison of laboratory data to Quebec Soil Guidelines and Guidelines for Canadian Drinking Water Quality.

(3) Assessment of risk to human health and the environment from specific locations (landfills, sewage outfalls and others).

The following subsections address each location and stain area on the site and present an evaluation of the risk assessment. Quality assurance and quality control of the analytical data appears in Appendix D. Risk assessment for the site is presented in detail in Appendix E, and summarized in Table 6.1.

6.1 SITE RISK ASSESSMENT SUMMARY

Results from the CAM-5 site exposure assessment were integrated in order to characterize the site-specific risk. As described in Volume 2, Section 3.0, the methods for characterizing non-carcinogenic risk are different from those used for carcinogenic risk. The quantification of CAM-5 site risk has therefore been segregated according to these categories.

Results have been summarized in Table E-6. and as may be seen the total carcinogenic risk was estimated at $\leq 2 \times 10^{-5}$. Based on the U.S. EPA site remediation goal of reducing cancer risks below 10^{-4}, the CAM-5 carcinogenic risk is less than criteria. The principal contributor was chromium intake from the Inhalation pathway. Although only a small area of significant chromium concentration was found, low level concentrations below background were distributed over a large area which resulted in greater potential exposures. The incremental risk above background is therefore much less than that estimated above. As discussed in Volume 2, a large slope factor is defined for the hexavelant form of chromium and therefore any portion of the chromium from CAM-5 site which is not in hexavelant form would reduce the estimated risk proportionately.

Table 6.1

CAM-5, MACKAR INLET: RISK ASSESSMENT SUMMARY

		Carcinogenic Risk	Non-Carcinogenic Risk
Site Worker		2×10^{-5}	6×10^{-1}
Northerner:	Adult	n/a	n/a
	Child	n/a	n/a
Standard		10^{-4}	1.0

n/a = Not Available

The CAM-5 site worker non-carcinogenic hazard index results are summarized in Table E-7. Ingestion of water contributed the largest amount to the risk index due to the chromium concentration in drinking water. The distribution of hazard quotients from other pathways is given in Figure E-2. The hazard index of 6×10^{-1} is less than the unity criteria however the reference dose was based on chromium VI. The reference dose for chromium III is 200 times greater than that for chromium VI, therefore the portion of chromium which is not in hexavelant form would reduce the estimated risk proportionately.

The uncertainty of the risk assessment is addressed in Section E.5.3.

The estimated contaminant intakes for caribou and grasses were compared to estimated safe values to characterize risk in a method similar to that used for human non-carcinogenic risk assessment. The sum of all hazard quotients in caribou was significantly smaller than the unity criterion and therefore caribou risks are considered small. Likewise, the hazard quotients for PCBs, lead and nickel in grasses were less than 1. The estimated intakes for the remaining contaminants were small, however, toxicity information was not available and therefore risks could not be quantified.

The estimated contaminant intakes for caribou and grasses were compared to estimated safe values to characterize risk in a method similar to that used for human non-carcinogenic risk assessment. The hazard quotients for lead, PCBs and TPH in caribou were significantly smaller than the unity criterion and therefore caribou risks are considered small. Likewise, the hazard quotients for PCBs in grasses was very small while that for lead in grasses was 0.15, still less than the unity criteria. The estimated intakes for the remaining contaminants were small however toxicity information was not available and therefore risks could not be qualified.

6.2 SITE BACKGROUND CONDITIONS

One water sample (C5-B) was taken to provide an indication of background water chemistry in the vicinity of the site. The sample was obtained from near the intake in the water supply lake located 100 m southwest of the Module Train.

