Stanley

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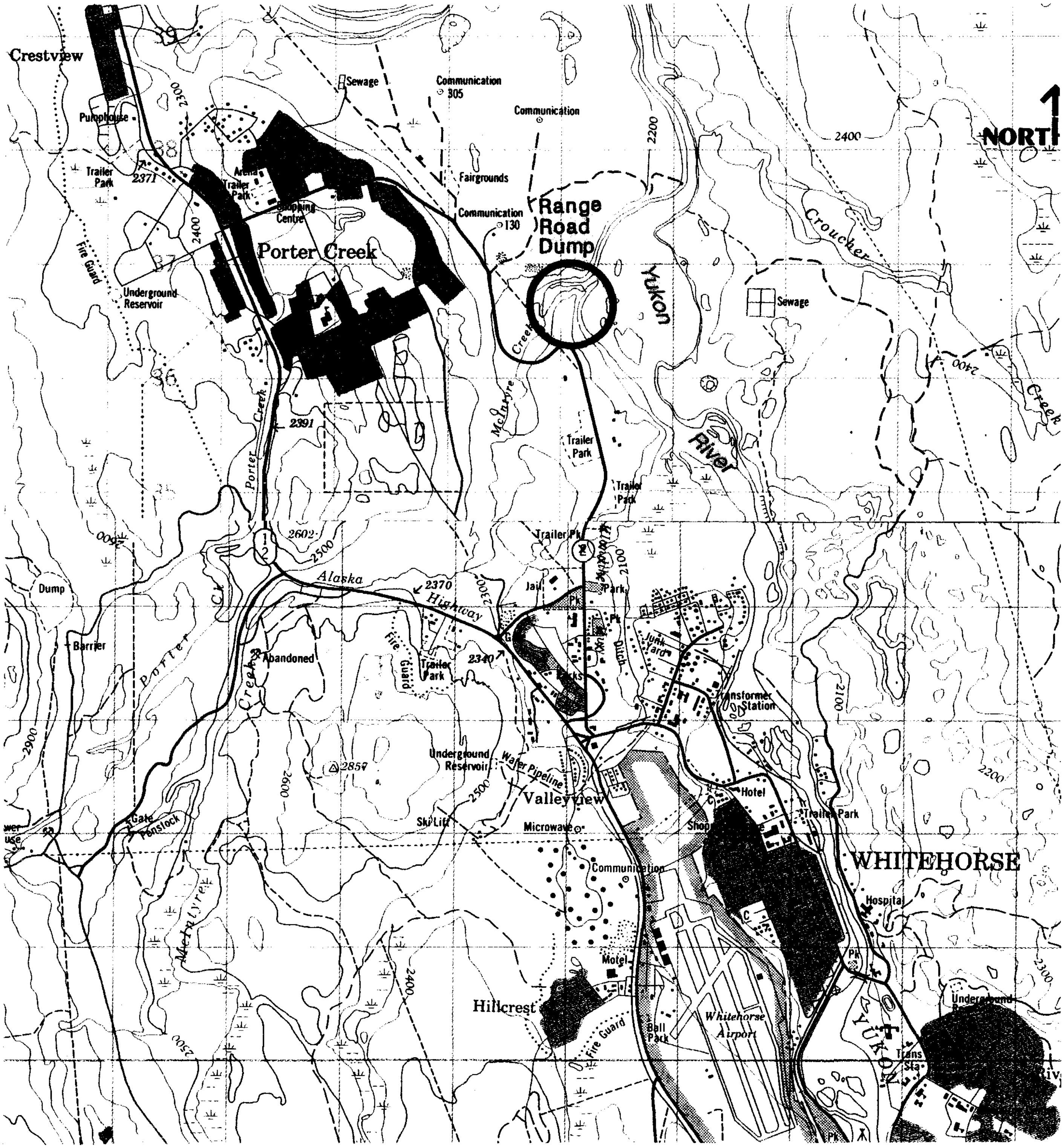

DETAILED SUBSURFACE INVESTIGATION RANGE ROAD DUMP SITE

PUBLIC WORKS CANADA
WHITEHORSE, YUKON

May 1992

Stanley

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May 20, 1992
File: 45-160-01-01

DIAND Technical Services
Box 4100
Whitehorse, Yukon
Y1A 3S9

Attention: **Mr. Dale Ostapowich, P.Eng.**
Director

Dear Sirs:

Reference: **Range Road Dump**
Detailed Subsurface Investigation

We are pleased to send to you 15 copies of our report that describes a detailed subsurface investigation at the Range Road Dump. The investigation utilized geophysical and topographic mapping to identify appropriate monitor well locations. Groundwater obtained from beneath and adjacent to portions of the dump shows enrichment of inorganic parameters such as chloride and conductivity. Pesticides, PCB's and other organic contaminants were not detected in the groundwater near the dump.

We have prepared large presentation versions of the report figures and would be pleased to present our findings to the public should you wish.

Please respond to either Reed Jackson or Bob Innes at (403) 423-4777 should you have any questions or concerns. It has been a pleasure to work with you on this assignment. Your efforts greatly assisted the success of the project.

Yours truly,

STANLEY ASSOCIATES ENGINEERING LTD.

Reed Jackson

Reed Jackson, B.Sc.
Senior Environmental Scientist

Bob Innes, P.Ag.
Project Manager

RJ/wt

Encl.

45-160-01-01/RPT-DISK#7-92/[YUKON\LOT.DOC]/RJ/Apr.'92

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EXECUTIVE SUMMARY

Stanley Associates Engineering Ltd. was commissioned by Public Works Canada to conduct a detailed subsurface investigation at the Range Road Dump near Whitehorse. The project was managed by DIAND Technical Services in Whitehorse.

The goal of the project was to determine the impact of the dump site to the environment. Specifically, Stanley would:

- establish whether or not the site has been contaminated by PCB's, toxaphene or other organic chemicals that may have been disposed of at the dump;
- if contamination is found, determine the source or location of that contamination; and
- determine the risks that such contamination would pose to McIntyre Creek and the Yukon River.

Stanley conducted the field investigative program at the site in January and February, 1992. The tasks completed included:

- a magnetometer survey to delineate the extent of buried wastes;
- a topographic survey to establish slopes and drainage patterns;
- completion of 17 boreholes above the dump and below the toe of slope;
- installation of 11 groundwater monitor wells;
- collection of downhole permeability and water level data; and
- obtaining representative groundwater samples from the monitor wells.

Groundwater samples were analyzed for a broad range of organic and inorganic parameters. The program included PCB's, persistent pesticides, petroleum hydrocarbons, chlorinated organics, trace metals and routine potability. Samples were also submitted for toxicity testing using Daphnia Magna as the test organism.

The data obtained from the field and analytical programs were brought together and summarized in this report. Maps and drawings were prepared to illustrate:

- historical site usage;
- topography and drainage;
- cross-sections;
- groundwater flow; and
- groundwater quality patterns.

The deposition of wastes at the dump site has had a measurable impact on groundwater quality. However, the impacts are considered to be relatively minor. The groundwaters downgradient of the dump primarily show enrichment of inorganic parameters, such as chloride and sulphate. Pesticides, PCB's, chlorinated organics, heavy metals, and petroleum hydrocarbons are below detection limits. Additionally, the undiluted groundwater samples are not toxic to Daphnia Magna.

Groundwater does flow from below the dump to both the Yukon River and McIntyre Creek. Groundwater discharge to the two surface water bodies is small relative to current flows. Measurable changes to downstream surface waters is very unlikely.

The dump site has been partially reclaimed and a large portion of the wastes are properly covered by earth. Further site works are required to cleanup surface debris, provide recontouring along the McIntyre Creek toe of slope and to revegetate the site. Periodic groundwater monitoring will allow for an assessment of changes in water quality over time.

GLOSSARY OF TERMS

Alkaline:	An alkaline substance has marked basic properties and has a pH level of more than 7. For example bleach is highly alkaline.
Aquifer:	Material - rock or sediment in a formations, or group of formations, which is saturated and sufficiently permeable to transmit water to wells and springs.
Aquitard:	A low-permeability unit that can store groundwater and also transmit it slowly from one Aquifer to another.
Bedrock:	The solid rock underlying surface soils or sediments.
Borehole:	A hole drilled or bored into the earth, especially for an exploratory well.
Develop:	Testing water levels by repeatedly bailing to remove fines from the well screen.
Groundwater:	The water contained below ground surface in interconnected pores located below the watertable.
Groundwater Discharge:	Water that is under artesian pressure so that when tapped by a well, the water in the well is able to rise above the level at which it is first encountered. It may or may not flow out at ground level.
Guidelines:	Health and Welfare Canada's Canadian Drinking Water Quality Guidelines, 1989.

Hydraulic Conductivity:	A coefficient describing the unit rate at which water can move through a permeable medium such as clay, silt or sand. Typically, hydraulic conductivity is much higher for sand than for clay.
Hydraulic Gradient:	The change in elevation of the watertable with a change in distance in a given direction.
Hydrogeology:	The study of the interrelationships of geologic materials and processes with water, especially groundwater.
Lithologic Log:	A record of the lithology of the rock and soil encountered in a borehole from the surface to the bottom. Also known as a **borehole log** or **well log**.
Magnetometer:	A precision instrument used to measure the total magnetic field in the ground. The natural magnetic field of the earth is disturbed by ferrous (iron bearing) materials.
PCB:	Polychlorinated biphyenyl (PCB) - an industrial chemical primarily used in electrical transformers. PCB's are very persistent in the environment and require special disposal.
Permeable:	For rock or earth material, the ability to transmit fluids. Permeability is equal to velocity flow divided by hydraulic gradient.
Persistent Pesticide:	A group of pesticides, now largely out of use, that take a long time to break down in the environment. Toxaphene, DDT and Mirex are better known examples.

Piezometer:	A non-pumping well, generally of small diameter, that is used to measure the elevation of the watertable or potentiometric surface. A piezometer generally has a short well screen through which water can enter.
Potable Water:	Water that is suitable for drinking.
Response Test:	An aquifer test made either by pouring a small instantaneous charge of water into a well or by withdrawing a slug of water from the well. A synonym for this test, when a slug of water is removed from the well, is a baildown test.
Static:	Having reached a constant value or constant range of values.
Surficial Geography:	Study of the features of the Earth's land surface.
Till:	Unstratified, unsorted glacial drift deposited directly by glacial ice.
Topography:	Shape and physical features of land.
Watertable:	The surface in an unconfined Aquifer or confining bed at which the pore water pressure is the same as the atmosphere. It can be measured by installing shallow wells extending a few feet into the zone of saturation and then measuring the water level in those areas.
Well Casing:	A solid piece of pipe, typically steel or PVC plastic, used to keep a well open in either unconsolidated materials or unstable rock.

1.0 INTRODUCTION AND TERMS OF REFERENCE

Stanley Associates Engineering Limited (Stanley) was commissioned in late December by the Department of Indian Affairs and Northern Development (DIAND) to conduct a site investigation at the Range Road Dump near Whitehorse, Yukon. Stanley committed to using staff from its Whitehorse office in the investigation as well as utilizing resources from their headquarters in Edmonton, Alberta.

The scope of the project was defined by DIAND to include the following elements:

- determine the limits of the wastes placed at the site;
- define the type of contaminants present at the site;
- delineate the extent of contamination;
- establish the likely pathways that contaminants would take between the dump and McIntyre Creek/Yukon River;
- assess the risks that any contaminants found would pose to the environment; and
- provide recommendations for further work required at the site.

Stanley's proposal for the investigation, that was accepted by DIAND, consisted of six tasks:

TASK 1: Project Organization and Client Liaison
TASK 2: Review of Background Information
TASK 3: Field Investigation Program
  1. Geophysical Survey by Magnetometer
  2. Borehole Drilling and Sampling
  3. Piezometer Installation at 9 locations
  4. Topographic Survey
  5. Sampling and Hydraulic Conductivity Testing
TASK 4: Characterize Hydrogeologic Setting
TASK 5: Analytical Program for Groundwater
TASK 6: Data Assessment and Reporting

Stanley advised in their proposal to DIAND that contaminant travel in the groundwater between the dump and adjacent water bodies would be the primary transport mechanism. Therefore, Stanley would concentrate its subsurface investigation on groundwater flow and quality. Detailed soils analyses would only be considered subsequent to this initial investigation and then only if required for further understanding.

The analytical program recommended by Stanley in their proposal was comprehensive and included additional parameters and tests beyond those required by DIAND. Stanley's experience at other waste disposal sites has identified that it is very important to determine the toxicity of potentially contaminated groundwaters. This is an accepted and quantifiable method that would help to evaluate the risks to waters in McIntyre Creek and the Yukon River. Stanley's proposed analytical program included PCB's, persistent pesticides, heavy metals, chlorinated organics, petroleum hydrocarbons and a Daphnia Magna bioassay. The bioassay would provide a direct measure of potential toxicity.

In summary, the work program proposed by Stanley and accepted by DIAND would focus on groundwater transport and groundwater quality. Information obtained on the groundwater flow direction and rate of flow, coupled with the concentration and toxicity of contaminants found, would provide a rational method for evaluating risks to McIntyre Creek and the Yukon River systems. Secondary project goals would provide: site topography; the limits of wastes in place; and a delineation of contamination in the groundwater.

2.0 PHYSICAL SETTING

The Range Road Dump is located approximately four kilometres to the north of downtown Whitehorse and north of the Range Road. The Town of Porter Creek lies 500 to 1500m to the west. Although the Range Road connects the two communities, the Alaska Highway provides the modern day transportation link.

2.1 TOPOGRAPHY AND WATERCOURSES

The dump site is situated at a steep sided plateau at the confluence of McIntyre Creek and the Yukon River (see cover page). The top of the plateau lies some 50m (165 feet) above the average Yukon River water level. North of the Range Road the flat topped portion of the site occupies approximately 8 ha (20 acres).

Detailed site topography is illustrated on Figure 1. The topographic contours were generated by a total station survey of critical points coupled with photogrammetric mapping. The mapping was completed by Underhill & Underhill of Whitehorse using 1985 stereo air photography.

McIntyre creek lies below the west side of the bluff. Within the study area the upper reaches of the creek have a steep gradient and a narrow channel. Closer to the Yukon River confluence, the creek bed is broad, shallow and has a low gradient. McIntyre Creek is a salmon spawning and fingerling habitat watercourse. Fish usage of the creek has been enhanced due to upstream dams and diversions that have modified discharge patterns so that discharge (1 m^3/s) is higher and more stable than would occur naturally. Yukon Electric Co. Ltd. proposes to construct a third power plant on the McIntyre Creek system which would divert 90% of the available creek flow to a new channel (Lister, 1991).

The Yukon River lies below the east side of the bluff north of the Range Road. At this location the River is broad and shallow with numerous seasonal mud flats and small islands. Discharge in the Yukon River below Whitehorse is controlled by the power supply dam at the north end of Schwatka Lake. Mean annual (1944-1985) discharge in the river is 260 m^3/s with a mean monthly range of 100 m^3/s (April) to 446 m^3/s (September).

Vegetation in the vicinity of the dump site consists of pine above the bank, with spruce, alder and willow below. Virtually all of the vegetation is estimated to be 20-50 years old. Most harvestable timber was clear cut within several kilometres of the Yukon River in the past by the river steamers and the military.

2.2 REGIONAL GEOLOGY

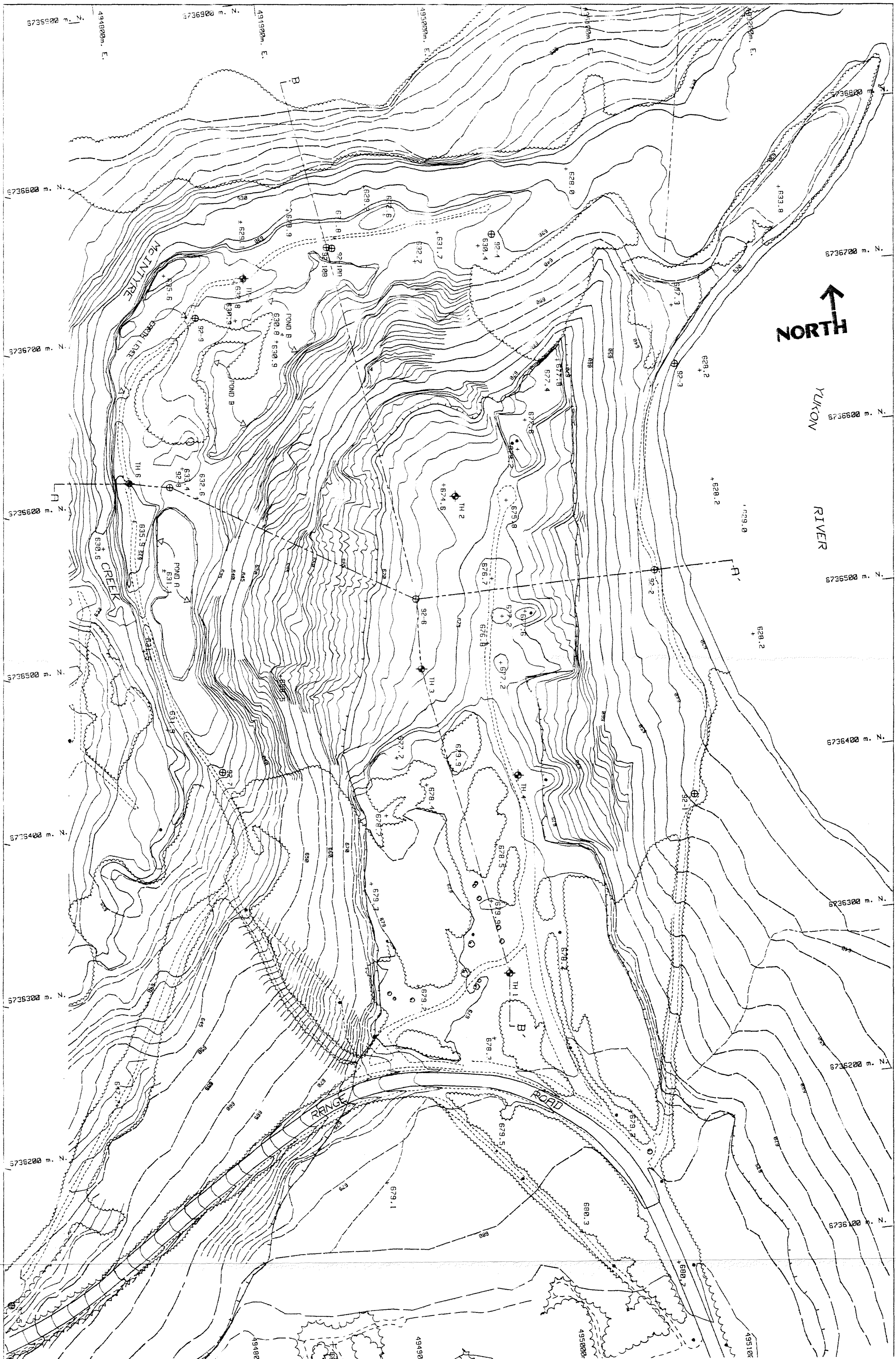
The Geologic Survey of Canada (1960), has mapped bedrock outcrops in the Whitehorse area. West of the Yukon River, on the high ground above Porter Creek, exposures of the Lewes River Group (siltstone, basalt flows, limestone and metamorphosed rock) are interspersed with younger granitic intrusions. In the near vicinity of the Range Road Dump, bedrock exposures are not evident.

Surficial geology has also been mapped by the Geologic Survey of Canada (1990). They report the local landform to be comprised of terraced sediments within abandoned meltwater channels. The sediments are primarily composed of silt with lesser amounts of sands and occasional gravel. These terrace sediments are up to 50m thick and are underlain by glaciofluvial or glaciolacustrine silts and clays.

Horizontally bedded silts and sands are visible on a large scale along the western edge of the McIntyre Creek Valley. Smaller but lithologically similar exposures are visible at the dump site.

Although regional hydrogeology has not been mapped for the Whitehorse area, the following notations describe the general hydrogeologic characteristics of the area:

- groundwater recharge takes place at higher elevations, discharge areas and springs are common at lower elevations along the major valleys;
- water supplies from the bedrock can be variable and unreliable due to groundwater flow through fractures;
- thick alluvial and outwash deposits may provide substantial groundwater supplies where fully saturated; and
- shallow groundwater flow in the Whitehorse area is generally towards the Yukon River Valley and/or major creek valleys.


NORTH
YUKON RIVER
McINTYRE CREEK
RANGE ROAD
POND A
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TH 1
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TH 3
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92-3
92-4
92-6
92-7
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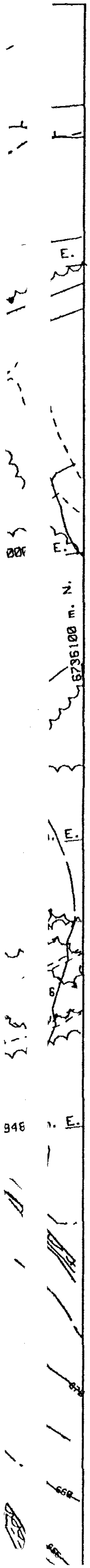

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LEGEND

	TRAIL
	BUSH LINE
	SHARP BREAK IN SLOPE
+679.9	SPOT ELEVATION
•	POWER/TELEPHONE POLE
TH 6	TESTHOLE
92-8	MONITOR WELL: (YEAR DRILLED -NUMBER)
650	TOPOGRAPHIC CONTOUR INTERVAL = 1m AND 5m

NOTE: TOPOGRAPHIC AND SITE DETAILS WERE PHOTOGRAMMETRICALLY GENERATED (UNDERHILL, 1992) FROM 1985 AERIAL PHOTOGRAPHY

SCALE 0 10 30 50m

(Legend for map from previous page)

Figure 1

SITE TOPOGRAPHY
RANGE ROAD DUMP
WHITEHORSE, YUKON 1992

3.0 RANGE ROAD DUMP HISTORY

3.1 EARLY USAGE (1942-1945?)

The Range Road Dump was first used as a disposal site in the early 1940's. The site was established by the U.S. Army during World War II and was closed subsequent to demobilization in 1945 (Environment Canada, 1986). The extent and nature of the disposal practices carried out by the military at the site are not known. However, common to the day was the unconfined deposition of wastes at surface. Large trench and cover operations were uncommon.

The U.S. Army during WW II was concentrated in the MacRae area many miles to the south of the Range Road. The four old dump sites in this vicinity likely accepted most of their wastes. A 1946 air photo of the site has been enlarged to a 1:1,000 scale (Drawing 1) and is included in a pocket in Appendix A following the text. Although the enlargement is grainy, the Range Road, McIntyre Creek and the Yukon River are clearly visible. Less obvious is the almost complete lack of trees in the area (logged for the steamboats and military usage) and the small area (0.25 ha) of disturbed ground that may have comprised the early dump site.

3.2 MUNICIPAL DUMP (1950?-1975)

The City of Whitehorse used the Range Road Dump Site for municipal waste disposal in the early 1950's (Environment Canada, 1986). This dump was the primary disposal site for more than twenty years and has accepted a large volume of wastes. The waste stream was primarily composed of household garbage, automobiles (2,000 ±) and demolition debris. Septic tank pumpouts and waste oils were also deposited at the site on a regular basis.