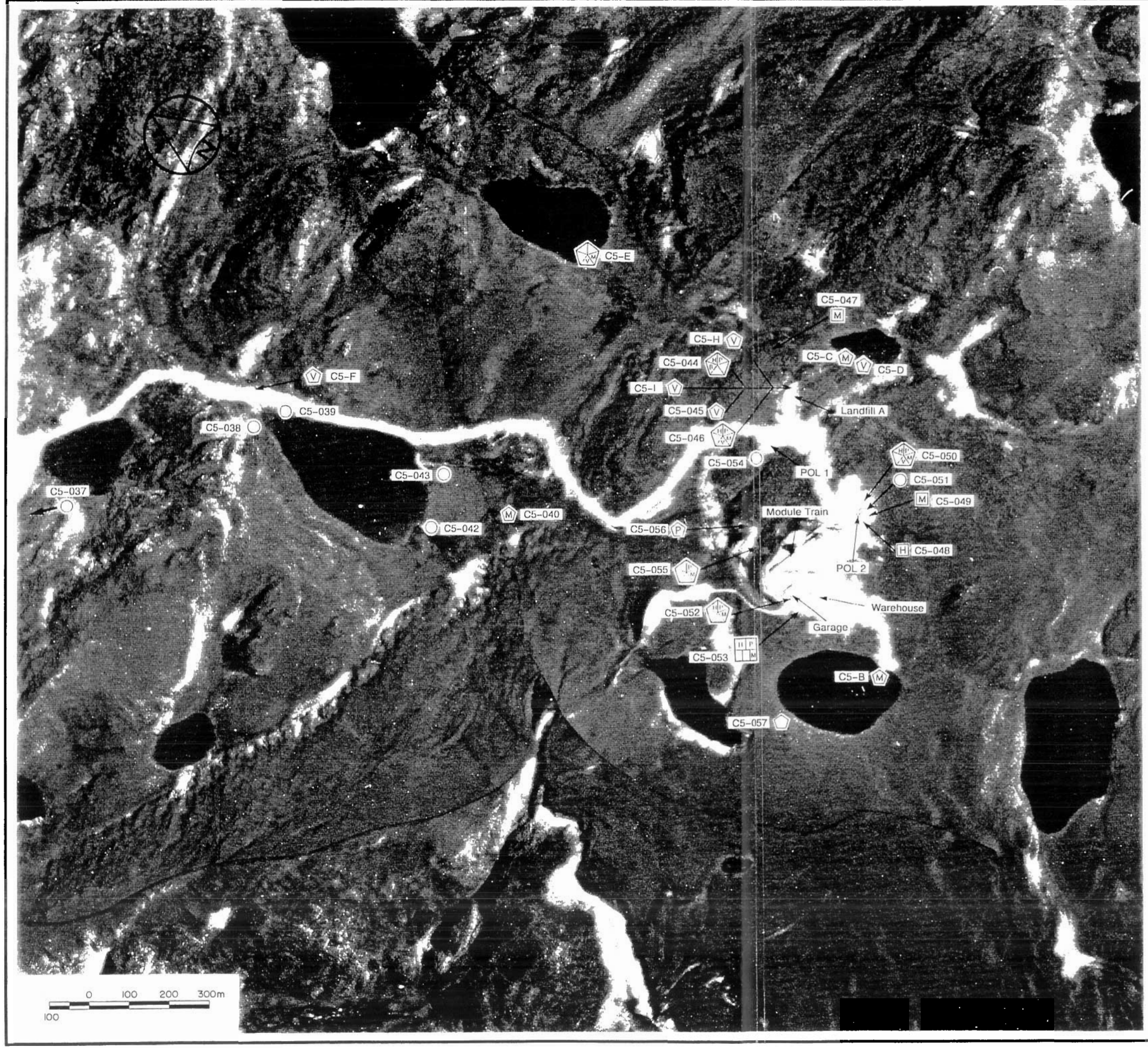
Two soil samples, C5-057 and C5-058, were taken to provide an indication of background soil chemistry. The former sample was taken at a point 40 m from the northwest end of the water supply lake. The latter was collected north of the west end of the Airstrip.

Sample site locations are presented in Figures 6.1 and 6.2.

Water sample C5-B was tested for the complete set of indicator chemicals.

Concentrations in the background water sample (C5-B) were below detection limits for all indicator chemicals analyzed with the exception of chromium (Appendix B). At 0.13 mg/l, the chromium concentration is above Guidelines for Canadian Drinking Water Quality (1987). It is not clear whether this relatively high chromium level represents background conditions or is a result of pollution from some source on the site.

Data for selected soil indicator chemicals for the two background soil samples are shown in Table 6.2. Concentrations of all analyzed indicator chemicals with the exception of silver were less than 50 percent of Level A. Silver was present at the method detection limit (5 mg/kg) which exceeds the study criterion of 1 mg/kg.



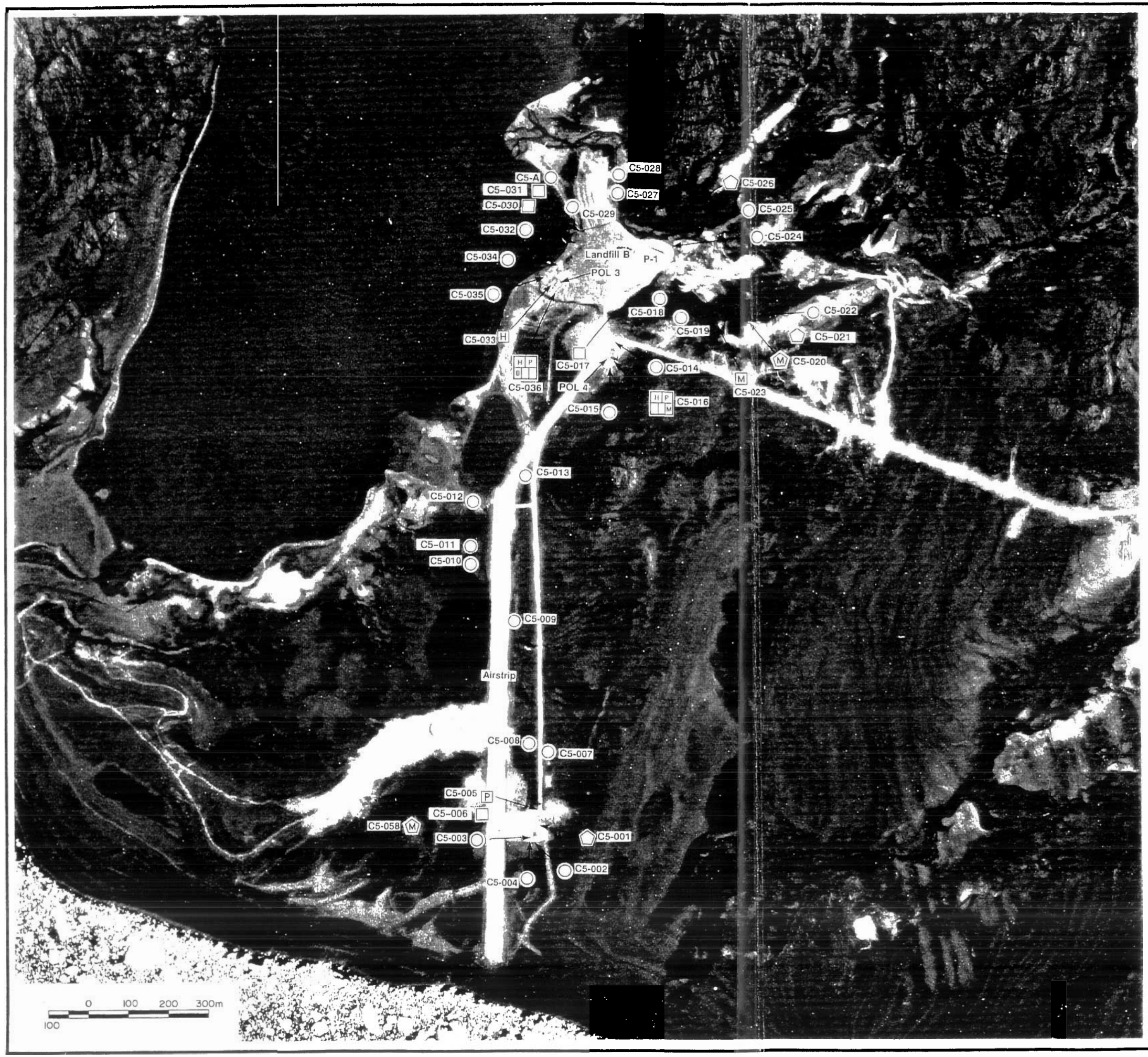
LEGEND

1ST ROUND TESTS RESULTS	2ND ROUND TESTS RESULTS	
		MULTIPLE PARAMETERS DETECTED
M	M	METALS DETECTED
B	B	BNA - BASE, NEUTRAL, ACID EXTRACTABLES DETECTED
H	H	HYDROCARBONS DETECTED
V	V	VOLATILES DETECTED
P	P	PCB DETECTED
		SAMPLE TESTED AND NO PARAMETERS DETECTED
○		SAMPLE TAKEN BUT NOT ANALYZED
C5 - 037		SOIL SAMPLE NUMBER
C5 - B		WATER SAMPLE NUMBER

CAM-5 MACKAR INLET

STATION AREA SAMPLE SITES AND PARAMETERS IDENTIFIED

FIGURE 6.1



LEGEND

1ST ROUND TESTS RESULTS	2ND ROUND TESTS RESULTS	
HPBVM	HPBVM	MULTIPLE PARAMETERS DETECTED
M	M	METALS DETECTED
B	B	BNA - BASE, NEUTRAL, ACID EXTRACTABLES DETECTED
H	H	HYDROCARBONS DETECTED
V	V	VOLATILES DETECTED
P	P	PCB DETECTED
⬠	□	SAMPLE TESTED AND NO PARAMETERS DETECTED
	○	SAMPLE TAKEN BUT NOT ANALYZED
C5 - 001		SOIL SAMPLE NUMBER
C5 - A		WATER SAMPLE NUMBER

CAM-5 MACKAR INLET

AIRSTRIP SAMPLE SITES AND PARAMETERS IDENTIFIED

FIGURE 6.2

Table 6.2

CAM 5, MACKAR INLET: SOIL ANALYTICAL RESULTS – BACKGROUND

Indicator Chemical (mg/kg)	Background Concentrations		Typical Ranges**
	C5-057	C5-058	
Arsenic	<0.1	0.8	0.7 - 15
Selenium	<0.5	<0.5	<0.1 - 1.2
Mercury	<0.05	<0.05	0.01 - 0.14
Barium	43	29	300-1500
Beryllium	<1	<1	1-2
Cadmium	<1	<1	-
Chromium	37	22	10 - 100
Lead	<10	<10	10-50
Nickel	21	11	-
Silver	<5	<5	0.2 - 3.2

** = Kabata - Pendias and Pendias (1984)

- = Data Not Available

6.3 LANDFILLS

There are three landfills; A, B and C at CAM-5.

6.3.1 LANDFILL A

6.3.1.1 Visual Observations and Sample Locations

Landfill A is an active landfill located along a steeply sloping bank 350 m northeast of the Module Train. Refuse including drums and barrels, as well as domestic tin and aluminum cans have been dumped over the valley wall.

Primary drainage from the landfill is to the east, toward a north-flowing stream adjacent to the toe of the landfill. Flow also occurs to the north from the landfill to this stream as well as to a small lake 100 m southeast which is drained by the same north-flowing stream.

Soil in the area was silty sand and much of the area was covered with cobbles and boulders. Some staining was evident east of the toe of the landfill.