The site was operated as an "open dump". Wastes were deposited on the surface and were frequently burned. Wastes were not covered with earth and were regularly pushed over the edge of the McIntyre Creek and Yukon River banks. A portion of these wastes fell straight into the Creek and the River.

A 1963 air photo of the site has been enlarged to a 1:1,000 scale (Drawing 2) and is included in a pocket in Appendix A. Unlike the previous photo taken in 1946, the 1963 photography clearly shows a broad area of waste disposal at the site. A few buildings are evident near the Range Road and tipping faces on both the Yukon River and McIntyre Creek banks are apparent.

As the volume of wastes at the site increased, a greater proportion of newly deposited refuse would fall into the adjacent Creek and River. A slope failure within the landfill resulted in the movement of a large mass of garbage into McIntyre Creek in 1968 (Environment Canada, 1986). Charges were laid against the City of Whitehorse which resulted in the construction of a levee to divert McIntyre Creek away from the toe of the garbage. The City was subsequently required by the Water Board to relocate waste disposal to a new site (War Eagle) and the Range Road Dump was closed in November, 1975.

3.3 LATER YEARS (1975-1992)

Cleanup at the dump site has consisted of pushing earth over the sides of bluff which was intended to cover the wastes. Still visible today are metals, plastics and demolition debris on both the Yukon River and McIntyre Creek bluffs (see Plate 1). A summer tire cleanup in 1991 removed several hundred tires from the Yukon River shoreline.

A 1985 air photo of the site has been enlarged to a scale of 1:1,000 (see Drawing 3 in Appendix A). Several new features have been highlighted on this photograph:

- earth now covers most of the open dump that was visible in the 1963 photo;
- a dashed line depicts the approximate alignment of McIntyre Creek in 1963; and
- an earth levee is apparent along the eastern edge of the present course of McIntyre Creek.

1) **Yukon River Bluff**

2) **McIntyre Creek Bluff**

PLATE 1

VISIBLE WASTES - FALL, 1991

The earthen cover on the wastes appears to have been derived from two sources. Firstly, the top of the bluff shows clear evidence of being substantially cut down. A power line right of way crosses the site which has poles centered within small areas of higher ground (Plate 2). It appears that one to three metres of original ground has been downcut and pushed over the old tip slopes. Secondly there is evidence that some earth cover was brought into the site. Non native till soils are visible as cover below the Yukon River bank.

Although entrance to the site is blocked to vehicles at the Range Road, evidence of some recent dumping is evident. Plate 2 also illustrates an old fridge and assorted scrap metals that lie on the southern forested portion of the site.

3) Earth Cover and Down Cut

4) Surface Scrap

PLATE 2

EARTH COVER AND SURFACE SCRAP

4.0 1992 FIELD PROGRAM

4.1 INITIAL OBSERVATIONS AND PROGRAM DESIGN

Stanley personnel conducted two site inspections prior to beginning work. The first was undertaken in October 1991 during the preparation of the proposal. The second site visit preceded the start-up meeting in January, 1992 between Stanley and DIAND. Initial site visits and analyses of available air photos resulted in the following observations:

- the obvious downcutting on top of the bluff (to obtain cover material) would mean that the existence of buried wastes in the center of the plateau was thought to be unlikely;
- two unconnected waste deposits were thought to exist, one the Yukon River side and one on the McIntyre Creek side of the bluff;
- the tipping of wastes over the bank would result in deposits in the order of 45m thick;
- the refuse visible at surface was very coarse (car bodies, appliances, rubble, etc.) and would be difficult to penetrate by drilling;
- the local exposures of bedded silts and sands indicated relatively simple geology; and
- horizontally bedded deposits with variable permeability do not readily transmit waters vertically.

Reed Jackson and Bob Innes of Stanley then met on January 20, 1992 with:

- Dale Ostapowich - Public Works
- Lorne Gay - DIAND
- Vic Enns - Environment Canada
- Bryce Walt - City of Whitehorse
- Perry Savoie - Y.T.G.

At this meeting, Stanley presented their initial observations and described a slightly revised field program. The revised program would concentrate the subsurface and monitor installation components of the investigation at the base of the refuse. No attempt would be made to penetrate the 45m thick waste deposits. A magnetometer survey would be used to map buried wastes.

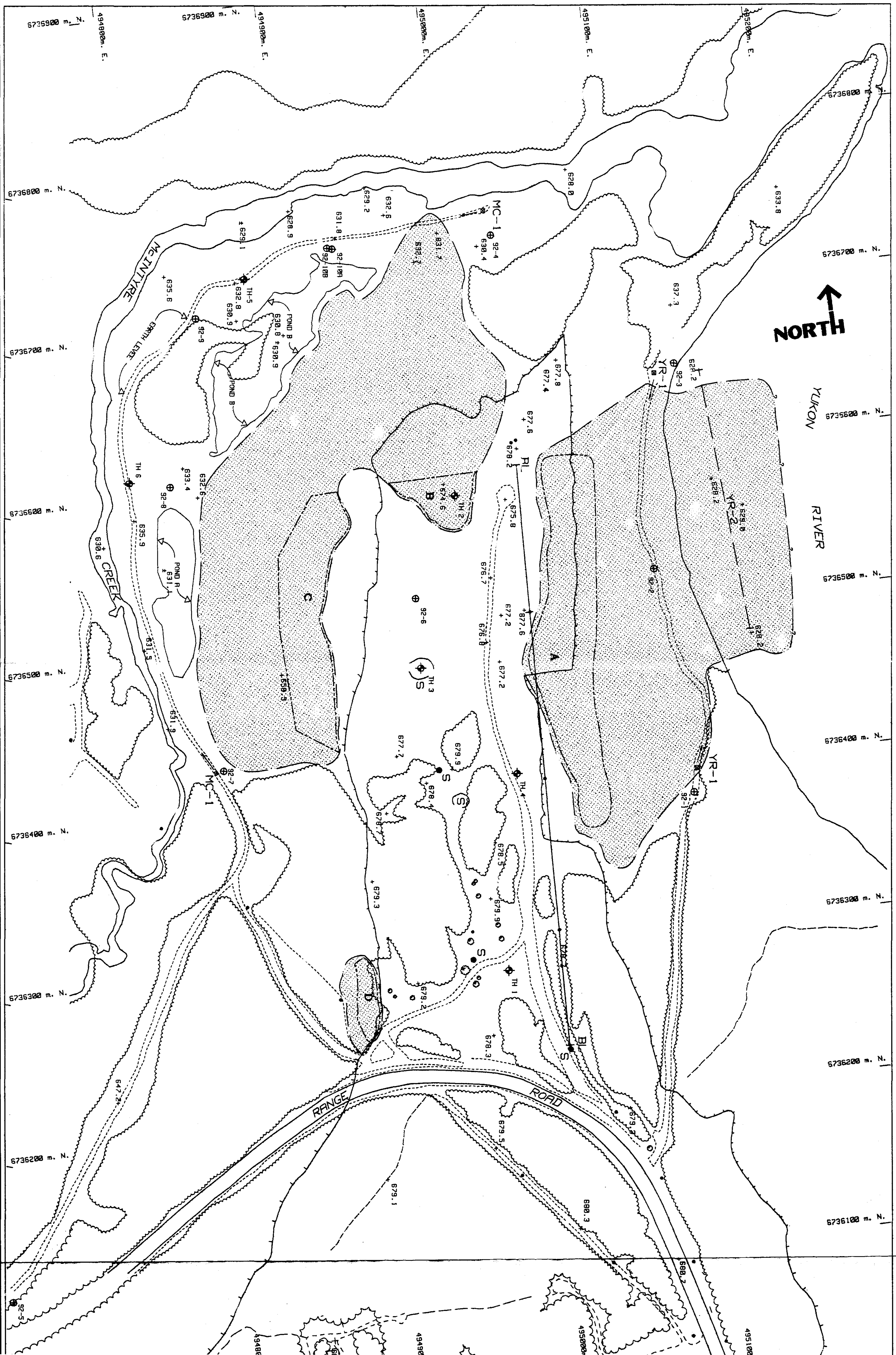
This revised program was deemed acceptable to the group assembled. Vic Enns, with Environment Canada, was subsequently interested in the details of the groundwater analytical program. He was provided with a target list of persistent pesticides for review and comments.

4.2 MAGNETOMETER SURVEY

Amerok Geophysics, a small firm located in Whitehorse, was hired to conduct a magnetometer survey of the dump site. Several surveyed lines (Figure 2) were laid out on the site which consisted of:

- a north-south baseline (BL) on top of the plateau along the power line right-of-way;
- 19 east-west lines at right angles to the baseline (at 20m intervals) and extending from bank to bank;
- a north-south line along the trail at the foot of the Yukon River embankment (YR-1);
- a second Yukon River line (YR-2) parallel to the first and approximately 50m to the east and out onto the ice; and
- a curved line from south to northeast along the top of levee along McIntyre Creek (MC-1).

A magnetic field survey was conducted at the site on January 30 and 31, 1992 utilizing a proton precision magnetometer. Measurements were taken at 5m intervals on lines 20m apart on top of the plateau. The two Yukon River (YR-1,2) and one McIntyre Creek (MC-1) lines had measurement taken at 5m intervals along their length. Amerok's report and figures are attached in Appendix B. The report by Amerok refers to Figure 1 (not drawn) which is equivalent to Figure 2 in this report.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RANGE ROAD
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LEGEND

═	TRAIL
⬭	BUSH LINE
┐	SHARP BREAK IN SLOPE
+679.9	SPOT ELEVATION
•	POWER/TELEPHONE POLE
TH 6	TESTHOLE
92-8	MONITOR WELL: (YEAR DRILLED -NUMBER)
92-10A 92-10B	MONITOR NEST (A-DEEP / B-SHALLOW)
BL	BASELINE FOR DETAILED MAG SURVEY
YR-1,2	YUKON RIVER MAG SURVEY LINES
MC-1	McINTYRE CREEK MAG SURVEY LINES
•S	SURFACE MAGNETIC ANOMALY
▨	LIMIT OF BURIED MAGNETIC ANOMALY BY SURVEY
▨	APPROXIMATE LIMIT OF BURIED REFUSE

SCALE 0 10 30 50m

(Leg for map from previous page)

Figure 2

MAGNETOMETER SURVEY
RANGE ROAD DUMP
WHITEHORSE, YUKON 1992

The following conclusions are summarized from Ameroks report and are illustrated on Figure 2:

- areas A, B, C and D on the plateau correspond to significant accumulations of metal;
- spot anomalies, labelled S, are due to surface debris (see Plate 2);
- the toe of the buried wastes reaches the levee along McIntyre Creek near the north end of Line MC-1;
- a debris layer on the bed of the Yukon River extends at least 50m east of the embankment;
- the data confirms that most of debris was pushed over the edge of the plateau; and
- there does not appear to be any significant deposits of refuse on top of the plateau.

4.3 TEST DRILLING AND MONITOR WELL INSTALLATION

The Whitehorse area had received well above average snow falls in the winter of 91-92. Snow depths at the toe of the plateau exceeded one metre. A D-6 CAT bulldozer was hired from a local contractor (Kathy's Construction) to clear snow and improve access for drilling. This work was completed on February 9, 1992.

Midnight Sun Drilling, of Whitehorse, was contracted by Stanley to provide a drill rig and crew for the test drilling and monitor installation component of the program. The rig was a four-wheel drive off-road vehicle with a CME 750 rear mounted drill. Boreholes were advanced utilizing either 150mm O.D. continuous flight solid auger or 250mm O.D. hollow stem. Lithology was logged by Reed Jackson of Stanley.

The rig had been carefully serviced prior to commencing the job and was free of oil or lubricant leaks. The augers were pressure washed and rinsed with well water before drilling. Augers muddied during a boring operation were returned to the shop and washed before reusing.

A total of 17 boreholes were completed at the site between February 10 and 13, 1992 (see Figure 2). Six boreholes (TH-#) were used for geologic data collection only and were abandoned. Eleven boreholes were completed as monitor wells (92-#). Borehole logs and monitor completion details can be found in Appendix C. The work was conducted in three distinct zones:

•	Zone 1:	Top of the plateau - one monitor and four testholes;
•	Zone 2:	Yukon River embankment - three monitors; and
•	Zone 3:	McIntyre Creek - seven monitors and two testholes arrayed below the dump face.

Access was very difficult along the narrow trail that angled across the embankment on the Yukon River side of the plateau. Large chunks of metal and demolition debris poke out of the embankment where the trail crosses the refuse-tip slope. Monitor 92-2 was drilled in the middle of the tip slope after several unsuccessful attempts to penetrate metals and concrete.

Monitor wells were constructed (see logs in Appendix C) of 50mm PVC casing and 10 slot machine cut PVC screen. The well casings and screens were acid washed and rinsed at the factory and plastic wrapped. Care was taken to prevent contamination of the pipe with greases or oils from the rig and clean gloves were worn during installation. Screens were packed with 10-20 sand and the remaining borehole annulus was backfilled with bentonite chips. A locked protective casing was placed at surface.

4.4 IN-SITU TESTING AND MONITORING

Waterra hand pumps were dedicated in each monitor to reduce the risk of cross-contamination. This pump consists of a foot valve attached to HDPE tubing. Raising and lowering the tubing at surface creates a pumping action. Monitors were repeatedly pumped to remove fines from the screen which acts to "develop" the well.

Ten of eleven monitors (92-6 was dry) were response tested by pumping down the water level in the monitor and then measuring the water level recovery over time. This data was interpreted using a microcomputer program (Thompson, 1987) that calculates hydraulic conductivity or how fast water is transmitted through a unit area. Table 1 summarizes the screened interval, the geologic unit opposite the screen and the calculated hydraulic conductivity. Appendix D contains the computer generated data summary and calculations.

TABLE 1
MONITOR COMPLETION SUMMARY AND HYDRAULIC CONDUCTIVITY

Monitor	Screened Interval (metres)	Geologic Unit	Hydraulic Conductivity (cm/s)
92-1	2.4 - 5.4	silt	7×10^{-5}
92-2	3.7 - 6.7	silt	1×10^{-5}
92-3	2.3 - 5.3	silt	2×10^{-4}
92-4	2.2 - 5.2	silt	4×10^{-4}
92-5	3.1 - 6.1	silt	2×10^{-5}
92-6	29.0 - 32.0	silt/sand	Dry
92-7	2.3 - 5.3	silt/sand	2×10^{-5}
92-8	2.3 - 5.3	silt	4×10^{-5}
92-9	2.3 - 5.3	silt	3×10^{-5}
92-10A	11.3 - 14.3	clay/silt	3×10^{-6}
92-10B	2.3 - 5.3	silt	9×10^{-6}

The calculated hydraulic conductivity of the silt, sand and clay deposits range from a high of 4×10^{-4} cm/s at monitor 92-4 to a low of 3×10^{-6} cm/s at monitor 92-10A. These values fall within the expected range and are considered to be representative.

Water levels were measured in all monitors or two consecutive days to establish static conditions. This data is summarized in Table 2.

TABLE 2

WATER LEVELS AND ELEVATIONS (metres)

Monitor	Ground Elevation	Depth To Water Below Ground Feb. 14, 92	Depth To Water Below Ground Feb. 15, 92	Groundwater Elevation Feb. 15, 92
92-1	640.15	1.17	1.17	638.98
92-2	436.52	3.98	3.99	632.53
92-3	631.10	1.72	1.72	629.38
92-4	630.54	0.66	0.66	629.88
92-5	650.47	4.04	4.04	646.43
92-6	674.07	DRY	DRY[1]	-[2]
92-7	636.04	1.33	1.34	634.70
92-8	633.36	1.92	1.91	631.45
92-9	633.00	1.74	1.74	631.26
92-10A	632.03	0.91[3]	FLOWING[4]	-[5]
92-10B	632.19	1.34	1.34	630.85

NOTES:

1 Dry to 32.0m
2 Groundwater elevation is below 642.07m
3 Still responding
4 Flowing over top of casing at 0.76m above ground
5 Piezometric elevation exceeds 632.79m

4.5 GROUNDWATER SAMPLING

All but Monitor 92-6 (dry) were fully purged in the afternoon of February 15, 1992 in preparation for sampling. Groundwater samples were collected on February 16, 1992 by Reed Jackson and Ruth Hall of Stanley. Field measurements of pH, Temperature and Electrical Conductivity (E.C.-μS/cm) are recorded in Table 3.

TABLE 3
FIELD MEASUREMENTS

Monitor	pH	Temperature	E.C.
92-1	6.5	3	730
92-2	7.0	2	3000
92-3	6.5	3	420
92-4	7.0	3	1470
92-5	7.0	3	730
92-6	-	-	-
92-7	6.5	3	540
92-8	7.0	3	580
92-9	6.5	2	390
92-10A	7.0	3	480
92-10B	6.5	3	1470
92-11	Duplicate of 92-4		

A total of ten unique water samples were collected in bottles from each monitor. Monitor 92-4 had two full bottle sets collected with one set labelled 92-11 as a blind duplicate to confirm the laboratory quality assurance. Table 4 summarizes the sample bottles and field preservatives. The metals and mercury samples were field filtered (0.45 μ) prior to preserving.

TABLE 4
BOTTLES AND PRESERVATIVES

ANALYSIS	BOTTLE	PRESERVATIVE
Routine	500 ml Polyethylene	None
Metals	500 ml Polyethylene	5 ml 20% Nitric Acid
Mercury	100 ml Polyethylene	1 ml Nitric Acid/Dichromate
Cyanide	100 ml Polyethylene	1 ml 6N NaOH
Nutrients	100 ml Polyethylene	1 ml 1 & 1 Sulfuric Acid
Daphnia	1 litre Amber glass	None
AOX	1 litre Amber glass	2 ml 1 & 1 Nitric Acid
Purgables	1 litre Amber glass	2 mg Ascorbic Acid/2 ml 1:HCL
Pesticides	2 litre Clear glass	none
Hydrocarbons	2 litre Clear glass	none

Sample bottles were packed in coolers and shipped by air to EnviroTest and Norwest Laboratories in Edmonton, Alberta. The Laboratories confirmed receipt of the samples on January 17, 1992.

5.0 RESULTS

5.1 LIMITS OF WASTES IN PLACE

The wastes that were placed at the site contained a large component of metals that were readily identified by the magnetometer survey. The survey identified four areas on the edges of the plateau that exhibited strong evidence of covered wastes. These areas included:

Area A:	250m long zone along the east edge of the plateau above the Yukon River;
Area B:	50m long zone on the north edge of the plateau above McIntyre Creek;
Area C:	150m long zone in the west edge of the plateau above McIntyre Creek and obviously connected to Area B below the top of the bank; and
Area D:	50m long zone on the southwest edge of the plateau and near the Range Road.

Area D is now reforested but portions of car bodies and other metal scraps are evident. This area lies behind the cluster of buildings evident in Drawing 2 (Appendix A) and is not thought to have been part of the main dump.

The limits of the wastes in place (Figure 2) on the Yukon River side of the plateau have been interpolated to be between Area A and the YR baselines below the slope. The limit of waste on the bed of the Yukon River is not fully defined. Local residents have described metallic scrap and garbage visible on downstream mud flats that likely originated from the dump.

The limits of wastes on the McIntyre Creek side of the site are also mapped on Figure 2. Since the McIntyre Creek levee magnetometer survey line (MC-1) indicated little buried metal, the base of the refuse was plotted from topographic contours and field observations. Areas B and C above the bank have been extrapolated to the toe of slope.

The drill program confirmed the use of magnetometer data for the delineation of buried wastes. The following confirmatory observations can be made:

- TH1, TH4 and 92-6 were advanced through the top of the plateau outside areas A, B, C and D and no wastes were intersected;
- TH3 was drilled through an area mapped as surface metals on the plateau and only a few rusty metal scraps were encountered in the upper 0.9m;
- TH2 was centered in area B and met refusal in metal and concrete at 0.8m;
- 92-2 drilled through the tip slope on the Yukon River side took several attempts to penetrate 3.5m of buried wastes; and
- TH5, TH6, as well as Monitors 92-4, 5, 7, 8, 9, 10A and 10B drilled beyond the toe of slope along McIntyre Creek did not intersect any buried wastes.

5.2 SITE GEOLOGY

The surficial deposits on the top of the plateau are described by borehole logs for TH1, 3, 4, 5 and 92-6 (Appendix C). Borehole 92-6 was advanced to 32.9m and is most descriptive of the alternating beds of silts and fine sands that comprise the plateau.

Below the plateau, along both the Yukon River and McIntyre Creek the native deposits are primarily composed of silts. The following exceptions are worthy of comment:

- buried organic (topsoil, peat) horizons are present at 92-4, 92-10, TH5 and TH6 which resulted from the construction of the levee along McIntyre Creek;
- a gravel pocket present at 92-8 and TH6 appears to be continuous from the toe of the refuse to the creek;
- a thick lacustrine clay sequence was intersected at depth at 92-10; and
- a pebbled silt with organic seams was intersected from 0.6m to 2.9m at 92-4.

Several soil samples were submitted to Norwest Laboratories for grain size and organic carbon determination (Appendix E). Silt is present in the submitted samples in proportions of 44 to 66%. Sands and clays are more variable. Soil organics are below the detection limits of 0.05 to 0.09% except for the 3.6 to 4.0m interval in 92-6 where 0.17 to 0.31% organic carbon/organic matter is reported.

Most deposits did not exhibit any odour nor show any evidence of staining. The buried organic layers did have a slight odour likely resulting from decomposition in the absence of oxygen.

The site geology is illustrated on the east-west Cross-Section A-A′ (Figure 3) and on north-south Cross-Section B-B′ (Figure 4). Cross-Section alignments are illustrated on the Site Topography Map (Figure 1). These cross-sections also depict the buried wastes delineated by the magnetometer survey.

5.3 GROUNDWATER FLOW

Groundwater elevations measured at the 10 monitors were previously presented in Table 2 in Section 4.4. The total station survey at the site was conducted in early February when the upper portions of McIntyre Creek had some open water. Ice levels on the Yukon River and lower McIntyre Creek are assumed to approximate the river water level.

Shallow groundwater flow is radial, away from the base of the peninsular plateau and towards the Yukon River and McIntyre Creek. The calculated horizontal gradient is approximately 0.2% on the Yukon River side and less than 0.10% on the McIntyre Creek side.

Horizontal groundwater velocity (V) in the upper silts and sands is defined by:

$$V = \frac{\text{hydraulic conductivity (k) x horizontal gradient (I)}}{\text{porosity } (\Theta)}$$

If we assume:

1. Hydraulic Conductivity measured at a monitor well is constant between the well and a discharge point at the River or Creek;
2. Horizontal gradient is estimated by dividing the difference between a groundwater elevation at a monitor and the stage elevation at the River or Creek by the straight line distance between them; and
3. Porosity is estimated at 40% (Freeze and Cherry, 1979),

- then Table 5 presents the range of groundwater velocities present at the site.