A sample of landfill leachate was obtained 8 m east of the toe of the landfill (C5-H). Water sample C5-I was taken 50 m northeast, and downslope from the toe of the landfill. Two water samples were also taken at the point where drainage from the vicinity of the landfill flows into the small lake to the southeast (C5-C), 50 m downstream to the northeast, and at an inflow to another small lake to the north (C5-E).

Four soil samples were collected near the landfill. Sample C5-045 was taken 8 m east of the toe of the landfill. Sample C5-044 was taken on a steep slope farther east. The two remaining samples were taken to the north adjacent to streams draining the landfill (C5-046 and C5-047).

The sample locations are provided on Figure 6.1.

6.3.1.2 Analytical Results

Water samples C5-C, C5-D, C5-E, C5-H, and C5-I were submitted for the first round of analyses and tested for the full or partial set of indicator chemicals as shown in Appendix C.

Chromium was detected in water sample C5-E but was comparable to background levels. Nickel was present in samples C5-C and C5-E above the Guidelines for Canadian Drinking Water Quality (1987).

Soil samples C5-044, C5-045, and C5-046 were tested for the complete set of indicator chemicals. Based on the results of these analyses, sample C5-047 was tested for the complete set of indicator chemicals except volatile organics.

Soil sample results are presented in Table 6.3.

Several indicator chemicals were present in soils taken from the landfill vicinity. Barium was present in concentrations above 50 percent of Level A in C5-046 and C5-047. C5-047 also contained chromium and nickel above 50 percent of Level A, but within the range expected for background.

TPH was above Level B in C5-044 and above 50 percent of Level A in C5-046. Concentrations of PCBs exceeded Level A in C5-044 and C5-046.

Table 6.3

CAM 5, MACKAR INLET: SOIL ANALYTICAL RESULTS – LANDFILL A

Indicator Chemical (mg/kg)	Quebec Guidelines A	B	C	Background C5-057	C5-058	C5-044	C5-045	C5-046	C5-047
Arsenic	10	30	50	<0.1	0.8	0.2	<0.1	0.4	<0.1
Barium	200	500	2000	43	29	42	29	160	110
Chromium (total)	75	250	800	37	22	11	18	29	44
Lead	50	200	600	<10	<10	<10	17	<10	<10
Nickel	50	100	500	21	11	<5	7	17	27
TPH	100	1000	5000	<5	<5	1600	<5	230	<5
PCB	0.1	1	10	<0.01	<0.01	0.13	<0.01	0.24	<0.01
Cl4 Ethylene	0.1	3	30	<0.001	<0.001	<0.001	0.024	0.004	-
Fluorene	0.1**	10	100	<0.03	<0.03	0.50	<0.03	<0.03	<0.03
Phenanthrene	0.1**	5	50	<0.03	<0.03	0.57	<0.03	<0.03	<0.03
Toluene	0.1	3	30	<0.002	<0.002	<0.002	0.075	0.780	-

TPH=Total Petroleum Hydrocarbon
PCB=Polychlorinated Biphenyls
- = Not Analyzed
** = PAH Total

Samples C5-045 and C5-046 contained detectable levels of Cl_4-ethylene. Sample C5-044 contained fluorene and phenanthrene above Level A.

6.3.1.3 Evaluation of Risk Assessment and Analytical Results

The results of the overall risk assessment show that carcinogenic and non-carcinogenic risks are below the levels established for this study. TPH exceeded the Level B guideline and may also be migrating from the area and pose a hazard. Exposed debris in the area may pose a safety hazard and should be removed. There were no acute risks identified. The site should be redesigned and the drainage rerouted to prevent migration.

6.3.2 LANDFILL B

6.3.2.1 Visual Observations and Sample Locations

A second, much larger abandoned landfill is found east of POL 3 (Plates 5 & 6). The full extent of the filled area is difficult to determine but it appears to underlie much of the present scrap metal and drum storage area. One face of the landfill area (250 m east of the POL 3) slopes steeply to a north-south oriented river valley to the east. Barrels and various types of metal waste, possibly including electrical equipment, were observed in the slope. A second face is located 50 m northeast of the lakeshore POL. Soil in the area is predominantly silty sand with a gravel substrate. No staining or leachate was observed in the vicinity of the landfill.

A water sample was taken near the mouth of the stream draining the most easterly face of the landfill (C5-A) but was not submitted for analysis.

Eight soil samples were taken on the landfill site. Five were collected along the riverbank at the base of the landfill slope. C5-024 was collected from a midslope location at the south end of the landfill area. Samples C5-025, C5-026, C5-027 and C5-028 taken sequentially downstream, north along the streambank. Three samples were taken at the lakeshore face where small drainage channels enter the lake (C5-029, C5-030 and C5-032). Samples C5-030 and C5-026 were submitted for analyses.

The sample locations are provided in Figure 6.1.

6.3.2.2 Analytical Results

Soil samples C5-026 and C5-030 were tested for the complete set of indicator chemicals. No indicator chemicals exceeded the 50 percent Level A study criteria.

6.3.2.3 Evaluation of Risk Assessment and Analytical Results

No indicator chemicals were identified above the Quebec B guideline. Although no evidence of contamination was found in the sample program, the location of this landfill adjacent to the lake represents a potential short and long term risk. The exposed debris could be further eroded by wind and runoff and pose a hazard. There are no acute risks noted on the site. The lake could be impacted from leachate migration from the landfill.

6.3.3 LANDFILL C

6.3.3.1 Visual Observations and Sample Locations

Landfill C is a small abandoned landfill located 250 m south of the POL 3 facility on the shore of the lake at the east end of the Airstrip. Partially exposed buried barrels were noted protruding from the slope at this location.

Soil in this area was a mixture of clay and organic material underlain by a gravelly clay substrate. Drainage away from the landfill is primarily to the north and northeast towards the river valley and lake.

One soil sample was taken immediately northeast of the landfill area (C5-020) and another was collected 50 m downgradient and to the east, adjacent to a small watercourse (C5-022). A third sample was taken 100 m farther downgradient and to the north (C5-023). Sample C5-022 was not submitted for analysis.

The sample locations are provided in Figure 6.1.

6.3.3.2 Analytical Results

Sample C5-020 was tested for the complete set of indicator chemicals. Based on the results of the analyses, sample C5-023 was tested for metals and TPH.

The soil sample results are presented in Table 6.4.

Chromium was above 50 percent of Level A in C5-020 and was consistent with background values. Nickel and chromium were above 50 percent of Level A in C5-023 and slightly higher than the background values. Chromium was within the range given in the literature. No data was available for nickel.

6.3.3.3 Evaluation of Risk Assessment and Analytical Results

No indicator chemicals were identified above the Quebec B guideline.

Although no evidence of contamination was found in the sample program, the location of this landfill adjacent to the lake represents a potential short and long term risk. The exposed debris could be further eroded by wind and runoff and pose a hazard. There are no acute risks noted on the site. The site should be redesigned and the drainage rerouted to prevent migration of leachate into surface waters.

6.4 POL AREAS

6.4.1 POL 1

6.4.1.1 Visual Observations and Sample Locations

POL 1 is located 200 m northeast of the Module Train. The area is characterized by a boulder, cobble and coarse gravel surface, covered mostly by moss and underlain by dark brown, coarse-grained sand.

The area drains to the northwest, joining the same drainage system that the sewage from the station sewage outfall follows. No evidence of hydrocarbon staining was observed on the soil or on water draining from the area.

One soil sample was taken in a small drainage channel on the west side of the POL 1 (C5-054) but it was not submitted for analysis.

6.4.1.2 Evaluation of Risk Assessment and Analytical Results

No staining was observed in the POL area. Sampling should be carried out as part of the clean-up procedure to determine if there is any substantial soil contamination.

Table 6.4

CAM 5, MACKAR INLET: SOIL ANALYTICAL RESULTS – LANDFILL C

Indicator Chemicals (mg/kg)	Quebec Guidelines			Background			
	A	B	C	C5-057	C5-058	C5-020	C5-023
Arsenic	10	30	50	<0.1	0.8	0.4	<0.1
Barium	200	500	2000	43	29	47	70
Chromium (total)	75	250	800	37	22	38	56
Nickel	50	100	500	21	11	19	31

6.4.2 POL 2

6.4.2.1 Visual Observations and Sample Locations

Two 246 m^3 diesel tanks are located on a concrete pad 100 m east of the Module Train. These tanks appeared to have been recently painted and were in good condition. However, strong hydrocarbon odours were present both inside and just outside of the dyke. Staining was observed on sand and gravel on the outer side of the east end of the dyke, it extended northeast. Evidence of hydrocarbon staining was also found on the surfaces of the small ponds to the east and west of the facility.

Soil samples were taken at three locations in the area. C5-048 was taken at the west corner of the dyke. C5-049 was collected southwest of the tanks outside the dyke. Sample C5-050 was taken at the exterior base of the dyke wall at the southeast corner, 1 m above a small pond. Samples from all three locations were submitted for analyses.

The sample locations are shown in Figure 6.1.

6.4.2.2 Analytical Results

Soil sample C5-050 was tested for the complete set of indicator chemicals. Based on the results from these analyses, samples C5-048 and C5-049 were tested for TPH and metals.

The results of the analyses of the soil samples are presented in Table 6.5.

TPH was above Level A criterion in C5-048 and at Level B in C5-050. TPH was not detected in C5-049. Sample C5-050 contained PCBs above Level A. Lead concentrations in excess of 50 percent of Level A were found in C5-049 and C5-050. Lead was not detected in the background samples taken at this site, but according to the literature it may be present at concentration up Level A.

6.4.2.3 Evaluation of Risk Assessment and Analytical Results

The results of the overall risk assessment show that carcinogenic and non-carcinogenic risks are below the levels established for this study.

Hydrocarbons appear to be migrating from the dyked area as indicated by the elevated level outside of the dyke. Low levels of lead were also noted inside and outside the dyke. The hydrocarbon and lead levels do not represent an acute risk at the measured concentrations; however, hazards may be present at depth. Further subsurface investigation should be carried out prior to establishing clean-up requirements.

There were no physical hazards located at the site. The potential for environmental risk is considered low because of the relatively localized contamination.

6.4.3 POL 3

6.4.3.1 Visual Observations and Sample Locations

POL 3 is located 50 m from the shore of the lake at the north end of the site. Two horizontal 69 m^3 diesel tanks are supported by skids to the east of a single 23 m^3 mogas tank. A pipe passes through the northeast corner of the berm to allow water from melted snow to exit. Soils in the area were sand and sandy gravels. A strong fuel odour was present north of the tanks within the dyke and on the north side of the facility.