TABLE 5
GROUNDWATER VELOCITY

SITE	HORIZONTAL GRADIENT	HYDRAULIC CONDUCTIVITY cm/s	GROUNDWATER VELOCITY (m/year)
92-1	0.20	7×10^{-5}	11.0
92-2	0.17	1×10^{-5}	1.3
92-3	0.20	2×10^{-4}	31.5
92-4	0.07	4×10^{-4}	22.1
92-5	-	2×10^{-5}	-
92-6	-	-	-
92-7	0.10	2×10^{-5}	1.6
92-8	0.03	4×10^{-5}	1.0
92-9	0.05	3×10^{-5}	1.2
92-10A	0.08	3×10^{-6}	0.2

The estimated horizontal groundwater velocity varies from tens of metres per year at 92-3 to less than a metre per year at 92-10. The average velocity is approximately 10m/year. This site characteristic would result in relatively short travel times of months to a few years between the refuse and the Creek or River. Faster travel times would be expected in the gravels intersected at monitor 92-8 and TH6 should they become saturated.

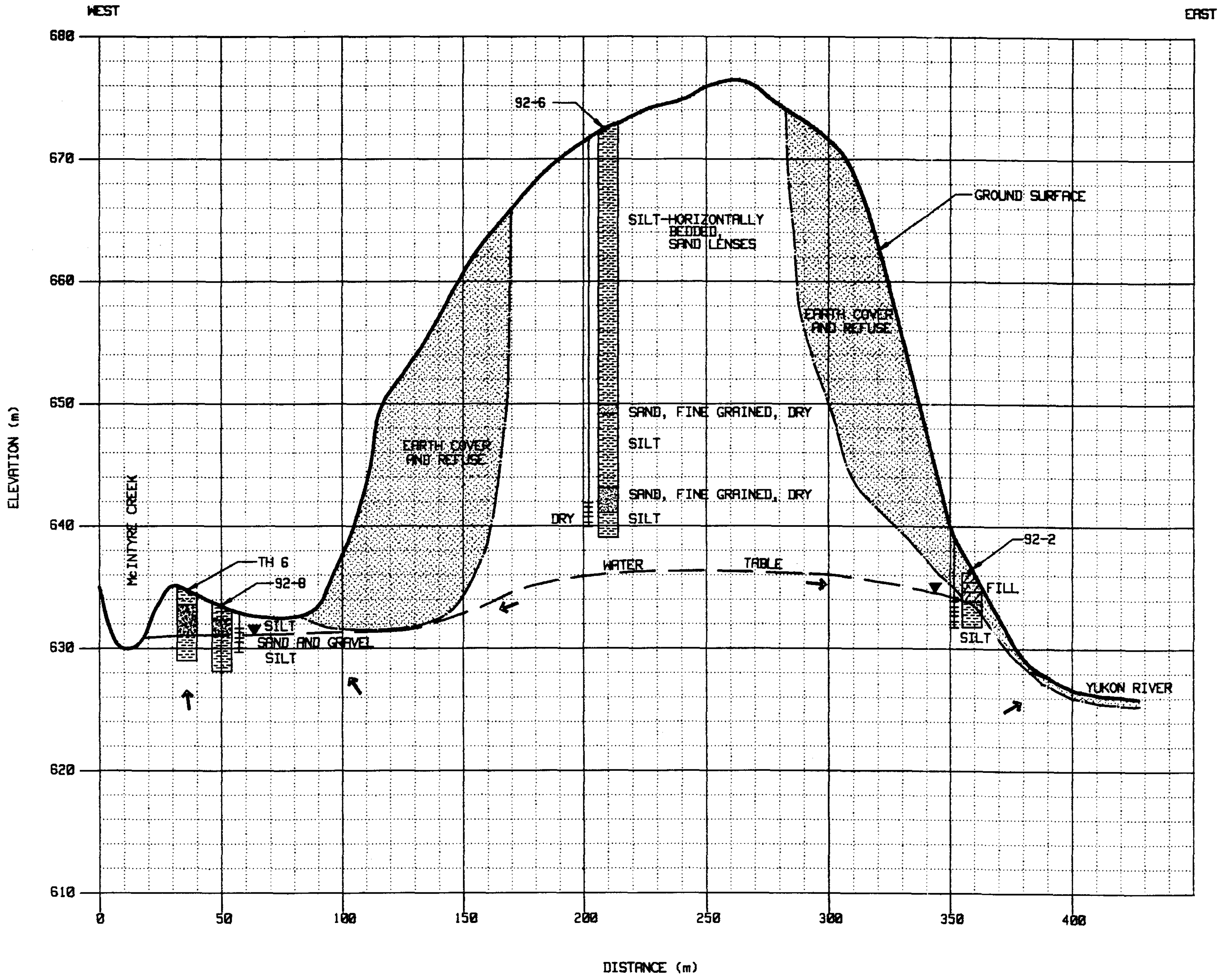


Figure 3

GEOLOGICAL CROSS SECTION A-A'
RANGE ROAD DUMP
WHITEHORSE, YUKON, 1992

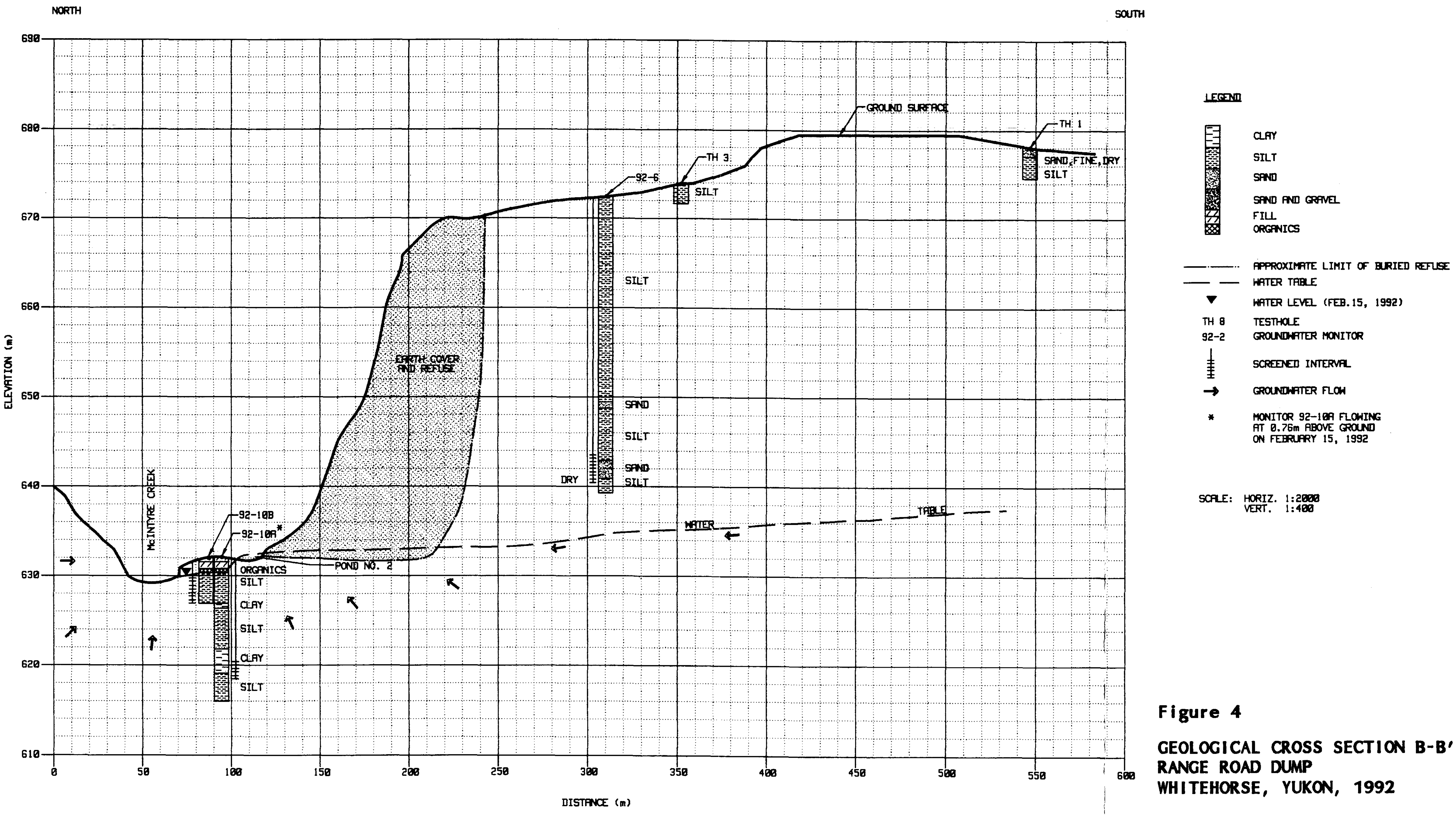


Figure 4

GEOLOGICAL CROSS SECTION B-B'
RANGE ROAD DUMP
WHITEHORSE, YUKON, 1992

The vertical groundwater gradient can be determined from the nested Monitors 92-10A and 92-10B. Monitor 92-10A is completed at 11.3m to 14.3m below ground and Monitor 92-10B is completed at 2.3m to 5.3m. On February 15, 1992 (see Table 2), Monitor 92-A was flowing at 0.76m above ground and Monitor 92-B had a water level of 1.34m below ground. This describes strong groundwater discharge conditions with an upward vertical gradient of at least 0.35 m/m.

Horizontal and vertical groundwater flow patterns are illustrated on Figure 5 and are also depicted on Cross-Sections A and B (Figures 3 and 4). Shallow groundwater flow is clearly identified as radial away from high ground and towards the Yukon River and McIntyre Creek.

Two shallow ponds (see Plate 3) are evident at the toe of slope between the refuse and McIntyre Creek. These ponds labelled A (southern) and B (northern) are a surface expression of the water table. Additionally, the construction of the levee along McIntyre Creek has trapped surface runoff behind it which is thought to have raised the local watertable.

A number of dead spruce trees lie within the current limit of Pond B. These dead trees have submerged root systems. Other adjacent spruce with their roots above the pond level are alive and well.

5.4 GROUNDWATER QUALITY

5.4.1 Previous Work

Environment Canada has studied water and soils in the vicinity of the Range Road Dump on two previous occasions. The first study was conducted in 1983 to 1985 and included soil/water sampling in McIntyre Creek, Yukon River, Pond B and several shallow test pits excavated at the toe of slope of the dump. The report prepared by Axbey and Slonski (Environment, 1986) describes *"elevated levels of metals, plus other parameters such as ammonia, phosphates, sulphates and C.O.D.... There were no elevated levels of PCB's or pesticides"*. One sample collected from Pond B did contain a measurable PCB concentration of 0.09 ($\mu g/g$) ppm. Analytical procedures are not reported.

The second Environment Canada study was conducted in the fall of 1990. The methodology consisted of composited sediment sampling in Pond A, Pond B, McIntyre Creek (3 sites) and the Yukon River. The sediments were analyzed for DDT metabolites and PCB's. The report (Environment, 1991) describes *"no stations that reported detectable levels of DDT. Low levels of PCB... were reported at the dump toe; Pond A (0.13 µg/g) and Pond B (0.06/0.07 µg/g). Low levels of PCB's near detection, were detected in the McIntyre Creek sediments at the mouth (0.02 mg/g)."* The analytical procedure is not reported.

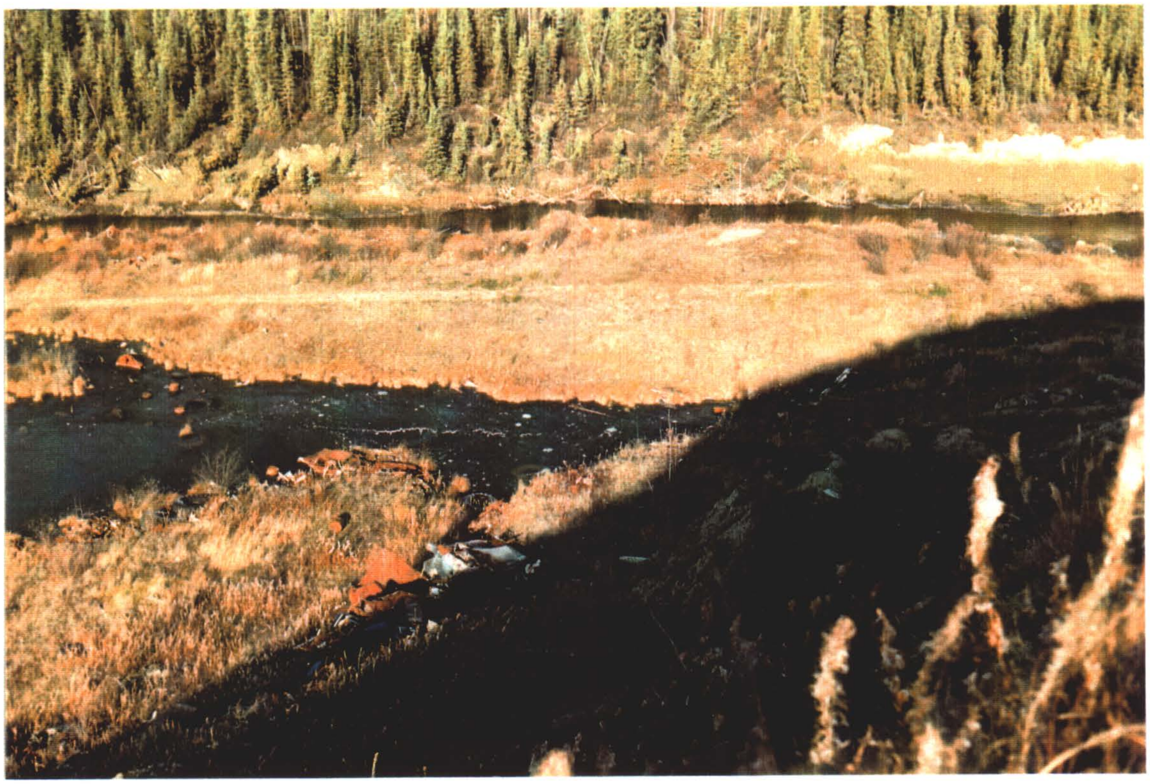
5.4.2 1992 Groundwater Quality

The ten sets (plus one duplicate) of groundwater samples analyzed from the February 15, 1992 monitoring were analyzed for a broad range of parameters. The laboratory reports (Appendix E) provide the raw data, the analytical methodology and inter-laboratory quality assurance/quality control (QA/QC). Appendix F contains summary tables for all data on a Monitor specific basis.

ORGANICS

The concentration of organic compounds in the groundwater at the Range Road dump is very low. In summary:

- PCB's were not detected (<0.0001 ppm);
- organochlorine pesticides - including toxaphene, DDT, DDE and DDD (see Appendix F for target list) were not detected (<0.000025 ppm);
- organophosphate pesticides (see Appendix F for target list) were not detected (<0.0001 ppm);
- volatile hydrocarbons (purgeables) were not detected (<0.050 ppm);
- base nuetral - acid extractable organics and petroleum hydrocarbons were not detected (<0.010 ppm);

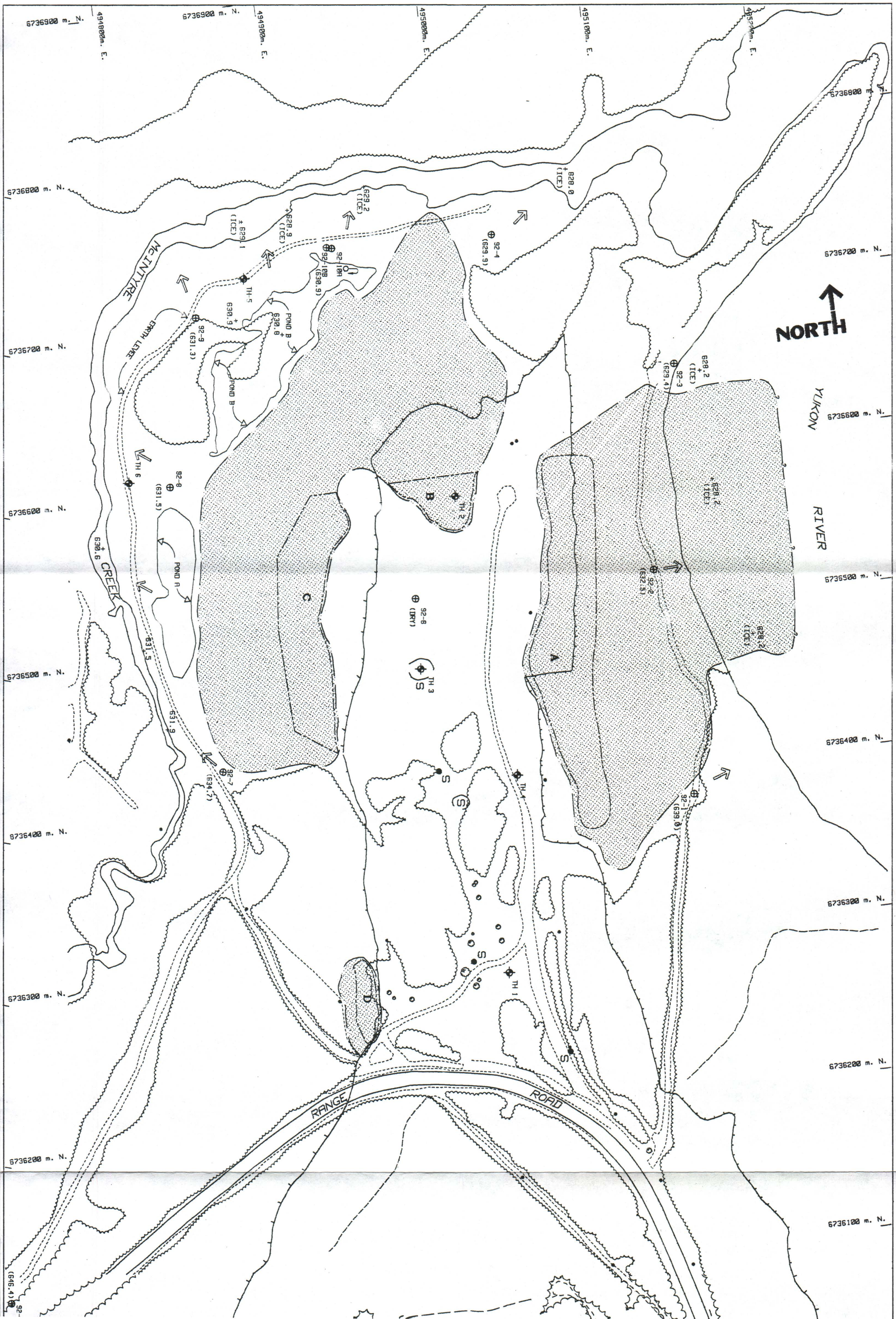


5) **Pond A**

6) **Pond B**

PLATE 3

POND A & B - FALL, 1991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6736400 m. N.
6736300 m. N.
6736200 m. N.
6736100 m. N.
NORTH
YUKON RIVER
McINTYRE CREEK
EARTH LEVEE
POND A
POND B
RANGE ROAD
A
B
C
D
TH 1
TH 2
TH 3
TH 4
TH-5
TH 6
S
92-1 (639.0)
92-2 (632.5)
92-3 (629.4)
92-4 (629.9)
92-6 (DRY)
92-7 (634.7)
92-8 (631.5)
92-9 (631.3)
92-10A
92-10B (630.9)
628.0 (ICE)
628.2 (ICE)
628.2 (ICE)
628.2 (ICE)
628.2 (ICE)
629.2 (ICE)
628.9 (ICE)
629.1 (ICE)
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630.6
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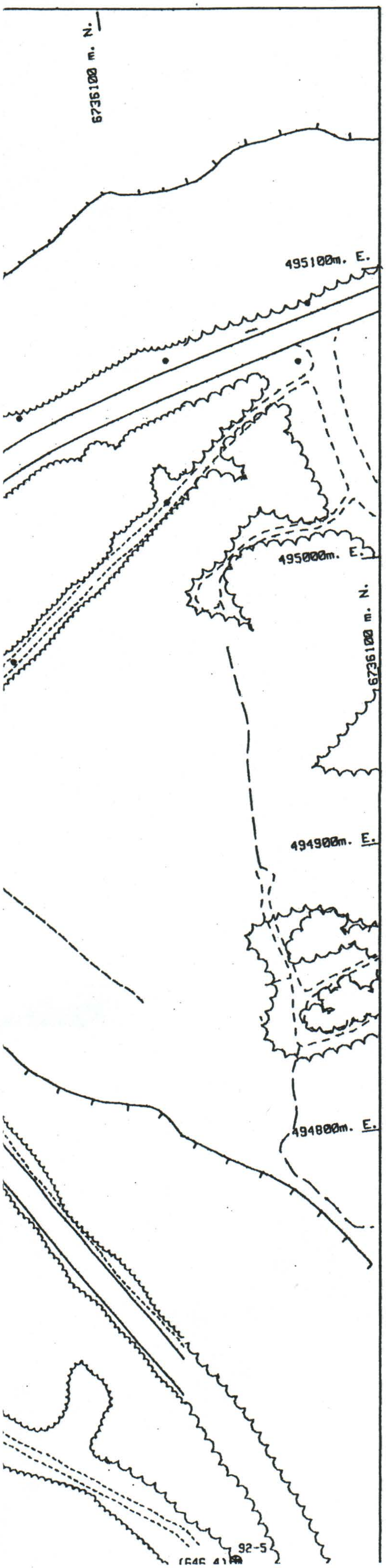
631.9
(646.4)
92-



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LEGEND

┄┄┄	TRAIL
⬭	BUSH LINE
┐	SHARP BREAK IN SLOPE
+679.9	SPOT ELEVATION
•	POWER/TELEPHONE POLE
● S	SURFACE MAGNETIC ANOMALY
▨	LIMIT OF BURIED MAGNETIC ANOMALY BY SURVEY
▨	APPROXIMATE LIMIT OF BURIED REFUSE
TH 6	TESTHOLE
92-8	MONITOR WELL: (YEAR DRILLED -NUMBER)
92-10A 92-10B	MONITOR NEST (A-DEEP / B-SHALLOW)
(630.9)	GROUNDWATER ELEVATION (FEB.15, 1992)
⇗	GROUNDWATER FLOW
⚲	92-10A - FLOWING (FEB.15, 1992)

SCALE 0 10 30 50m

(Legend for map from previous page)

Figure 5

GROUNDWATER FLOW AND ELEVATIONS RANGE ROAD DUMP WHITEHORSE, YUKON 1992

- organically bound chlorine (AOX) compounds were not detected (<0.025 ppm) except in the background monitor 92-5 (0.11 ppm); and
- total organic carbon (TOC) was present at concentrations ranging from 1.2 mg/L at 92-1 to 15.4 mg/L at 92-4.

TOXICITY

EnviroTest Laboratories sublet toxicity testing to HydroQual Laboratories Ltd. (see Appendix E). The specific test conducted was the Daphnia Magna 48h Static Acute Toxicity Test. This procedure consists of placing a population of freshwater invertebrates (Daphnia Magna) into a undiluted sample as well as 50%, 25%, 12.5%, 6.25% and 3.125% strength dilutions. The populations are observed after 48 hours and toxicity is calculated (LC_{50}-lethal concentration for 50% of the population). This is a standard test done on effluents and water sources and is recognized by Environment Canada and the USEPA for the evaluation of acute toxicity.