Table 6.5

CAM 5, MACKAR INLET: SOIL ANALYTICAL RESULTS – POL 2

Indicator Chemical (mg/kg)	Quebec Guidelines A	B	C	Background C5-057	C5-058	C5-048	C5-049	C5-050
Arsenic	10	30	50	<0.1	0.8	0.7	0.5	0.5
Barium	200	500	2000	43	29	50	49	58
Beryllium	n	n	n	<1	<1	1	1	<1
Chromium (total)	75	250	800	37	22	22	25	26
Lead	50	200	600	<10	<10	13	41	39
Nickel	50	100	500	21	11	12	12	12
TPH	100	1000	5000	<5	<5	272	<5	1000
PCB	0.1	1	10	<0.01	<0.01	<0.01	<0.01	0.14

TPH=Total Petroleum Hydrocarbon
PCB=Polychlorinated Biphenyls
- = Not Analyzed
n = No Guidelines

A soil sample was taken inside the dyke in the northeast corner (C5-036). Sample C5-033 was taken below the pipe passing through the same corner of the dyke, 12 m from the lakeshore. A third sample (C5-034) was taken further downslope from the tanks, 1 to 2 m from the lakeshore. The sample site for C5-035 was located 30 m to the northwest of the tanks, 3 m from the shoreline.

The sample locations are shown on Figure 6.1.

6.4.3.2 Analytical Results

Soil samples C5-033 and C5-036 were submitted for analyses.

The soil sample results are presented in Table 6.6.

TPH concentrations above Level B were found in sample C5-033 and above Level C in C5-036. Sample C5-036 also contained detectable levels of PCBs and fluorene at greater than Level A and phenanthrene in excess of 50 percent of Level A.

6.4.3.3 Evaluation of Risk Assessment and Analytical Results

The results of the overall risk assessment show that carcinogenic and non-carcinogenic risks are below the levels established for this study.

Hydrocarbons appear to be migrating from the POL site towards the lake. The concentration of hydrocarbons down gradient from the POL is lower than inside the dyke but is higher than Level B. The trace levels of PAH are not a significant hazard. The high concentrations of hydrocarbons represent a significant hazard. The proximity of this site to the lake represents an environmental risk due to the potential for long term contaminant migration. This should be considered when the site is decommissioned.

6.4.4 POL 4

6.4.4.1 Visual Observations and Sample Locations

The POL 4 facility lies 200 m south of the lake and POL 3. A single, vertical 246 m^3 diesel tank is supported on a concrete slab. Coarse grained sands and gravels east of the tank showed evidence of staining. Strong fuel smells were also present in this area and soil within the west side of the dyke also had a strong hydrocarbon smell. A film of hydrocarbon was observed on a small pond nearby within the dyke, however an eroded discharge channel below a pipe through the west side of the dyke showed no staining or fuel odour.

Three soil samples were taken in the vicinity of POL 4. Sample C5-014 was taken to the east of the bulk tank, 2 m outside of the dyke. A sample was taken within the west side of the dyke, just upgradient of a small pond (C5-016). A third sample was collected 30 m farther west in an eroded discharge channel below a pipe in the dyke (C5-015).

6.4.4.2 Analytical Results

Soil sample C5-016 was tested for metals, TPH, and PCBs.

The results of the analyses of the soil samples are presented in Table 6.7.

Sample C5-016 had concentrations of lead in excess of Level B. TPH and PCBs were above Level A.

Table 6.6

CAM 5, MACKAR INLET: SOIL ANALYTICAL RESULTS – PQL 3

Indicator Chemicals (mg/kg)	Quebec Guidelines A	B	C	Background C5-057	C5-058	C5-033	C5-036
Barium	200	500	2000	43	29	18	18
Chromium (total)	75	250	800	37	22	16	20
Lead	50	200	600	<10	<10	14	<10
Nickel	50	100	500	21	11	6	6
TPH	100	1000	5000	<5	<5	2600	14000
PCB	0.1	1	10	<0.01	<0.01	<0.01	0.05
Fluorene	0.1**	10	100	<0.03	<0.03	-	0.73
Phenanthrene	0.1**	5	50	<0.03	<0.03	-	0.09

TPH=Total Petroleum Hydrocarbon
PCB=Polychlorinated Biphenyls
- = Not Analyzed
** = PAH Total

Table 6.7

CAM 5, MACKAR INLET: SOIL ANALYTICAL RESULTS – POL 4

Indicator Chemicals (mg/kg)	Quebec Guidelines			Background		
	A	B	C	C5-057	C5-058	C5-016
Arsenic	10	30	50	<0.1	0.8	0.8
Barium	200	500	2000	43	29	35
Chromium (total)	75	250	800	37	22	31
Lead	50	200	600	<10	<10	310
TPH	100	1000	5000	<5	<5	520
PCB	0.1	1	10	<0.01	<0.01	0.49

TPH=Total Petroleum Hydrocarbon
PCB=Polychlorinated Biphenyls

6.4.4.3 Evaluation of Risk Assessment and Analytical Results

The results of the overall risk assessment show that carcinogenic and non-carcinogenic risks are below the levels established for this study.

There was no acute hazards found on this site. No physical hazards were observed. Some evidence of hydrocarbon, lead and PCB contamination was found in the soil sample and confirmed by the observations made on site. The environmental risk is considered low for this site.

6.5 PALLET LINE AREAS

6.5.1 PALLET LINE 1

6.5.1.1 Visual Observations and Sample Locations

Pallet Line 1 consisted of a scrap metal and storage area located on a large previously landfilled area southeast of POL 3. Stored materials were found 200 m southeast of POL 3 and 160 m south of POL 4. No evidence of staining was observed on the pad.

Three soil samples were taken in the vicinity of the storage area. Sample C5-018 was taken directly beside the stored materials, 160 m south of POL 3. The second sample was obtained at the southwest corner of the storage pad (C5-017) and the third, 120 m southeast (C5-019).

6.5.1.2 Analytical Results

Soil sample C5-017 was submitted for metals, TPH and PCBs analyses.

All results were below 50 percent of Level A.

6.5.1.3 Evaluation of Risk Assessment and Analytical Results

The results of the overall risk assessment show that carcinogenic and non-carcinogenic risks are below the levels established for this study.

This site does not represent an acute hazard. Exposed metallic debris represents a physical hazard. It was observed in the field that this area served previously as a landfill. It is not possible to determine the potential for migration of contaminants from this area without further sampling and analyses to determine the extent of the underlying landfill area.

6.6 OUTFALL AREAS

6.6.1 SEWAGE OUTFALL

6.6.1.1 Visual Observations and Sample Locations

Untreated sewage from the Module Train area is disposed of through an outflow pipe at the northeast corner of the building compound (Plate 2). The outflow drains northward through silty clay material and then through an extensive boulder field farther north. The field drains into a delta-like area of clay and silt, splitting into two channels before entering a pond 1 km north of the train.

A strong sewage odour was detected 50 m from the sewage pipe outflow and to a lesser degree 750 m downstream. This odour was present at the more easterly inflow point to the pond but not at the west branch.

A water sample was taken 1.1 km north of the Module Train at the outflow of the pond (C5-F).

Soil samples were taken 50 m north of the outflow pipe (C5-055), 50 m further downstream (C5-056) and 750 m still further downstream (C5-040). Two samples were collected at the south end of the pond (C5-042, C5-043). Two more samples were taken near the outflow at the north end of the pond (C5-038, C5-039). Samples C5-038, C5-039, C5-042 and C5-043 were not submitted for analyses.

The sampling locations are shown in Figure 6.1.

6.6.1.2 Analytical Results

Water sample C5-F was submitted for the first round of analyses and tested for metals, TPH, PCBs, pesticides, and volatile organics.

The water sample contained low levels of benzene and toluene (9.2 μg/l and 2.3 μg/l respectively).

Soil samples C5-040, C5-055, and C5-056 were tested for the complete set of indicator chemicals, with the exception of volatiles in C5-040.

Results of the analyses are presented in Table 6.8.

The concentrations of various metals, PCBs and volatiles exceeded 50 percent of Level A in three samples: C5-040, C5-055 and C5-056. Chromium in sample C5-040 was above 50 percent of Level A, which is slightly higher than the background samples, but still within the range given in the literature. Mercury in sample C5-055 was above Level A. Sample C5-055 also showed lead above the 50 percent of Level A and PCBs exceeding the Level B criteria. PCBs exceeded the Level A criteria in sample C5-056. Sample C5-055 also exceeded the Level A criteria for silver and was twice the maximum value of the range given in the literature. Silver was not detected in the background samples. Cl_4-Ethylene and ethylbenzene were also detected in sample C5-055.

6.6.1.3 Evaluation of Risk Assessment and Analytical Results

The results of the overall risk assessment show that carcinogenic and non-carcinogenic risks are below the levels established for this study.

The levels of metals and PCBs found in the sewage outfall do not represent an acute risk. There were no physical hazards associated with the site. It appears that some contamination may be migrating from the outfall area and entering the pond where the water sample was taken. This cannot be determined with certainty because other sources of contamination could enter the watershed of this pond. The sewage outfall represents a risk to the small pond due to the potential migration of contaminants.

6.7 BUILDING PROXIMITIES

6.7.1 AIRSTRIP

6.7.1.1 Visual Observations and Sample Locations

Stain Area 1 was located near a group of structures including an airstrip hut, an unheated vehicle storage building, a beacon light and a refueler, all of which are located on an apron at the west end of the runway, 750 m from the runway's east end (Plates 3 and 4). The area around the survival shack located 180 m north of the runway apron has also been included. A large stained