The undiluted samples from all ten monitors sampled were not toxic.

METALS

Groundwaters were analyzed for 21 dissolved metals. Beryllium, cadmium, chromium, cobalt, copper, lead, mercury, molybdenum, nickel and silver concentrations were at or below their detection limits. Only manganese was present at concentrations above the aesthetic objective (0.05 ppm) of the Canadian Drinking Water Quality Guidelines (Guidelines). Manganese concentrations exceed the aesthetic objective at all monitor sites and range from 0.195 ppm at 92-8 to 1.23 ppm at 92-4.

Iron concentrations were analyzed by acid extraction. These results can be influenced by the amount of sediment in the sample. The highest iron concentration was measured in 92-4 at 3.24 mg/L. This monitor did produce a sediment rich water sample.

TABLE 6

GROUNDWATER QUALITY

	PARAMETERS EXCEEDING BACKGROUND VALUES				
MONITOR	SULPHATE >500 mg/L	EC >700μS/cm	CHLORIDES >50.0 mg/L	NITRATES >10.0 mg/L	C.O.D. >100 mg/L
92-1					x
92-2	x	x	x	x	x
92-3					
92-4		x	x		x
92-5					
92-6					
92-7					
92-8					
92-9					
92-10A					
92-10B		x	x		x

E.C.	-	Electrical Conductivity
C.O.D.	-	Chemical Oxygen Demand

6.0 DISCUSSION

6.1 SUMMARY OF IMPACTS IDENTIFIED

6.1.1 Waste Disposal

The site was briefly used as a dump by the U.S. military in the early 1940's. What type of wastes were placed at this site or even the disposal practices or volumes are not known. The 1946 aerial photograph (Appendix A) shows minimal site disturbance.

The City of Whitehorse used the site as a municipal landfill for approximately 20 years. A wide range of municipal solid and liquid wastes were accepted at the site. The dump was frequently burned and wastes were not covered by earth.

Three distinct disposal areas were identified by Stanley's work program. From largest to smallest the disposal areas are described as:

1) the McIntyre Creek landfill that lies on the west and north sides of the bluff;
2) the Yukon River landfill that lies on the east side of the bluff and extends onto the bed of the River; and
3) a very small deposit of scrap steel in the southwest corner of the site.

Small amounts of refuse have been scattered on the top of the bluff since site closure in 1975. Several hundred tires were retrieved from the Yukon River below the dump in 1991.

6.1.2 Topography

The site topography has been modified in three substantial ways.

Firstly, an earthen levee was constructed below the toe of the McIntyre Creek landfill. A slope failure within the wastes blocked the creek bed and the City of Whitehorse was required to realign McIntyre Creek away from the landfill. The historical creek alignment is illustrated on Drawing 3 in Appendix A.

Secondly, reclamation activities after closure included down cutting the top of the plateau to provide cover material. Two to three metres of excavation near the current power line right of way are evident. Perhaps four to six metres of down cutting should be expected near the edge of the bank.

Thirdly, the large volume of wastes in the McIntyre Creek and Yukon River landfills has broadened the original bluff. Although slightly lower, the current landform is 50 to 100m wider from east to west.

6.1.3 Soils

The remaining soils above the bank showed no visible staining nor odours from the solid and liquid waste disposal at the site. The strong horizontal bedding in the upper silts on the bluff means that deep vertical migration of contaminants is unlikely. The soils most likely to be heavily contaminated have been down cut and pushed over the Yukon River and McIntyre Creek banks as cover.

No top soil has been placed on either the down cut plateau nor the partially covered wastes below the bank. Vegetation is sparse both above and below the bank.

The most heavily impacted soils are thought to exist below the wastes in the McIntyre Creek landfill. The Yukon River will have flushed the wastes present on the river bed. Environment Canada's previous studies (1986 and 1991) of the soils in the ponds below the McIntyre Creek landfill described only moderate changes in inorganic chemistry and trace amounts of PCB's.

6.1.4 Groundwater

Ten groundwater monitors have been sampled and analyzed for a broad range of organics and inorganics including 20^{+} trace metals. Nine of ten monitors were constructed either through the waste tip or beside it. Monitor 92-5 is distant from the dump, is hydraulically upgradient, and is considered to represent background conditions.

ORGANICS

No organic compounds potentially of concern to human or aquatic health were determined to be present in the groundwater. Twenty eight target pesticides, PCB's, total organics, petroleum hydrocarbons, volatiles and chlorinated organics were found to be absent.

Total organic carbon (TOC) is present at low background concentrations of less than 5 mg/L but exceeds 10 mg/L at monitors 92-2, 92-4 and 92-10B. The maximum TOC concentration was measured at 92-4 at 15.4 mg/L. Although this value is nearly 4 times the concentration of TOC at 92-5, it is still a very low number. The breakdown and release of organic compounds in the municipal wastes near 92-2, 92-4 and 92-10B is likely responsible for the higher TOC concentrations in those three monitors.

METALS

Trace metals (cadmium, chromium, lead, mercury, etc.) are present in the groundwater at very low concentrations - none of which exceed Canadian Drinking Water Quality Guidelines (Guidelines). Trace metal enrichment in the groundwater near the dump is not evident.

Manganese is naturally present in the groundwater at concentrations well above the aesthetic objectives (0.05 mg/L) under the Guidelines. Monitors 92-4 and 92-10B show enrichment of manganese in the groundwater at the toe of the McIntyre Creek landfill.

Iron is below the aesthetic objective of 0.3 mg/L under the Guidelines in 8 of 10 monitors. Similar to manganese, iron concentrations show enrichment at monitors 92-4 and 92-10B.

INORGANICS (ROUTINE POTABILITY)

The most obvious changes to groundwater quality are evident in the inorganic or routine potability parameters. Table 6 in the preceding section (5.4.2) clearly illustrated that electrical conductivity (EC), sulphate, chloride, nitrate and chemical oxygen demand (COD) are present at above background concentrations at some locations.

The following two areas distinctly show unusual groundwater quality:

- Monitor 92-2 - located within the Yukon River waste tip, has EC greater than 2500 μs/cm, chlorides of 220 mg/L, nitrates > 10.0 mg/L, sulphates > 500 mg/L and greatly elevated COD; and

- Monitors 92-2 and 92-10B - located below the downgradient end of the McIntyre Creek landfill, have EC > 700 μs/cm, chlorides > 50 mg/L, and COD > 100 mg/L.

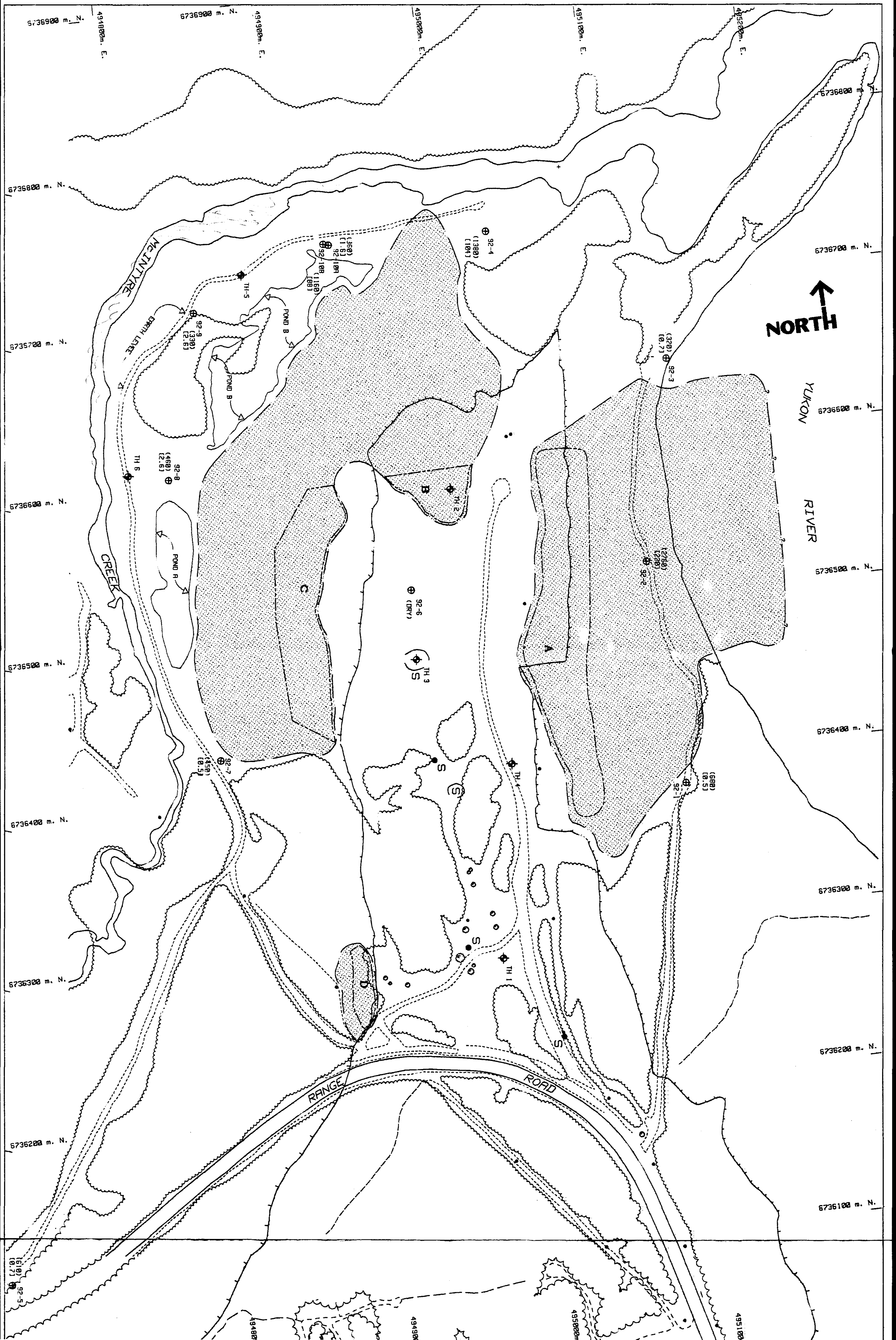
Monitor 92-1, located on the Yukon River bank and immediately north of the dump has an elevated COD concentration (306 mg/L). However, other parameters have background concentrations including chlorides (0.7 mg/L) and EC < 320 μs/cm).

Summary

Impacts to the groundwater are evident in the vicinity of the dump. Enrichment of iron, manganese, nitrates, COD and chlorides have occurred in the groundwater at monitors 92-2, 92-4 and 92-10B.

Figure 6 illustrates groundwater quality patterns with the 1992 study area. Electrical conductivity and chlorides were chosen as the two parameters that most clearly show impact boundaries. Electrical conductivity is an indirect measure of the total amount of ions present in solution. Chloride is a small negativity charged ion that is not impeded during groundwater flow through soils and sediments.

The Yukon River landfill extends out into the river. The shallow groundwater system under the landfill is described by monitor 92-2. This monitor is completed at the contact of the wastes with native soils and has poor water quality. Monitors 92-1 and 92-3 are completed at the northern and southern edges of the waste tip and do not show substantive impacts.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NORTH
YUKON
RIVER
McINTYRE
CREEK
EARTH LEVEE
POND B
POND B
POND A
TH-5
TH 6
TH 2
TH 3
TH 4
TH 1
92-9 (330) [2.6]
92-8 (460) [2.6]
92-10A
92-10B (160) [88]
(360) [1.6]
92-4 (380) [104]
92-3 (320) [0.7]
92-2 (260) [20]
92-1 (600) [0.5]
92-6 (DRY)
92-7 (450) [0.5]
92-5 (610) [0.7]
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B
C
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S
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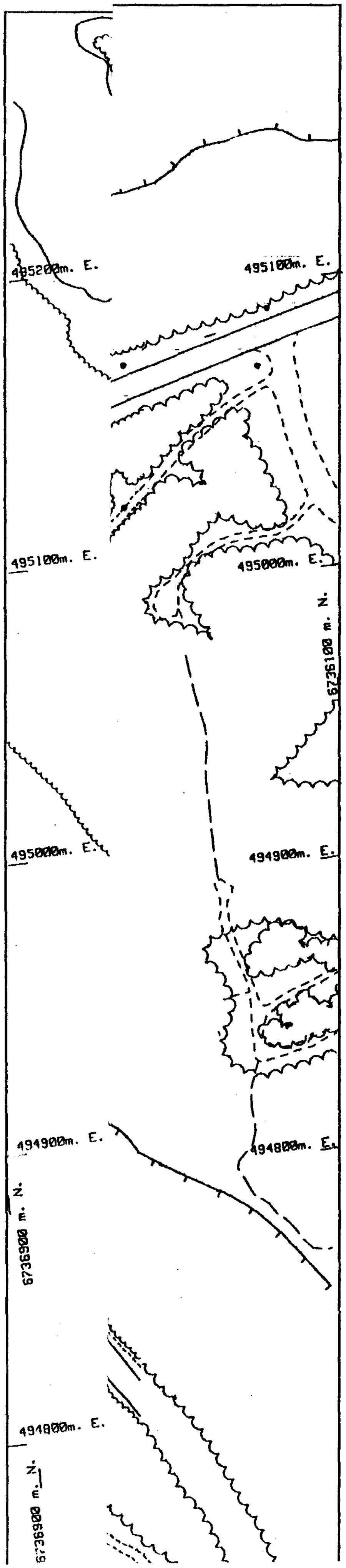

Stanley

LEGEND

┈┈┈	TRAIL
⬭	BUSH LINE
┐	SHARP BREAK IN SLOPE
+679.9	SPOT ELEVATION
•	POWER/TELEPHONE POLE
S ●	SURFACE MAGNETIC ANOMALY
▨	LIMIT OF BURIED MAGNETIC ANOMALY BY SURVEY
▨	APPROXIMATE LIMIT OF BURIED REFUSE
TH 6	TESTHOLE
92-8	MONITOR WELL: (YEAR DRILLED -NUMBER)
92-10A 92-10B	MONITOR NEST (A-DEEP / B-SHALLOW)
(680)	ELECTRICAL CONDUCTIVITY μS/cm
[220]	CHLORIDE mg/L

NOTE:

1. TARGET PESTICIDES, PCB'S AND TOTAL ORGANICS WERE NOT DETECTED.
2. DAPHNIA BIOASSAY - THE UNDILUTED SAMPLE WAS NOT TOXIC.

SCALE 0 10 30 50m

(Legend for map from previous page)

Figure 6

GROUNDWATER QUALITY (FEB. 15)
RANGE ROAD DUMP

The McIntyre Creek dump lies within the creek valley and partially overlies a former channel. Five monitor sites were established below the toe of slope and between the dump and the current course of McIntyre Creek. The three southern monitors have water quality similar to background and do not show any substantive impacts. However, impacts are apparent at monitors 92-10B and 92-4 that lie downgradient of Pond B and the northern toe of the dump respectively. Deeper groundwater at monitor 92-10A moves upwards (discharges) within this zone of shallow impact but has background water quality.

6.1.5 Surface Water

YUKON RIVER

The shallow groundwater below the Yukon River dump flows east towards the river bed (Figure 5). Although, this groundwater is of poor quality, it travels fairly slowly and has a low estimated discharge at 0.00007 m^3/s.

Discharge (Q) = Hydraulic Conductivity (K) x Gradient(I) x Area (A)
= 0.00007 m^3/s

Where: K and I are averaged from Monitor 92-1, 92-2 and 92-3, (Table 5).

A is estimated as a saturated thickness of 3m x 140m length of landfill.

Mean monthly Yukon River flows range from 100 to 446 m^3/s (Water Survey of Canada, 1989). This gives a conservative dilution factor of 1,400,000 to 6,400,000 : 1.

McINTYRE CREEK

The shallow groundwater below the McIntyre Creek dump flows west and northwest towards the current creek bed (Figure 5). Ponds A and B below the toe of slope contain shallow groundwater discharging from the landfill as well as surface waters trapped behind the levee.

The water quality described at monitor sites 92-4 and 92-10B is poor. These sites lie down gradient of Pond B and the northern toe of the McIntyre Creek dump. Discharge from the zone of impacted groundwater to the creek bed is estimated to be 0.0001 m^3/s.

Discharge (Q)	=	KIA
	=	0.0001 m^3/s
where:		K and I are averaged from Monitor 92-4 and 92-10B (Table 5).
		A is estimated as a saturated thickness of 3m x 250m length of discharge zone.

McIntyre Creek flows range from 0.63 to 1.43 m^3/s (Yukon Electrical, 1990). This gives a dilution factor of 6300 to 14300 : 1 at the 1990 discharge. Should a new dam be constructed and flows be diverted, McIntyre Creek discharge may drop to a low of 0.05 m^3/s during the summer (Lister, 1991). This would subsequently result in a dilution factor of 50:1.

Discharge of groundwater to the creek is evidenced in part as white evaporite deposits along portions of the bank. Plate 4 illustrates a section of the east bank of McIntyre Creek below the dump.

Under extreme rainfall or during spring runoff, Ponds A and B could overflow directly to McIntyre Creek. Overflow waters would be considerably diluted by the influx of rainwater or snow melt.

6.2 CONCLUSIONS

The Range Road Dump was used briefly in the 1940's as a military disposal site for unknown waste types and quantities. Subsequently, a much larger part of the bluff was used by the City of Whitehorse as a municipal waste disposal site. Wastes were frequently burned and pushed over the bank where they lay uncovered. This disposal method would drive off most volatile organic compounds and would also promote rapid leaching.

The site topography and disposal methods have created two large dumps on either side of the bluff. Other waste deposits on the site are thought to be minor.

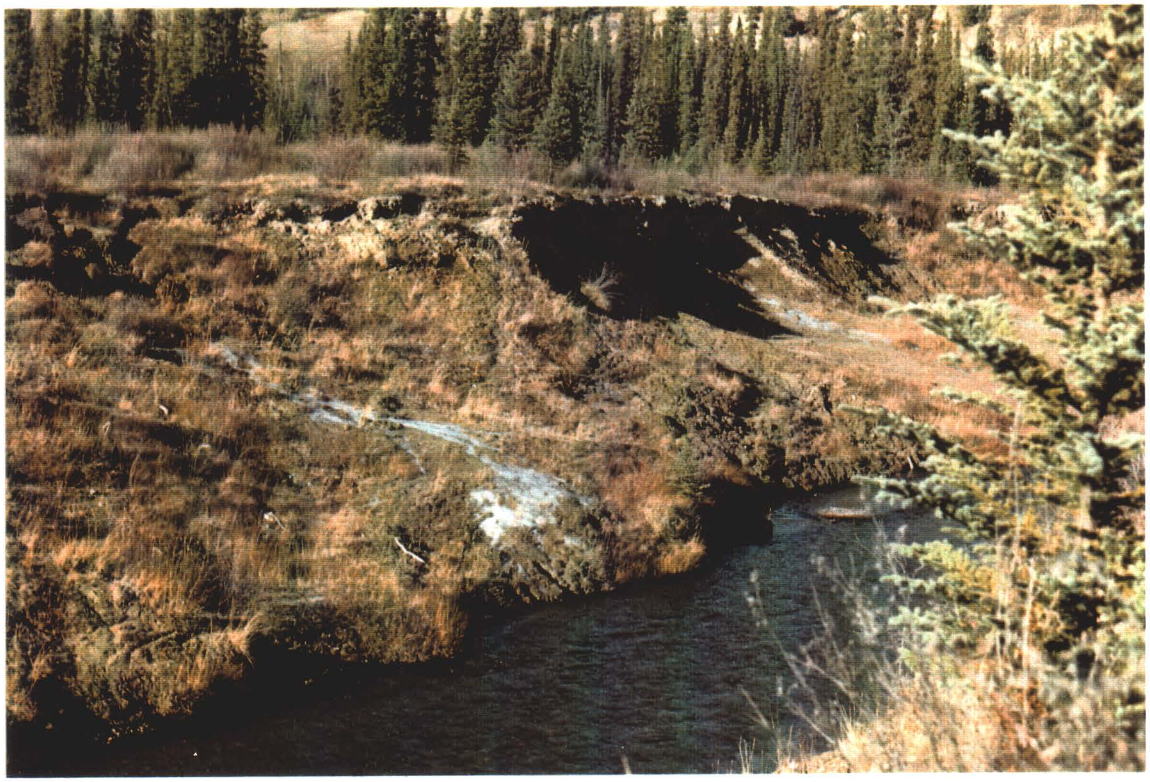

PLATE 4

McINTYRE CREEK BANK - FALL, 1991

The Yukon River dump and the McIntyre Creek dump have impacted shallow groundwater quality. However, the impacts identified are restricted to a few inorganic compounds. Only a nitrate concentration of 39.8 mg/L, in the groundwater below the Yukon River dump, exceeds a maximum acceptable value under the Guidelines. Additionally, the shallow groundwater at 92-4 and 92-10B below the McIntyre Creek dump is not aesthetically acceptable as domestic drinking water.

Deeper groundwaters below the dump are not thought to be affected by the waste disposal practices. Discharging (upward moving) groundwaters with background water quality were measured at Monitor 10B. The adjacent shallow monitor (10A) shows an impact from the nearby landfill. Where vertical groundwater flow is upwards, contaminants can't readily move downwards.

A detailed analytical program conducted on ten groundwater samples did not detect either trace metals or target organics (pesticides, PCB's, hydrocarbons) at concentrations above background values. In fact, the target organics were below detection limits in the parts per billion to parts per trillion range. Additionally, the 48 hour Daphnia Magna acute toxicity test reports note that **all undiluted groundwater samples were not toxic.**

The Yukon River and McIntyre Creek dumps have not been identified as a source of persistent pesticides nor PCB's. Although trace concentrations of PCB's were previously found in the sediments of Pond A & B below the McIntyre Creek dump, they are not mobile at measurable concentrations in the groundwater.

Shallow groundwater, impacted by the two large dumps, discharges to the adjacent river and creek. Discharge from below the dumps has been estimated to be 0.00007 m^3/s (2200 m^3/year) to the Yukon River and 0.0001 m^3/s (3150 m^3/year) to McIntyre Creek. Dilution factors at current stream flows are millions for the Yukon River and thousands for McIntyre Creek. Should McIntyre Creek flow be diverted for power generation, then the dilution factor may drop to 50 : 1 at low summer flows.

Current impacts from the Range Road Dump to the water quality in the Yukon River and McIntyre Creek is negligible. Even at the lowest estimated dilution rate (50 : 1), measurable changes in downstream waters is unlikely.

6.3 RECOMMENDATIONS

The Range Road Dump site has been partially reclaimed by placing earthen cover over the majority of the exposed wastes. However, a lot of scrap steel and tires are visible at surface both on the bluff and within the valley bottoms. These wastes should either be recovered and recycled or properly buried.

The two large ponds at the toe of the McIntyre Creek landfill are undesirable. The trapping of surface water in the ponds tends to raise the local watertable and thus saturate a larger portion of the basal wastes in the dump. Recontouring the toe of slope so that surface waters are shed directly to McIntyre Creek is desirable. This should be accomplished by adding earthen fill to the depression occupied by Ponds A and B so that a minimum 2% slope towards the creek is created.

The partial reclamation of the site has not included topsoil placement nor active replanting to enhance vegetive cover. An important long term aesthetic goal should include reforestation of the bluff. Pine grows well in the dryer microclimate on top of the plateau and spruce thrives on local slopes.

The landfill has had a measurable impact on inorganic groundwater quality adjacent to the dump. Periodic monitoring of the groundwater can readily be undertaken by using the permanent groundwater monitors installed by Stanley at the site. A reduced analytical program would be appropriate so long as no large changes in the concentration of dissolved constituents are observed.

Monitor 10A is completed at depth below the zone of shallow groundwater contamination. The groundwater in this monitor is of high quality and does not show any impacts from the dump or adjacent Pond B. This monitor flows at a slow rate and should be properly abandoned.

Amerok Geophysics has described a method that would provide a three dimensional mapping of the Yukon river and McIntyre Creek dump sites. This method consists of a seismic refraction survey that can determine the density difference between the wastes and the native soils below. This survey should be undertaken if there is a need to quantify the volume of wastes in place.

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APPENDIX B

MAGNETOMETER SURVEY
AMEROK GEOPHYSICS

A TOTAL MAGNETIC FIELD SURVEY OF THE RANGE ROAD DUMP SITE

Prepared for Stanley Associates Engineering Ltd.
Edmonton, Alberta

Amerok Geophysics
February 1992

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Whitehorse, Yukon
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Phone (403) 668-7672

February 10, 1992

Mr. Robert Innis M.Sc. P.Ag.
Senior Enviromental Scientist
Stanley Associates Engineering Ltd.
10160 112 Street
Edmonton, Alberta

Re: Letter of Transmittal

Dear Mr. Innis,

Please accept the report to which this letter is appended describing a total magnetic field survey of the Range Road dump site. I hope that our survey and this report fully meets your requirements. Thank you for the opportunity to work with Stanley Associates Engineering Ltd. on this interesting project.

Yours Sincerely,
AMEROK GEOPHYSICS

M.A. Power M.Sc.
Geophysicist

Summary

A total magnetic field survey of the Range Road dump site was conducted on January 30 and 31, 1992 to determine the location of buried metallic debris. The survey covered a grid on the elevated plateau in the centre of the property and lines along the McIntyre Creek levee, the access trail along the Yukon River and on the ice parallel to the embankment on the Yukon River side of the property. Most metallic debris is on the side of the plateau where it appears to have been pushed over the edge and buried. Some metallic debris is buried in the McIntyre Creek levee and beneath the access trail parallel to the Yukon River. Some debris also appears to have been pushed into the Yukon River in the northeast corner of the property.

A. Introduction

A total magnetic field survey of the Range Road dump site was conducted on January 30 and 31, 1992. Approximately 4.3 line-kilometres were surveyed on a grid covering the centre of the property and on lines along the McIntyre Creek levee and the Yukon River. This report describes the survey and its results.

B. Location and site description

The Range Road dump site is approximately 8 km north of the centre of Whitehorse on the west side of the Yukon River at its confluence with McIntyre Creek (Figure 1) The dump is centred on a small, steep sided plateau bounded by McIntyre Creek on the west and north, by the Yukon River on the east and by Range Road on the south. A levee topped by a road parallels McIntyre Creek and an access trail runs along the foot of the embankment on the Yukon River side of the plateau. Several trails originating at Range Road run the length of the plateau. A power line runs the length of the property along the east side of the plateau and a telephone line runs along the west edge of the plateau. The southern portion of the plateau contains a stand of pine saplings and the McIntyre Creek levee passes through a stand of willow and alders with some spruce. The southern flanks of the plateau are covered with older stands of spruce and pine.

The property is underlain by glaciolacustrine clays and silts covered with a thin layer of soil. The glacial deposits are quite the embankments, the waste on the top of the plateau is covered by soil and overburden. There are several patches of surface debris which have been covered with soil in the southern wooded portion of the plateau.

C. Method and instruments

Buried ferromagnetic material can be located by mapping perturbations in the earth's magnetic field. The techniques used in this work were originally developed for mineral exploration and are well described in Telford *et al.* (1990). All rely upon the fact that the earth's magnetic field is relatively uniform over large areas and field disturbances can be directly attributed to near surface concentrations of material with contrasting magnetic susceptibility. Most of the earth's magnetic field is approximated by a magnetic dipole whose axis is nearly parallel to the earth's spin axis. In the Whitehorse area, the earth's field is declined approximately 31° from true north and inclined at 75° from the horizontal and has an amplitude of approximately 57000 nanoteslas (nT). In the absence of any material which has a high magnetic susceptibility, the local magnetic field will roughly conform to these values and be uniform over a large area. The earth's field can be resolved into horizontal and vertical components or measured as a vector magnitude. The latter measurement is known as the total magnetic field strength.

Many materials can develop an internal magnetic field when placed in an external magnetic field. Magnetic susceptibility is a measure of the ease with which an internal magnetic field may be induced by an external magnetic field. Most materials display a very small negative or positive magnetic susceptibility (diamagnetism or paramagnetism). Iron, steel and a series of transition element alloys display strong magnetic susceptibility and are termed ferromagnetic. In ferromagnetic material, the earth's magnetic field induces a strong local internal magnetic field which is vector-added to the earth's field. The axis of the induced field will parallel the local earth's field.

In the case of compact, near surface ferromagnetic objects such as would be found in a landfill, the associated total magnetic field anomaly will be positive to the magnetic south of and immediately over the object and negative to the magnetic north of it. The relative amplitudes of the positive and negative peaks is a function of the inclination of the earth's field. At this site, positive anomalies will develop on the southwest side and on top of ferromagnetic material and a smaller negative response will develop on the northeast side. The amplitude of the response will be proportional to the amount of magnetically susceptible material in the object and inversely proportional to the depth of burial while the wavelength of the response will be proportional to the depth of burial. Near surface material commonly produces a high amplitude, short wavelength perturbations of the total magnetic field. On the north side of significant concentrations of magnetic debris, the total magnetic field amplitude will be depressed by the presence of south-seeking magnetic poles induced on the underside of the debris package.

Perturbations in the total magnetic field can be accurately measured with a variety of magnetometers. Proton precession magnetometers are commonly used to measure the total magnetic field on the ground while more sensitive optically pumped cesium or potassium crystal magnetometers are used in airborne magnetometer surveys. In both cases the instruments exploit the same physical property. If a spinning electrical charge is aligned so that its spin axis is close to that of a magnetic field, the spin axis of the charge will precess around the axis of the field. The effect is similar to that of a spinning top precessing around a vertical axis if its spin axis is not itself vertical. The precession frequency is a physical constant (the Larmour Frequency) and is proportional to the strength of the earth's magnetic field.

Proton precession magnetometers incorporate a container filled with a hydrogen rich fluid - naphtha, kerosine or ethanol - enclosed in a sensor housing consisting of an air-cored solenoid. The solenoid is energized by a transient electrical current producing a strong, temporary local magnetic field in the sensor. This aligns the solitary protons forming the nuclei of hydrogen atoms so that their spin axes parallel the energizing magnetic field. Upon termination of the sensor's magnetic field, the aligned nuclei begin to precess around the earth's magnetic field lines at the Larmour Frequency. This generates a small alternating current which is picked up by the solenoid (acting as a receiving antenna), amplified, analyzed and displayed. The accuracy of such measurements depends upon the gradient of the local magnetic field in the sensor. Near a magnetic source, the gradient of the earth's field is quite strong and consequently the protons in the sensor will precess at different frequencies depending upon their location in the sensor. This degrades the signal. Average background measurements are accurate to within 1 nT but this could degrade seriously near ferromagnetic material. To minimize this effect, the sensor is normally carried on a staff and elevated above the ground to sample a more uniform magnetic field.

A more serious source of error in magnetic field surveys is temporal variation of the earth's field created by ionospheric disturbances. On days when the earth's field is relatively quiet, this effect may be removed by continuously measuring the magnetic field at a fixed point and using this recorded variation to correct the survey data.

The data in this survey were collected using an EDA Omni IV proton precession magnetometer (S/N 230) and an EDA Omni IV base station magnetometer (S/N 232). The base station magnetometer was set to cycle at a 20 second interval and located in the southeast corner of the property in an area free of magnetic material. There were no significant disturbances of the earth's magnetic field during the period of the survey. The survey was conducted on the grid described below. Measurements were taken at 5 metre intervals on lines spaced 20 metres apart. The magnetometers are equipped with an internal microprocessor and all data was dumped to a computer at the end of the survey day through an RS232C serial port. Temporal variation of the earth's magnetic field was removed by connecting the base station and field magnetometers together and running an internal program while dumping the data.

Amerok Geophysics installed a survey grid consisting of a north-south baseline and 19 survey lines running from the east edge of the plateau to the west edge (Figure 1). The baseline is coincident with the power line running the length of the plateau and is designated 100 W. Survey lines coordinates are from 0N to 360N. The baseline is picketed at 20 metre intervals along its length and the survey lines are picketed at the ends and where required for alignment. Three additional lines were surveyed. Line YR-1 follows the access trail along the Yukon River at the foot of the embankment. Line YR-2 runs roughly parallel to YR-1 about 50 m offshore. Line MC-1 runs along the top of the levee on the east side of McIntyre Creek. These lines were picketed at 100 m intervals along their length.

D. Results

The raw data collected during the survey is tabulated in Appendix B. This consists of base station records, corrected field records (temporal variation removed) and raw field records. Appendix C (in the master copy only) contains the digital data in ASCII format on disc.

The corrected total magnetic field data is plotted in individual line profiles in Figures 8 to 29 (Appendix A). Figure 7 is a stacked profile map showing the grid with the data for each line plotted above the line. Figure 2 is a contour map prepared from the data after gridding and filtering. A 3-point moving average filter was applied to the gridded data to stabilize the plotting routine. Normally, magnetic field data will not show the dynamic range evident in this data set unless the survey is conducted over massive magnetite or pyrrhotite. The moving average filter attenuates high amplitude, short wavelength responses to reveal the general features of the magnetic field.

Lastly, a set of pseudo-isometric projections of the total field data was prepared. The data is plotted as z=f(x,y) where z is the total magnetic field measurement. These diagrams were constructed with gridded unfiltered data and reveal most of the high amplitude, high frequency features in the data. The gridding process employs a rectangular box 60 metres by 10 metres and computes a weighted average of the field values within the box which is then assigned as a z value. The data is weighted by the inverse square of its distance from the grid node undergoing interpolation.

The projections and the profiles in Figures 27 to 29 display anomalies characteristic of near surface ferromagnetic debris. The amplitudes of the anomalies are quite high and the wavelengths short. The magnetic field is depressed in the areas northeast of the large positive anomalies. In the profiles, the field depressions (ie. values significantly below 57100 nT) occur on the north and northeast side of debris in the embankments.

In addition to the line profile data, Figure 7 shows the inferred boundaries of the areas containing abundant metallic (ferromagnetic) debris. Several isolated anomalies on the grid may be caused by nearby metal and are indicated by S; these spot anomalies could be caused by material beneath the snow or actually buried. The larger areas indicated in Figure 7 are zones where the magnetic field response suggests that metallic material is beneath the line or nearby. On the magnetic-north side of some areas, a total field depression occurs and this may conceal additional debris; consequently this area is included in the area believed to contain ferromagnetic material. Debris in areas **A** and **B** is covered by dirt while some exposed debris occurs at areas **C** and **D**. Segments of lines YR-1, YR-2 and MC-1 which pass over or near ferromagnetic debris are indicated in Figures 27 through 29.

E. Conclusions and recommendations

Areas **A** through **H** indicated in Figure 7 and Figures 27 through 29 probably contain significant accumulations of metal and should be avoided when drilling. Spot anomalies at other locations are probably due to surface debris. The data suggests that most of the ferromagnetic debris was pushed over the edge of the plateau and later covered with overburden. The toe of the debris pile on the west side of the plateau reaches the McIntyre Creek levee at one location near the north end of Line MC-1 and a debris fan extends at least 50 m out into the Yukon River on the east side of the plateau. There does not appear to be any significant deposit of ferromagnetic debris on the top of the plateau.

The magnetic field data only indicates the surface location of metallic debris. The data cannot be used to accurately estimate the depth of any debris accumulation or the quantity of metal therein. Since the debris was deposited on fairly competent overburden and then covered with loose material, a seismic refraction survey could be used to determine the approximate depth of the individual pits or trenches and hence the volume of debris in place (Carpenter *et al*. 1991). Ground radar would probably not work well in this setting because the debris would scatter any incident radiation before it encountered the base of the deposit. If further remedial action involves the removal of the buried debris, a seismic refraction survey could be conducted to estimate the quantity of material in place.

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Telford, W.M., L.P. Geldart and R.E. Sheriff (1990) Applied Geophysics (Second Edition). New York: Cambridge University Press.

Appendix A. Diagrams and Figures

List of Figures

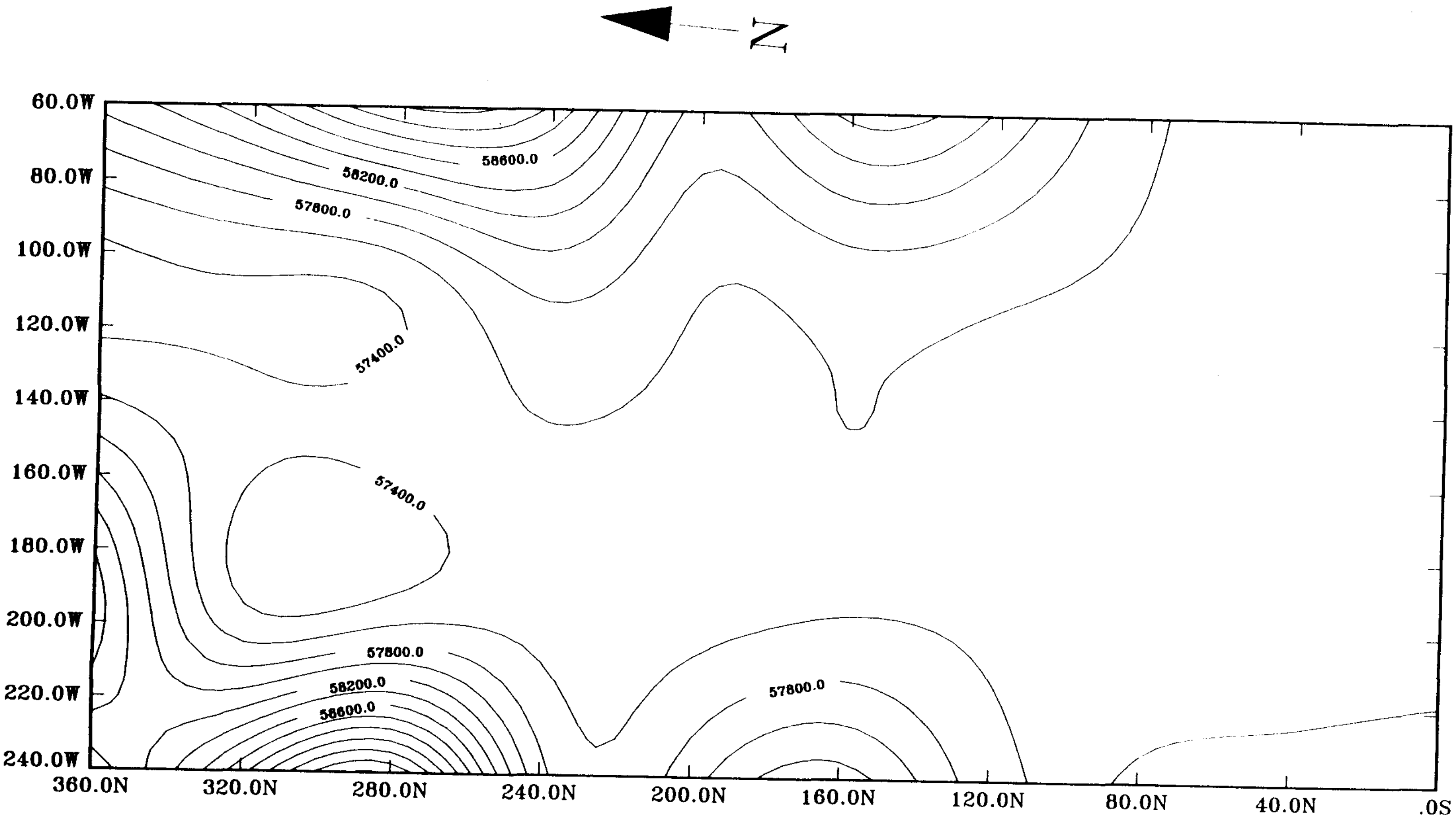
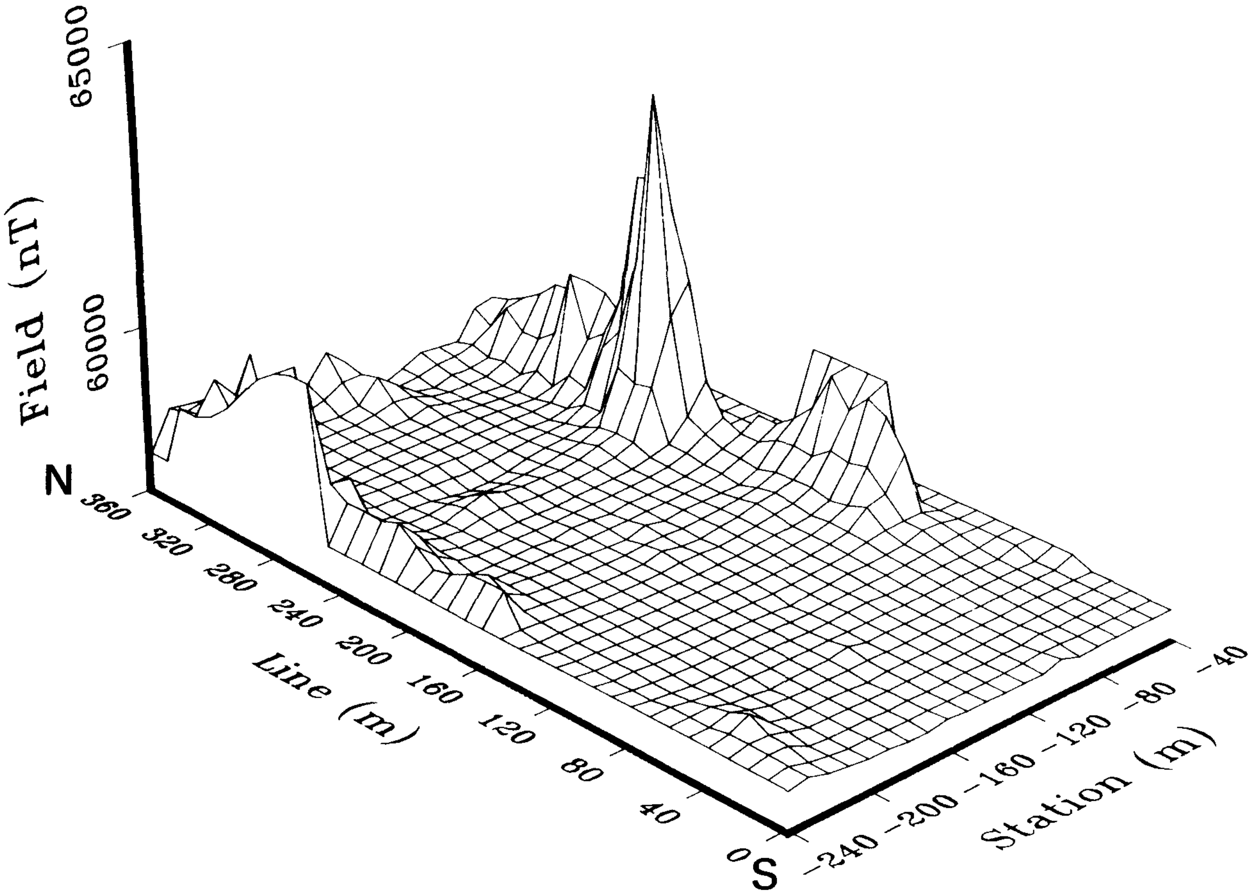


Figure 2. Contour map of total magnetic field

SENTAR
Range Road Dump
Total Magnetic Field

Scale 1: 2000
06 FEB 92
NTS:
Figure 2.
AMEROK GEOPHYSICS



SENTAR	Scale 1: 2000	06 FEB 92
Range Road Dump Total Magnetic Field	NTS:	Figure 3.
	AMEROK GEOPHYSICS	

Figure 3. Psuedo-isometric projection viewed from southwest

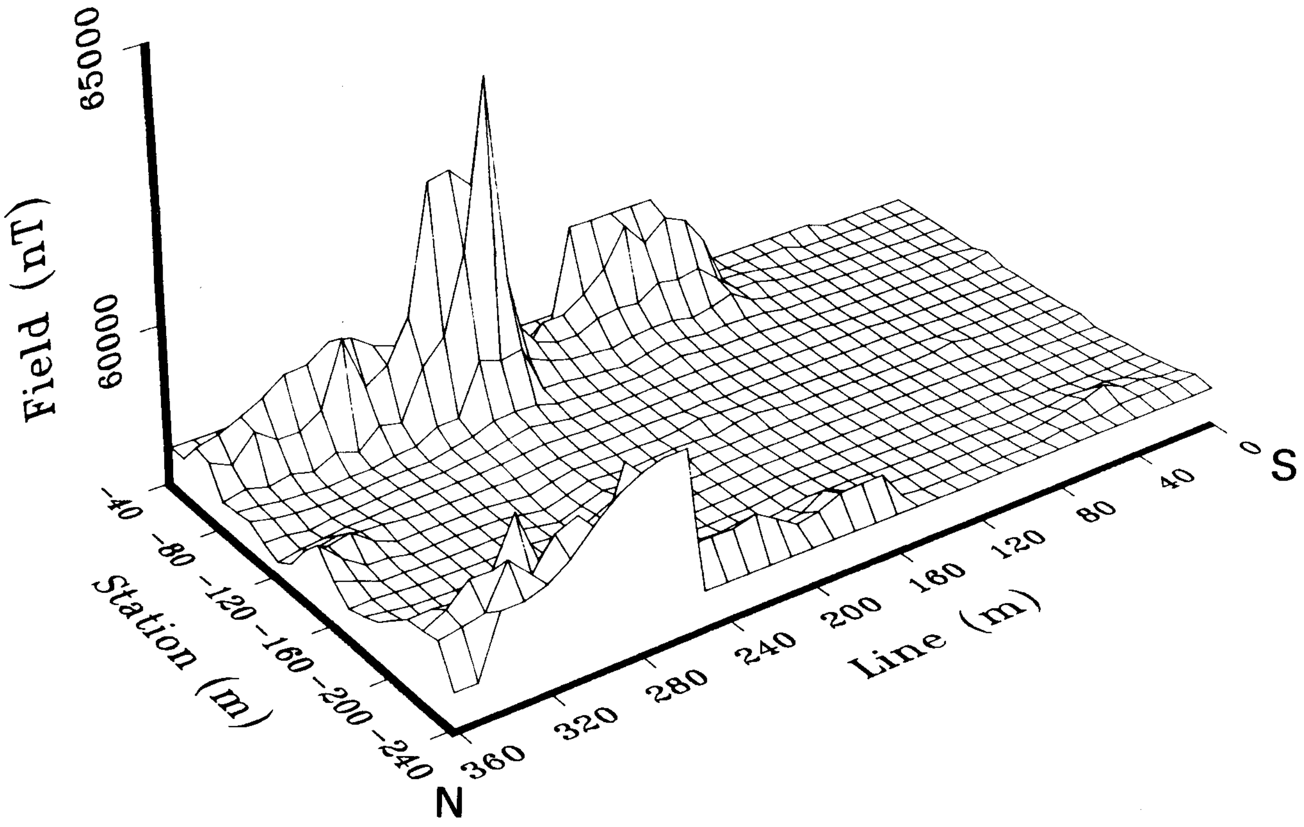


Figure 4. Psuedo isometric projection viewed from northwest

SENTAR	Scale 1: 2000	06 FEB 92
Range Road Dump	NTS:	Figure 4.
Total Magnetic Field	AMEROK GEOPHYSICS	