Table 6.8

CAM 5, MACKAR INLET: SOIL ANALYTICAL RESULTS – SEWAGE OUTFALL

Indicator Chemicals (mg/kg)	Quebec Guidelines			Background				
	A	B	C	C5-057	C5-058	C5-040	C5-055	C5-056
Arsenic	10	30	50	<0.1	0.8	0.2	0.5	<0.1
Mercury	0.2	2	10	<0.05	<0.05	<0.05	0.33	<0.05
Barium	200	500	2000	43	29	62	63	29
Chromium (total)	75	250	800	37	22	43	36	22
Lead	50	200	600	<10	<10	<10	33	<10
Silver	2	20	40	<5	<5	<5	6	<5
Nickel	50	100	500	21	11	23	14	11
PCB	0.1	1	10	<0.01	<0.01	<0.01	3.3	0.26
Cl4-Ethylene	0.1	3	30	<0.001	<0.001	-	0.003	<0.01
Ethylbenzene	0.1	5	50	<0.002	<0.002	-	0.002	<0.002

TPH=Total Petroleum Hydrocarbon
PCB=Polychlorinated Biphenyls
N/A=Not Analyzed

area exists on the coarse grained sand surface 10 m east of the vehicle storage area and a harsh, slightly sweet odour was observed immediately west of the storage building.

Drainage from this area is to the northeast, parallel to the runway. A film of hydrocarbon was present on water saturated sands 50 m northeast of the storage shed and a harsh odour was detectable. A film of hydrocarbon was present over a large area of pond on the north side of the runway, 400 m northeast of the shed, however no staining or odour was evident northeast toward the lakeshore where the pond outflows.

Soil samples were taken immediately east (C5-002) and northeast of the storage building (C5-001 and C5-003). Two samples were gathered 50 m northeast of the storage shed (C5-005 and C5-006) and two more 100 m downstream; sample C5-007 was taken on the south side of the road parallel to the runway and C5-008 on the north side. A sample was taken 200 m farther northeast adjacent to the south side of the runway (C5-009) and another, 350 m farther northeast (C5-004). One sample was taken at the outflow of the large pond north of the runway (C5-010). Two samples were taken, one 50 m to the north of the east end of the runway (C5-013) and one 80 m northeast of the east end of the runway. One soil sample was taken in the vicinity of the survival shack (C5-037) but was not submitted for analysis.

The soil sampling locations are shown in Figure 6.1.

6.7.1.2 Analytical Results

Soil sample C5-001 was tested for the complete set of indicator chemicals. Samples C5-005 and C5-006 were tested for metals, TPH, and PCBs.

The sample collected at the northeast storage shed (C5-006) contained TPH exceeding the Level A criterion. PCBs in excess of the Level A criteria were present in Sample C5-005. The remaining indicator chemicals were present in concentrations below 50 percent of Level A.

6.7.1.3 Evaluation of Risk Assessment and Analytical Results

The results of the overall risk assessment show that carcinogenic and non-carcinogenic risks are below the levels established for this study.

Although the soil sampling results do not show high levels of contaminants, the visual observations of the site indicate that there is some source of hydrocarbon contamination in the area. There are no acute or physical hazards associated with the site. Further sampling is required to delineate the extent of contamination in this area and define potential environmental risk. The area potentially affected by this stain appears to be quite large.

6.7.2 MAIN MODULE TRAIN

6.7.2.1 Visual Observations and Sample Locations

The stain area was located near the main compound area in which the Module Train, warehouse and garage are located.

Extensive areas of the main compound are comprised of coarse sand and gravel surface which, particularly to the west of the buildings, had stained pockets ranging from 0.5 - 3.0 m^2 (Plate 7). A hydrocarbon film was present in a small stream flowing west, downslope, away from the structures.

Two soil samples were obtained west of the buildings; one 10 m from the garage (C5-052) and a second by a small stream, 40 m farther west (C5-053). Both were submitted for analyses.

Locations of the soil samples are shown in Figure 6.1.

6.7.2.2 Analytical Results

Soil samples C5-052 and C5-053 were analyzed; C5-052 for the complete set of indicator chemicals, and C5-053 for metals, TPH, and PCBs.

Results of the analyses of the soil samples are presented in Table 6.9.

PCBs were detected in two samples (C5-052 and C5-053) in excess of the Level A criterion. Samples C5-052 and C5-053 contained lead concentrations above 50 percent Level A. TPH was above 50 percent of Level A in C5-053 and above Level A in C5-052.

6.7.2.3 Evaluation of Risk Assessment and Analytical Results

The results of the overall risk assessment show that carcinogenic and non-carcinogenic risks are below the levels established for this study. No indicator chemicals were identified above the Quebec Level B guideline.

The sampling results show a moderate degree of contamination from hydrocarbons in the stained area. No acute or physical hazards exist.

Table 6.9

CAM 5, MACKAR INLET: SOIL ANALYTICAL RESULTS – STAIN AREA 2

Indicator Chemicals (mg/kg)	Quebec Guidelines			Background			
	A	B	C	C5-057	C5-058	C5-052	C5-053
Arsenic	10	30	50	<0.1	0.8	0.4	-
Mercury	0.2	2	10	<0.05	<0.05	<0.05	0.07
Barium	200	500	2000	43	29	36	41
Chromium (total)	75	250	800	37	22	22	23
Lead	50	200	600	<10	<10	42	44
Nickel	50	100	500	21	11	9	10
TPH	100	1000	5000	<5	<5	370	58
PCB	0.1	1	10	<0.01	<0.01	0.12	0.20

TPH=Total Petroleum Hydrocarbon
PCB=Polychlorinated Biphenyls
- = Not Analyzed