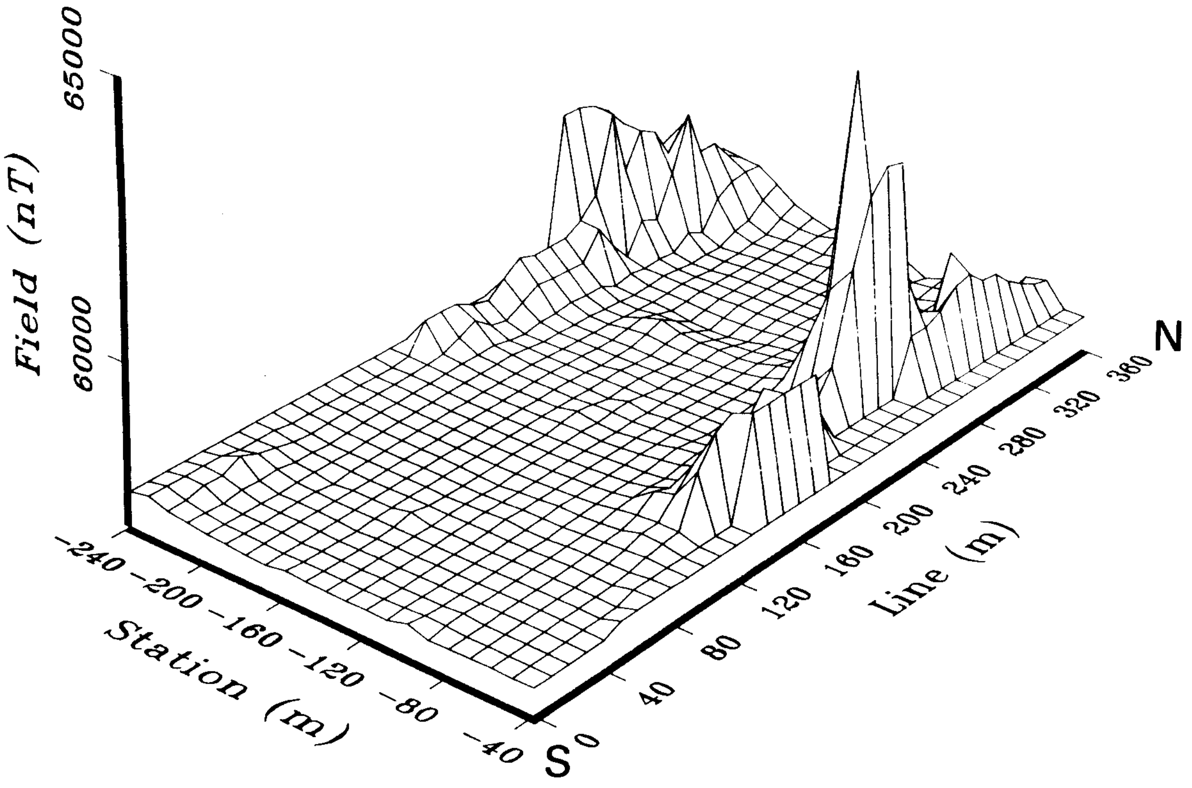
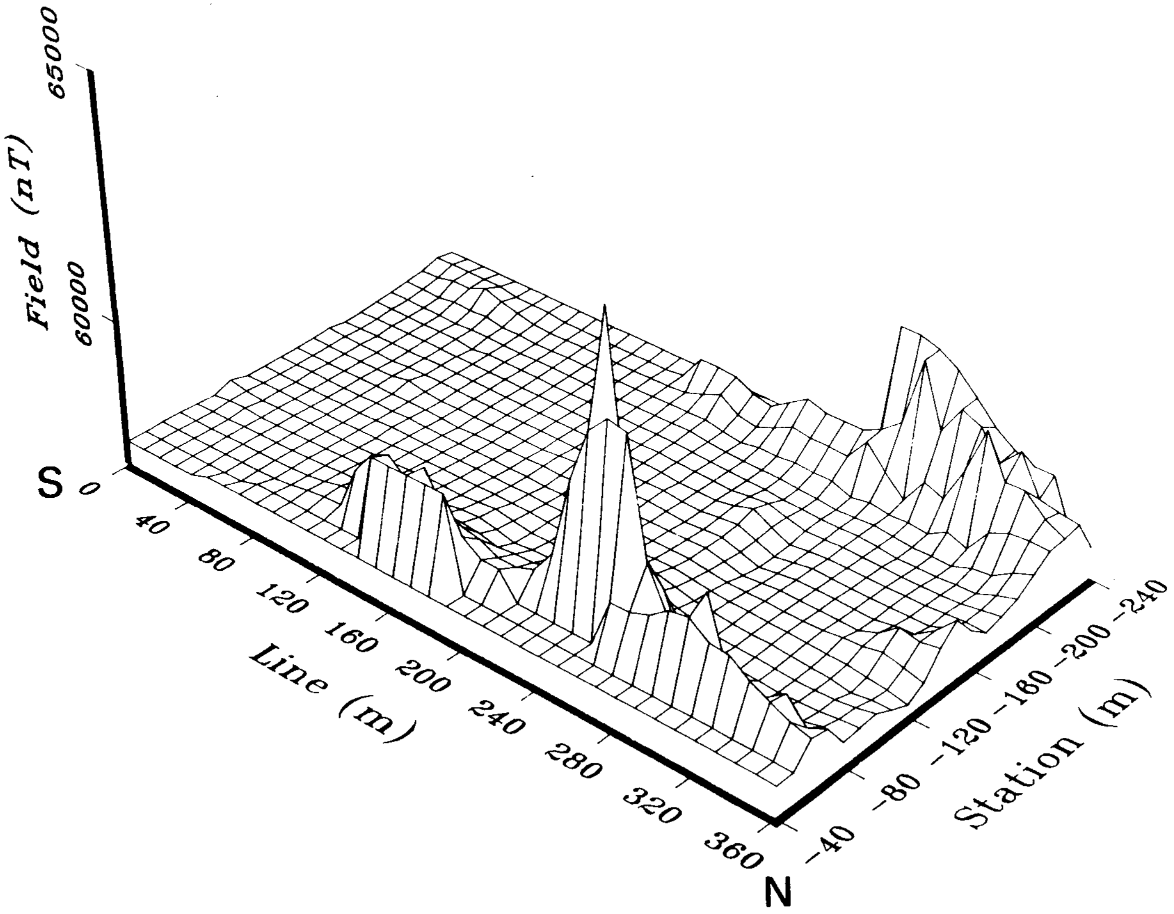


Figure 5. Psuedo-isometric projection viewed from southeast

SENTAR
Range Road Dump
Total Magnetic Field

Scale 1: 2000
06 FEB 92
NTS:
Figure 5.
AMEROK GEOPHYSICS



SENTAR Range Road Dump Total Magnetic Field	Scale 1: 2000	06 FEB 92
	NTS:	Figure 6.
	AMEROK GEOPHYSICS	

Figure 6. Psuedo-isometric projection viewed from northeast

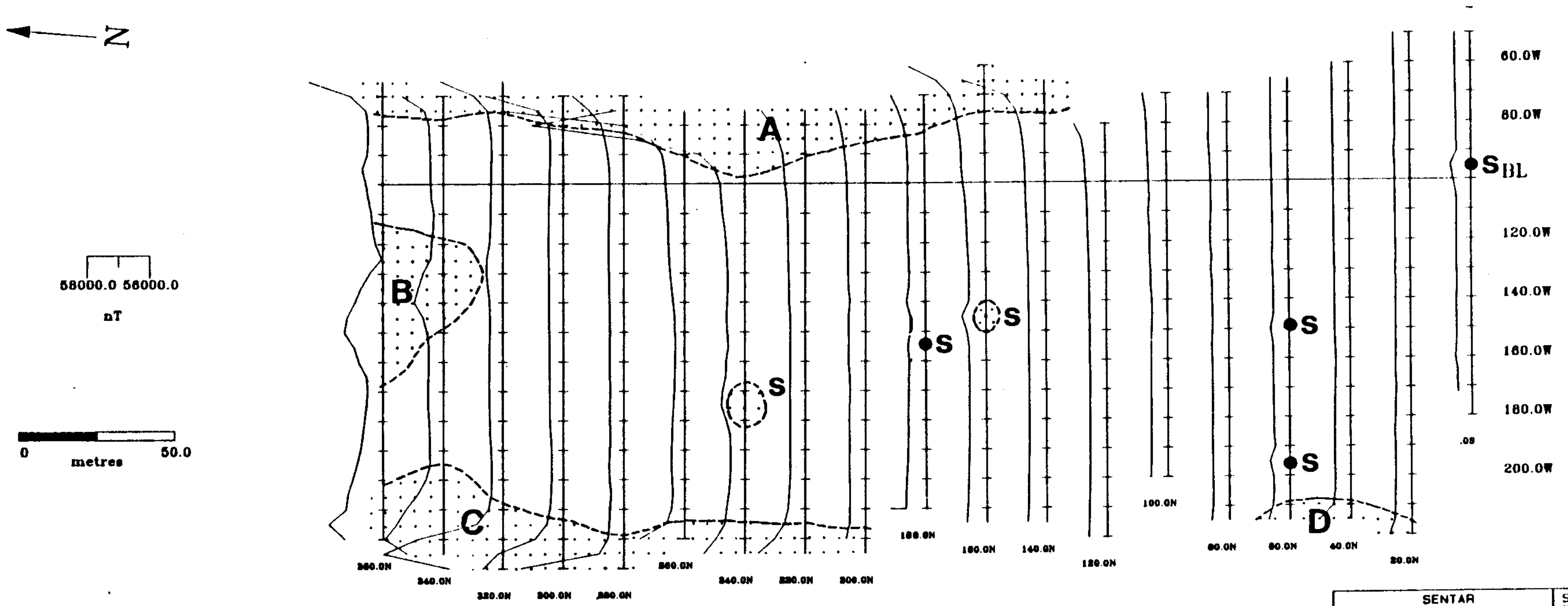
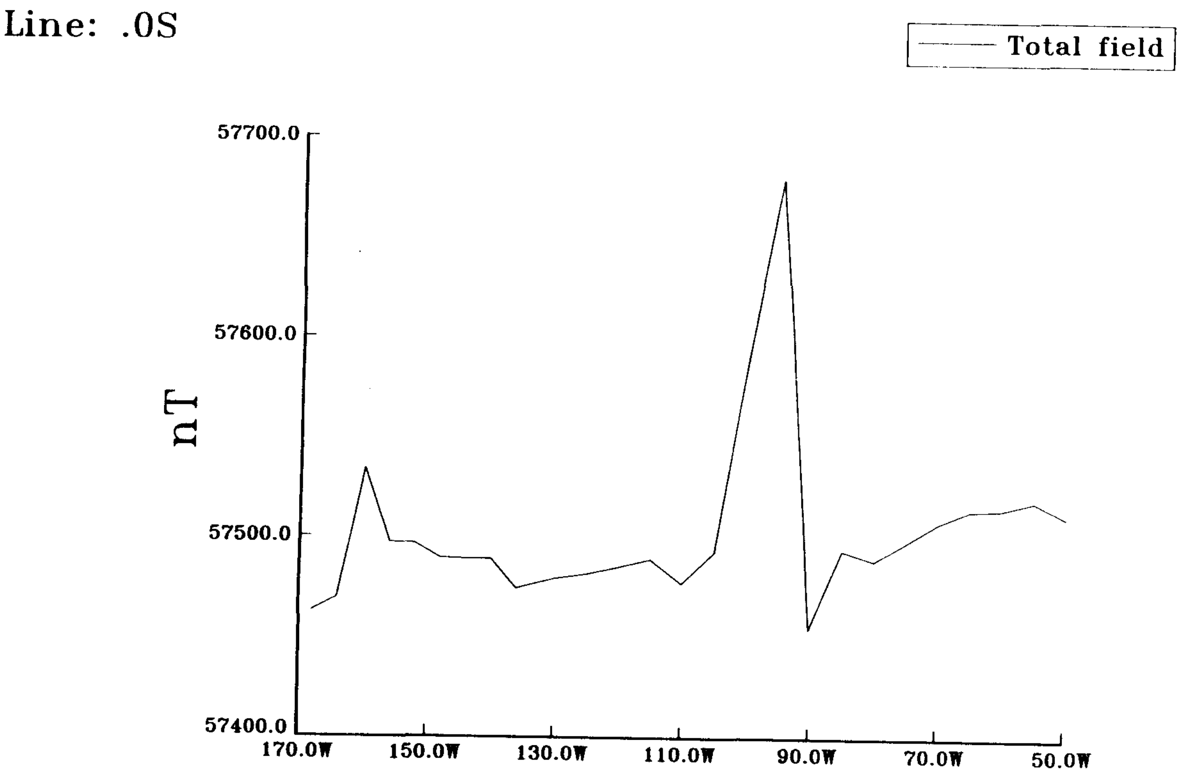


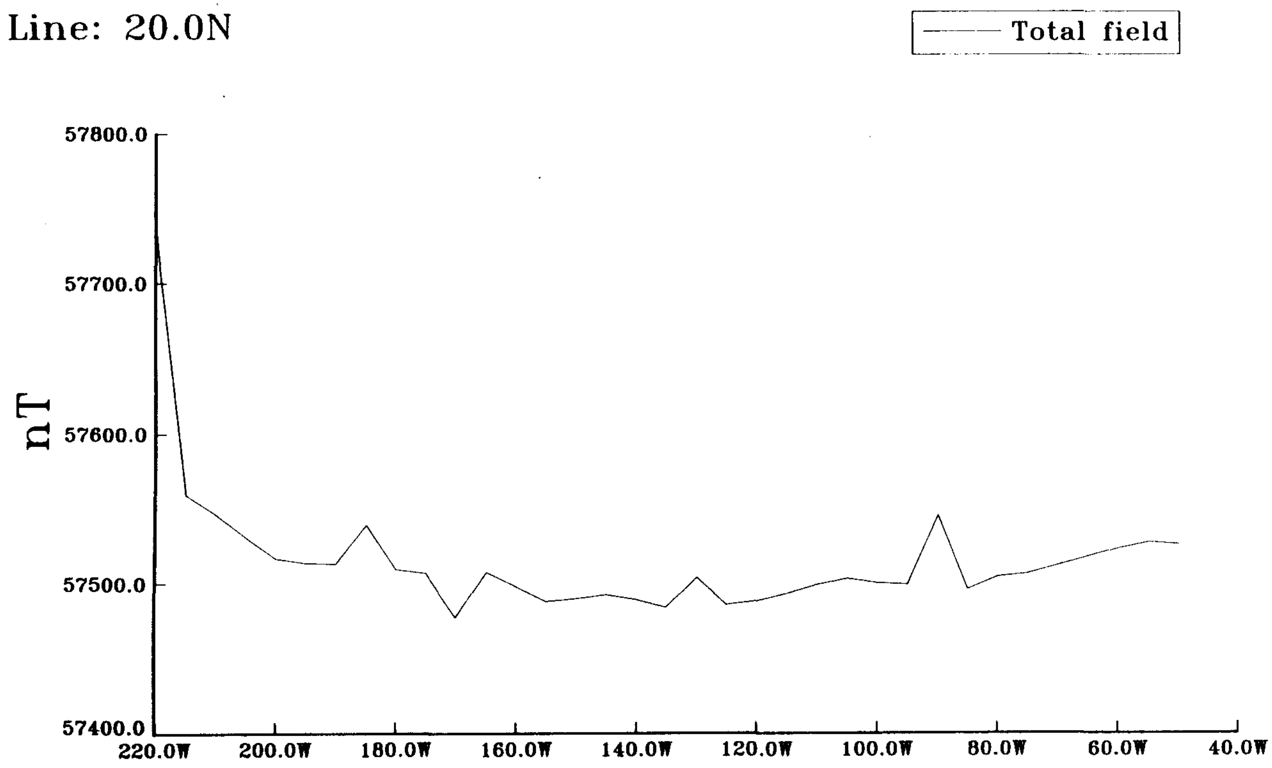
Figure 7. Stacked profile map showing areas with buried metallic debris

SENTAR	Scale 1:900	06 FEB 92
Range Road Dump	NTS: Figure 7.	
Total Magnetic Field	AMEROK GEOPHYSICS	

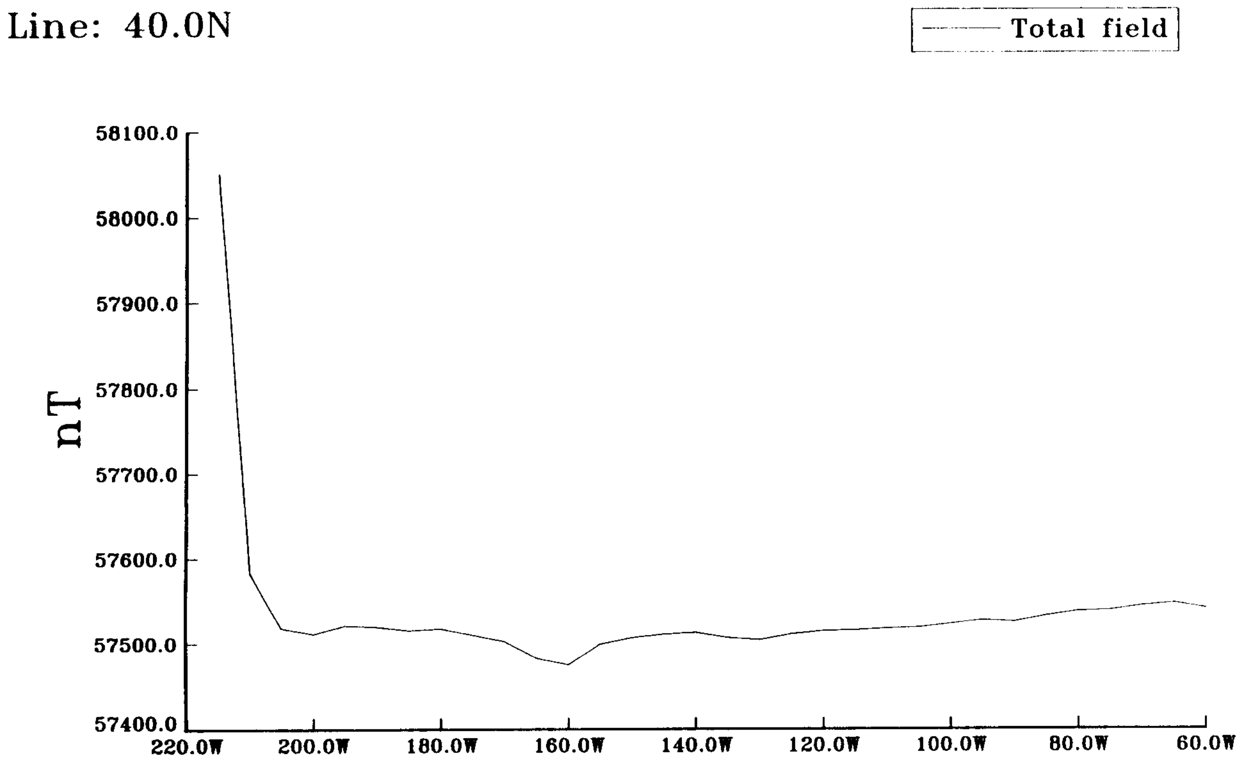


SENTAR
Range Road Dump
Total Magnetic Field

Scale 1: 800
06 FEB 92
NTS:
Figure 8.
AMEROK GEOPHYSICS



SENTAR	Scale 1: 800	06 FEB 92
Range Road Dump	NTS:	Figure 9.
Total Magnetic Field	AMEROK GEOPHYSICS	



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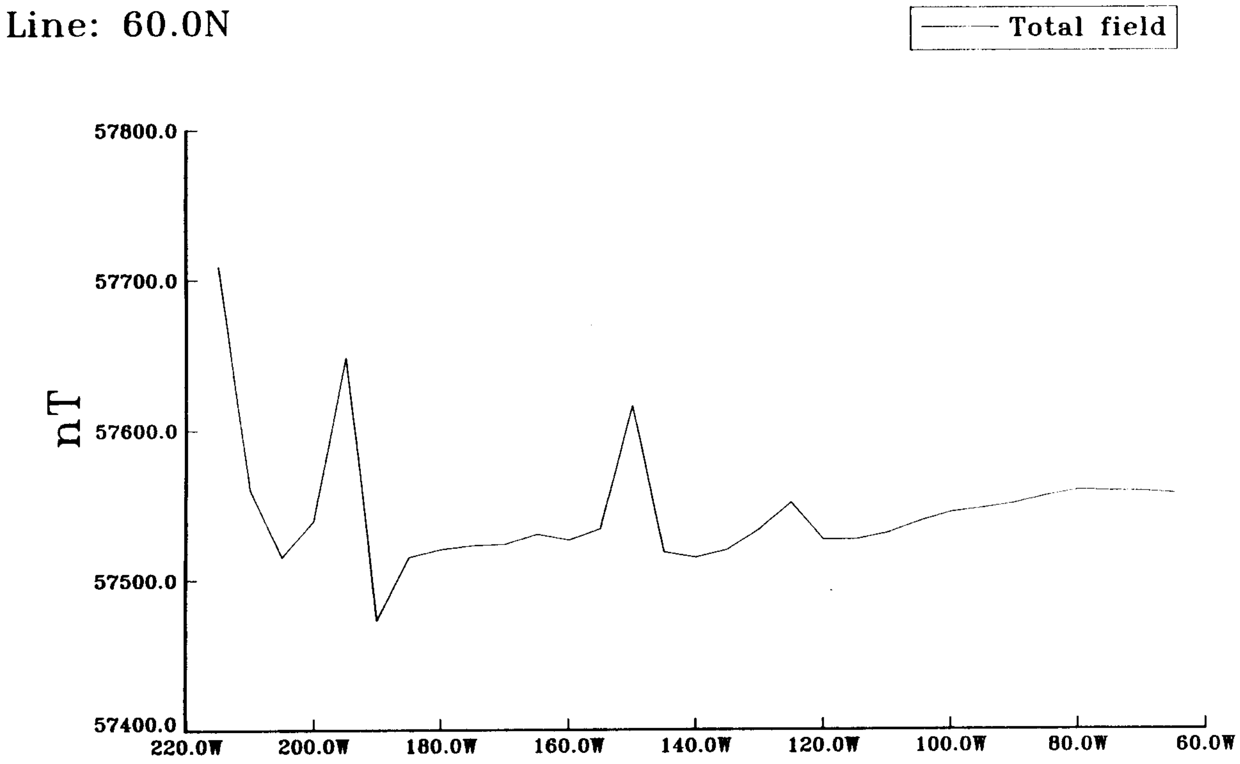
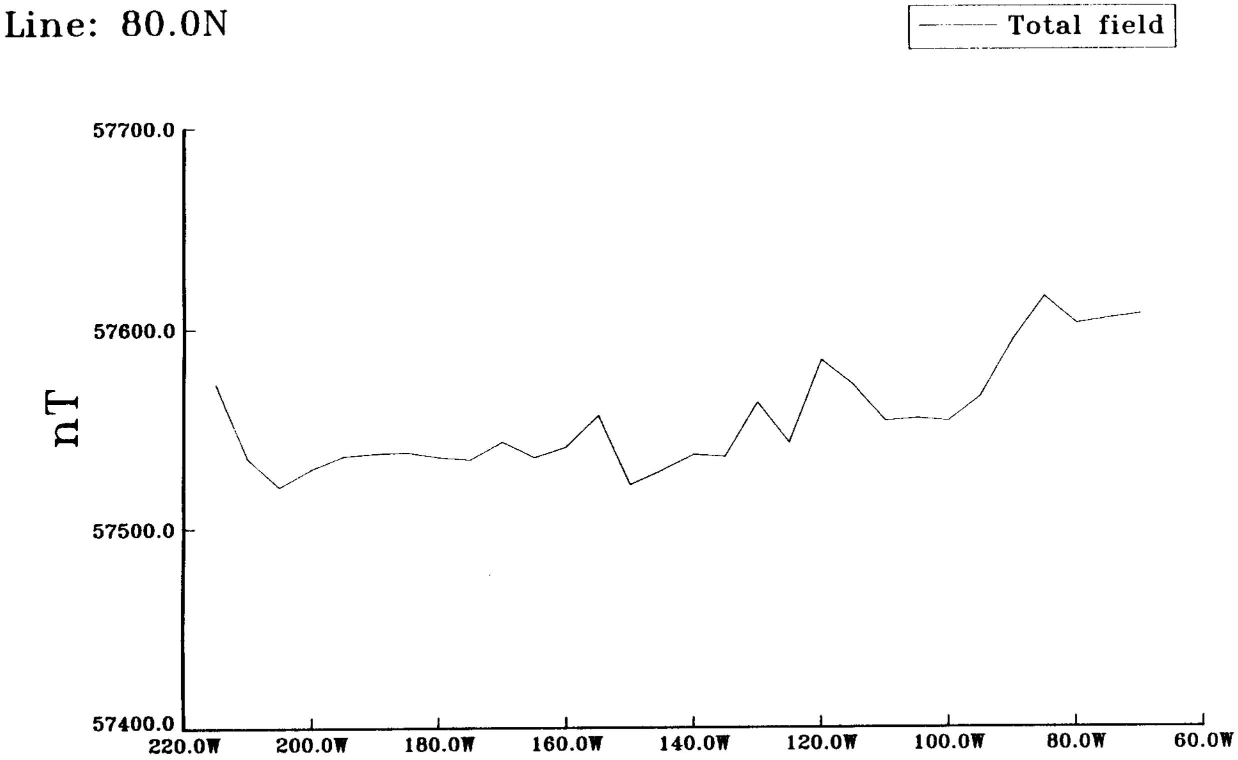
Range Road Dump	NTS:	Figure 10.
Total Magnetic Field	AMEROK GEOPHYSICS	



SENTAR
Range Road Dump
Total Magnetic Field

Scale 1: 800
06 FEB 92
NTS:
Figure 11.
AMEROK GEOPHYSICS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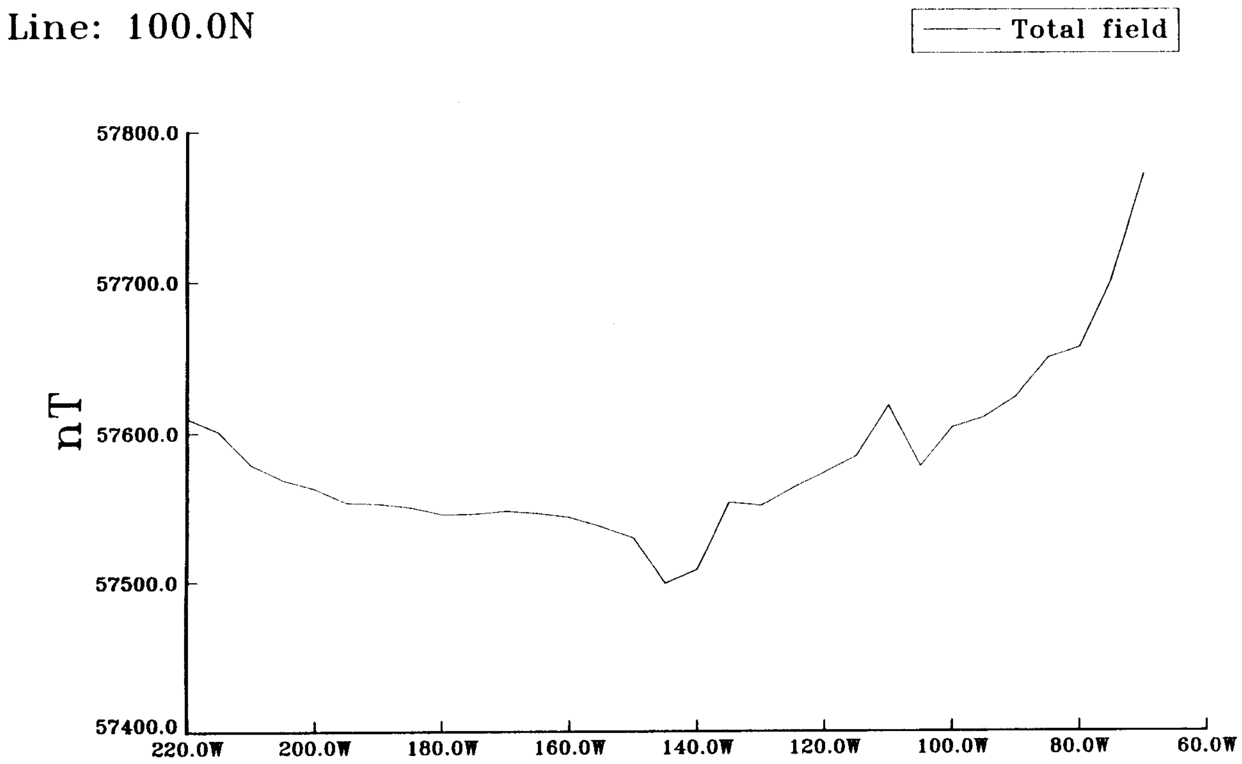
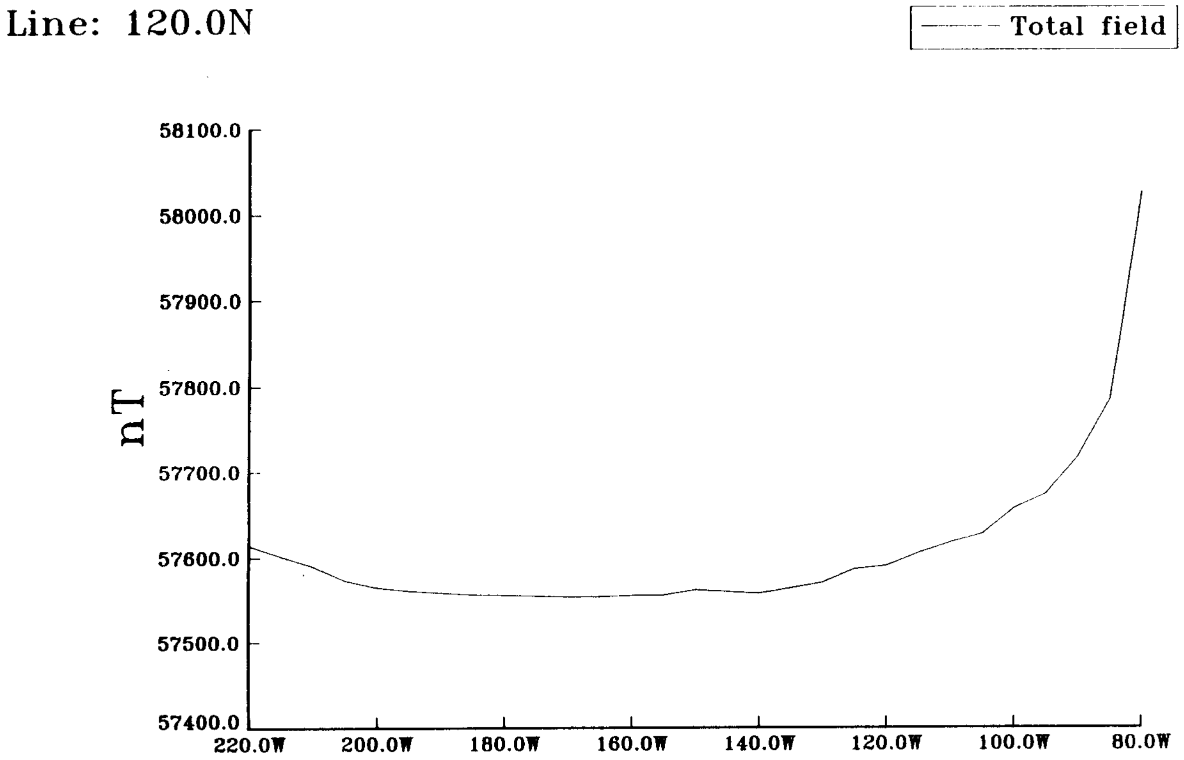
SENTAR
Range Road Dump
Total Magnetic Field

Scale 1: 800
06 FEB 92
NTS:
Figure 12.
AMEROK GEOPHYSICS

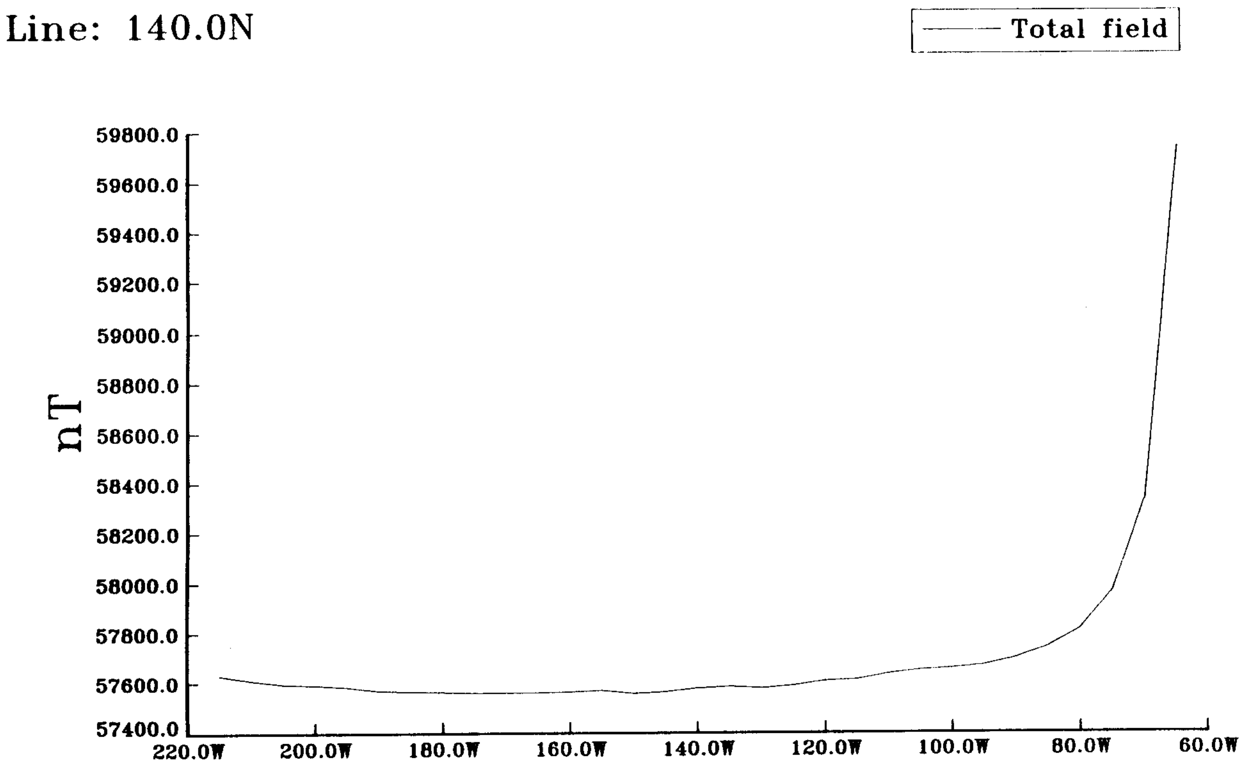


SENTAR
Range Road Dump
Total Magnetic Field

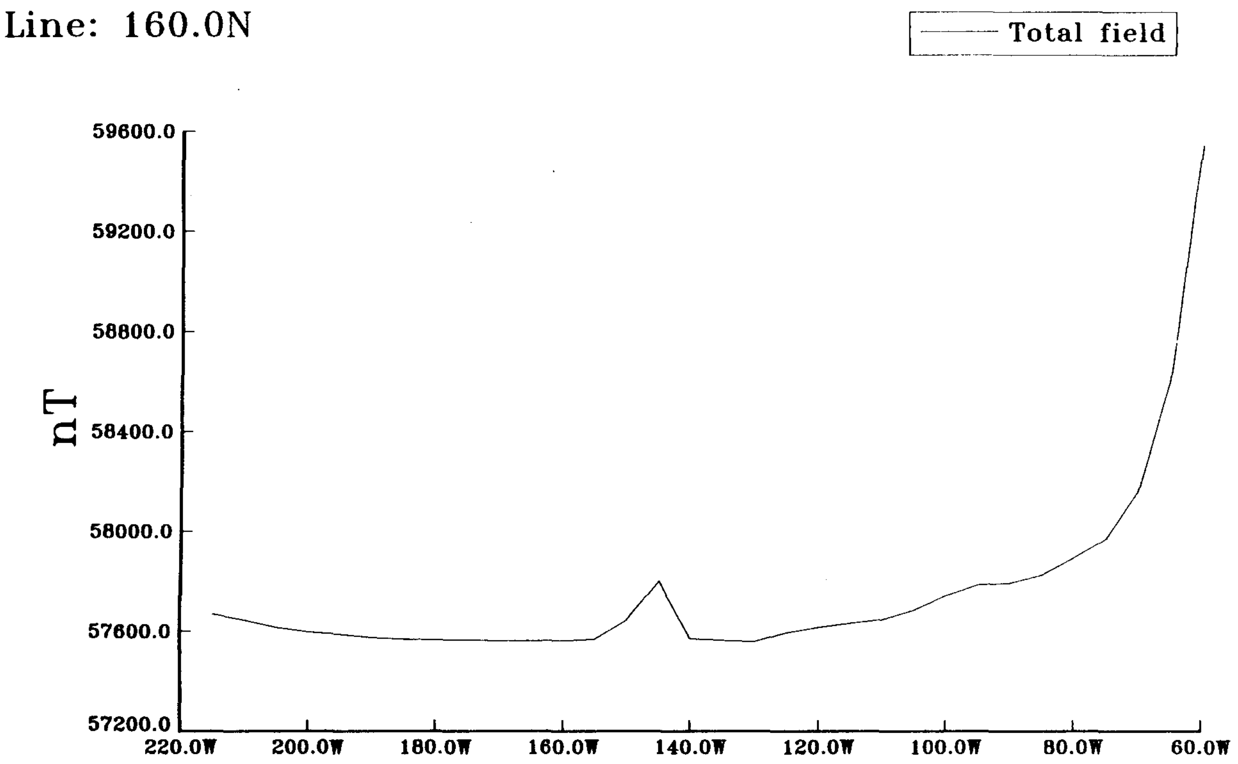
Scale 1: 800
06 FEB 92
NTS:
Figure 13.
AMEROK GEOPHYSICS



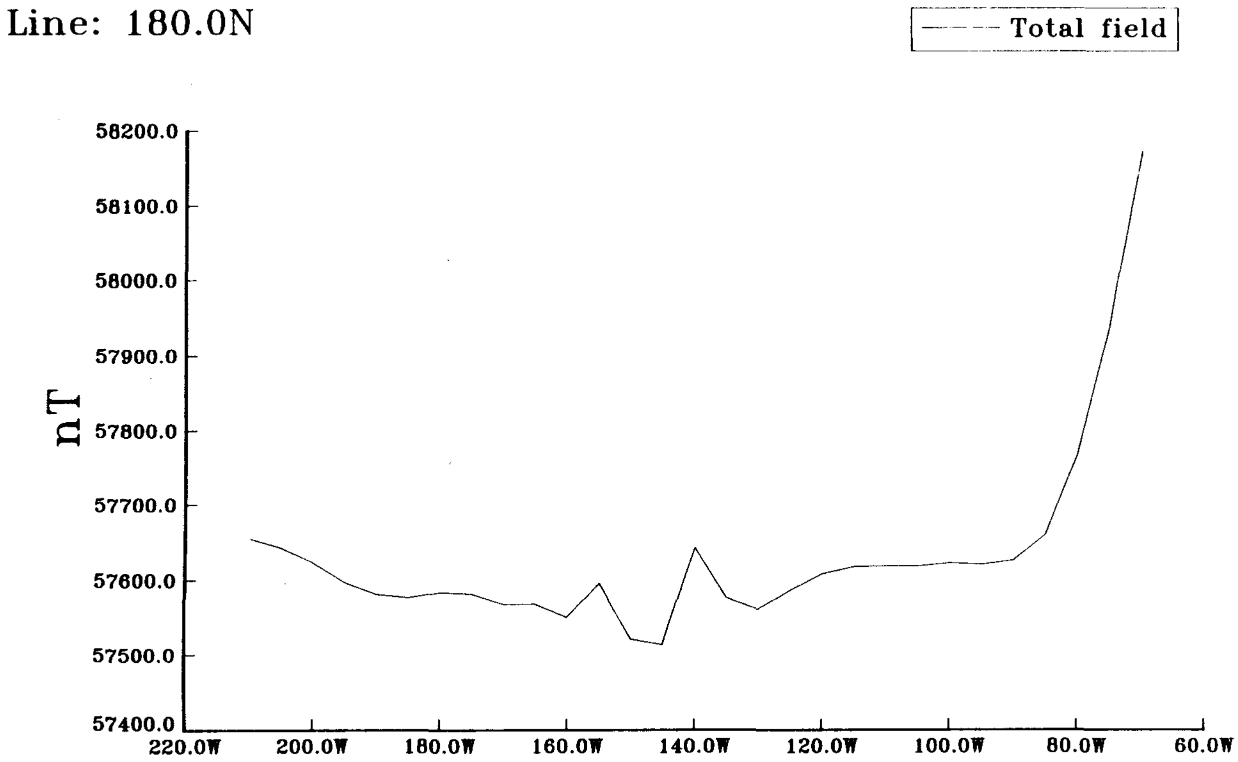
SENTAR	Scale 1: 800	06 FEB 92
Range Road Dump Total Magnetic Field	NTS:	Figure 14.
	AMEROK GEOPHYSICS	



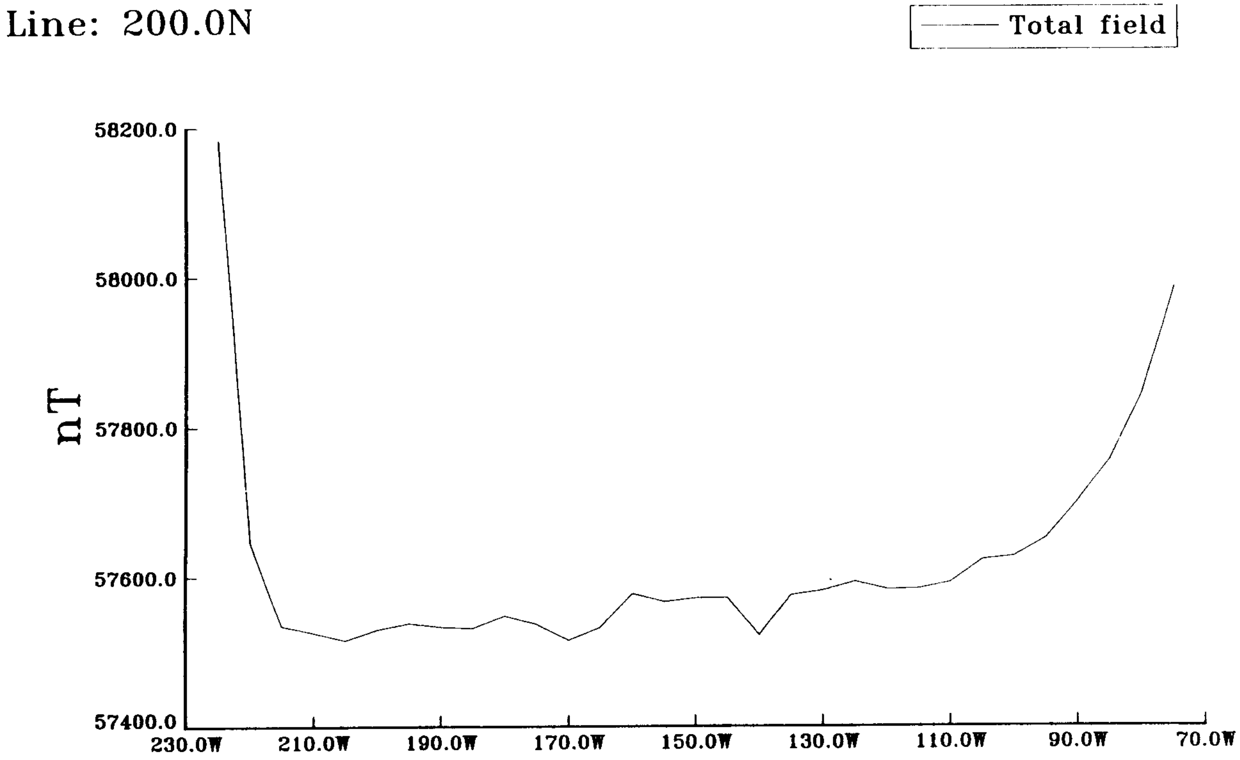
SENTAR	Scale 1: 800	06 FEB 92
Range Road Dump Total Magnetic Field	NTS:	Figure 15.
	AMEROK GEOPHYSICS	



SENTAR	Scale 1: 800	06 FEB 92
Range Road Dump	NTS:	Figure 16.
Total Magnetic Field	AMEROK GEOPHYSICS	

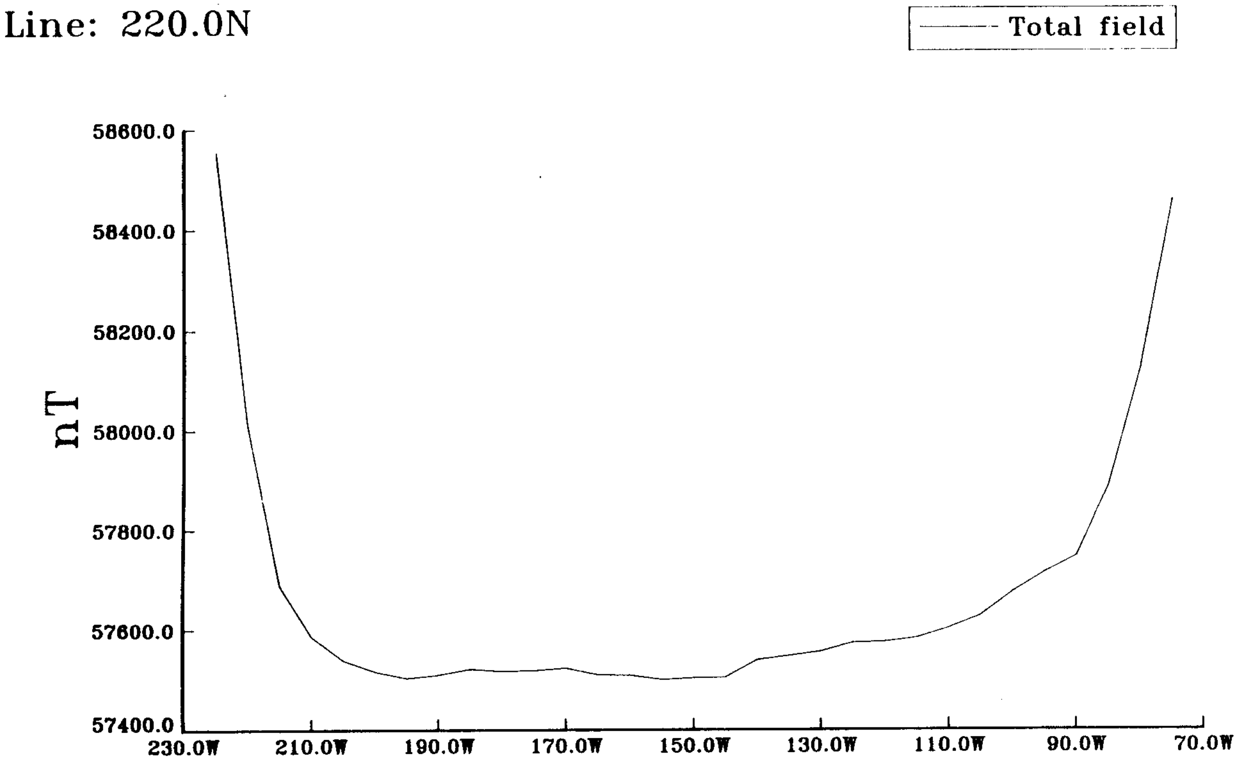


SENTAR	Scale 1: 800	06 FEB 92
Range Road Dump Total Magnetic Field	NTS:	Figure 17.
	AMEROK GEOPHYSICS	

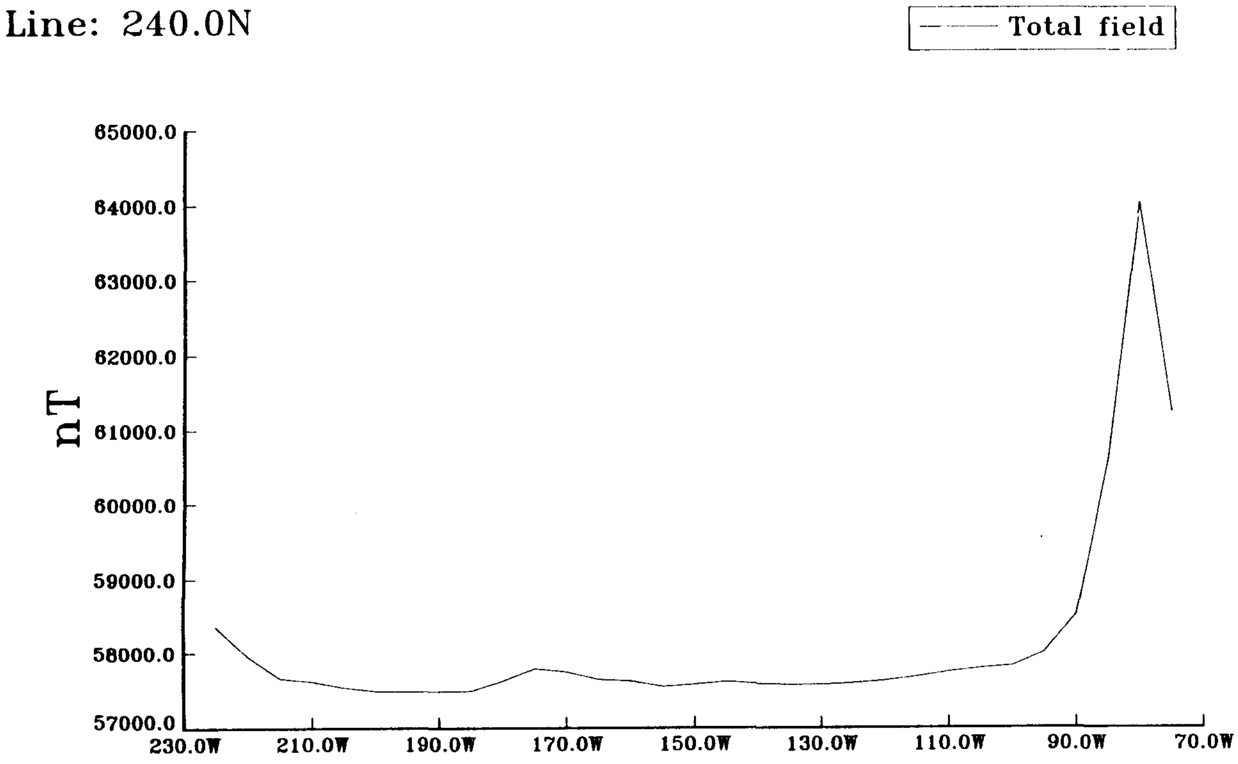


SENTAR
Range Road Dump
Total Magnetic Field

Scale 1: 800
06 FEB 92
NTS:
Figure 18.
AMEROK GEOPHYSICS

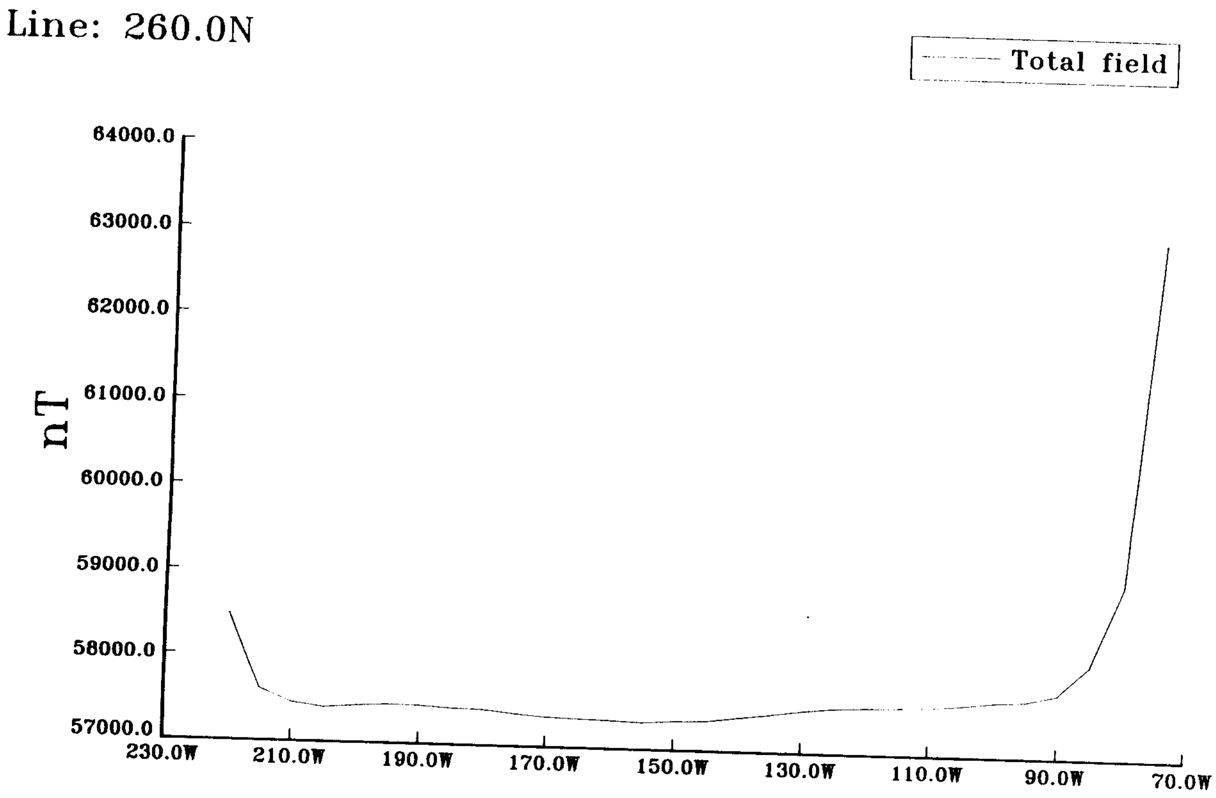


SENTAR	Scale 1: 800	06 FEB 92
Range Road Dump Total Magnetic Field	NTS:	Figure 19.
	AMEROK GEOPHYSICS	



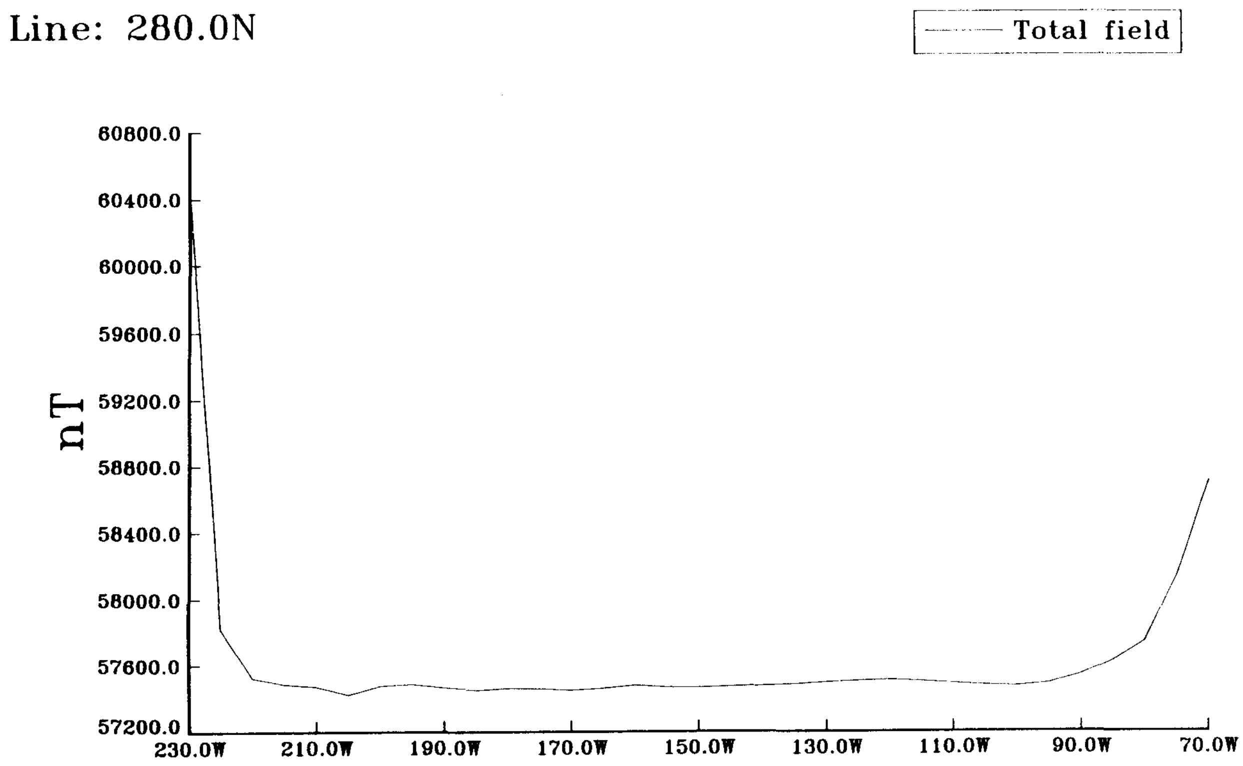
SENTAR
Range Road Dump
Total Magnetic Field

Scale 1: 800
06 FEB 92
NTS:
Figure 20.
AMEROK GEOPHYSICS

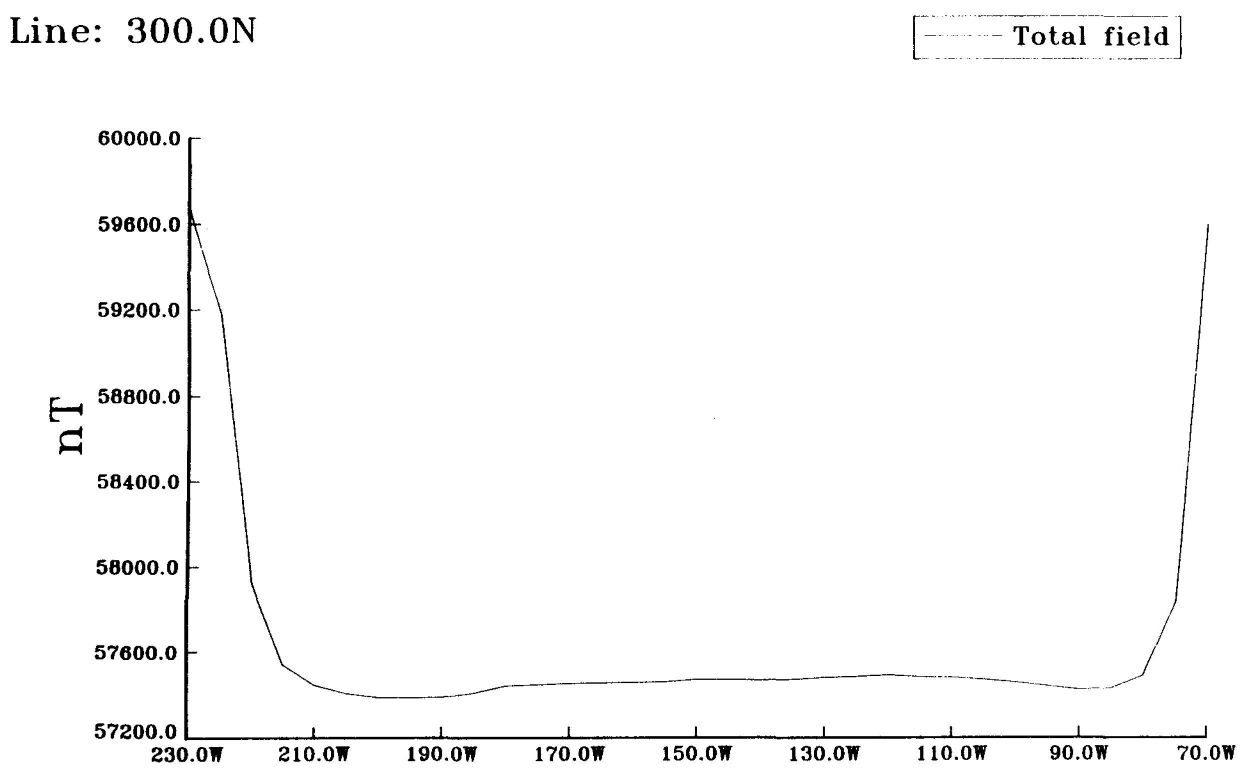


SENTAR
Range Road Dump
Total Magnetic Field

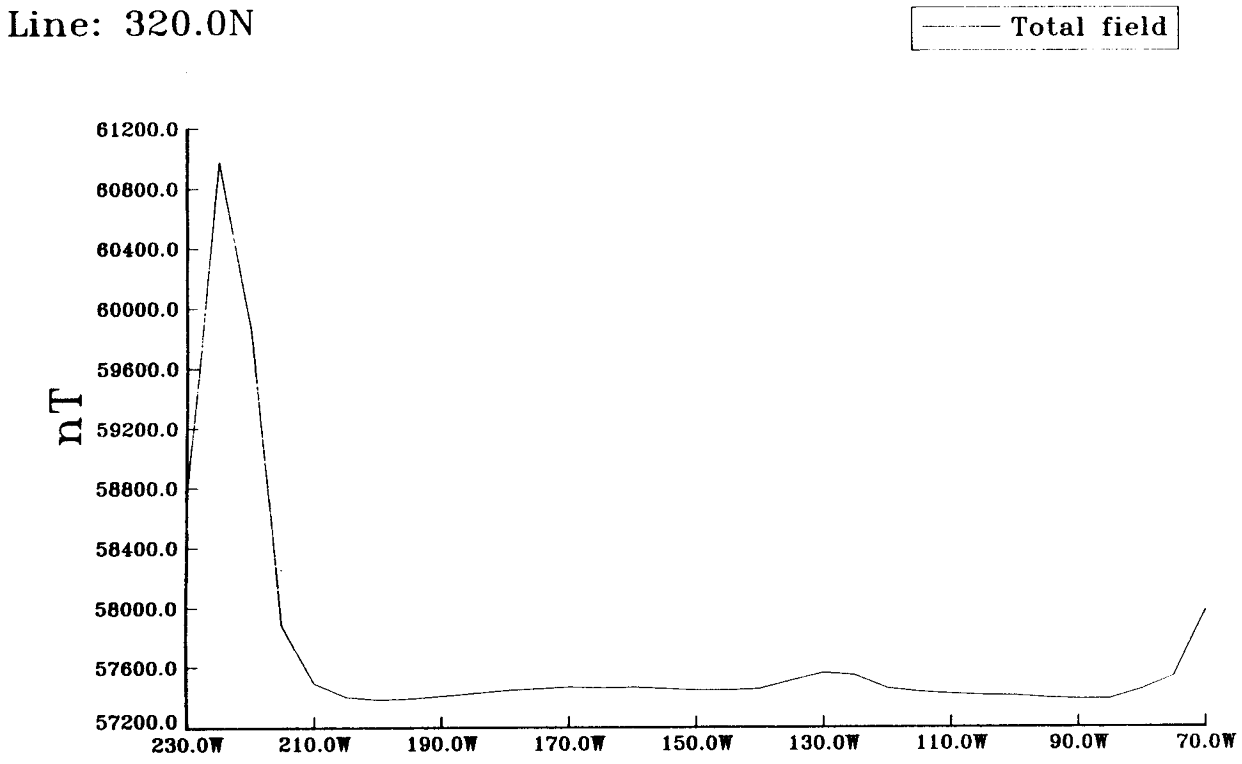
Scale 1: 800
06 FEB 92
NTS:
Figure 21.
AMEROK GEOPHYSICS



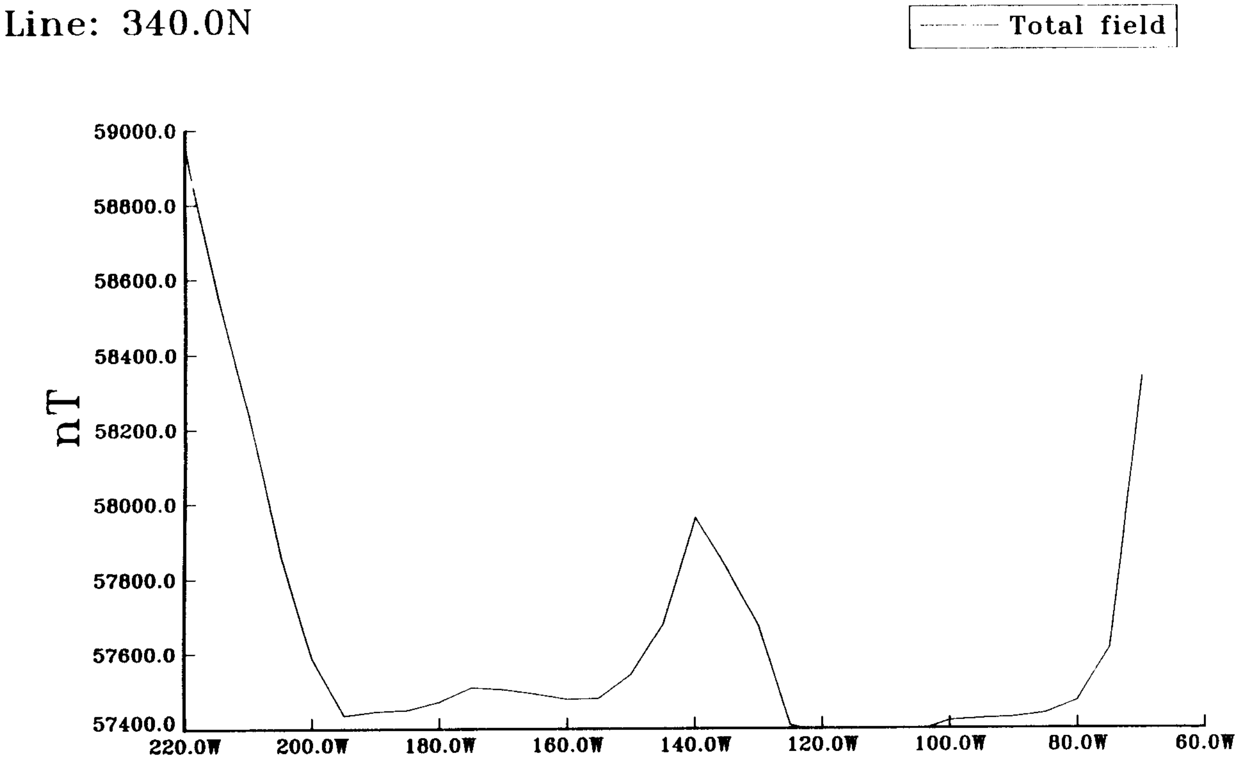
SENTAR	Scale 1: 800	06 FEB 92
Range Road Dump	NTS:	Figure 22.
Total Magnetic Field	AMEROK GEOPHYSICS	



SENTAR	Scale 1: 800	06 FEB 92
Range Road Dump	NTS:	Figure 23.
Total Magnetic Field	AMEROK GEOPHYSICS	

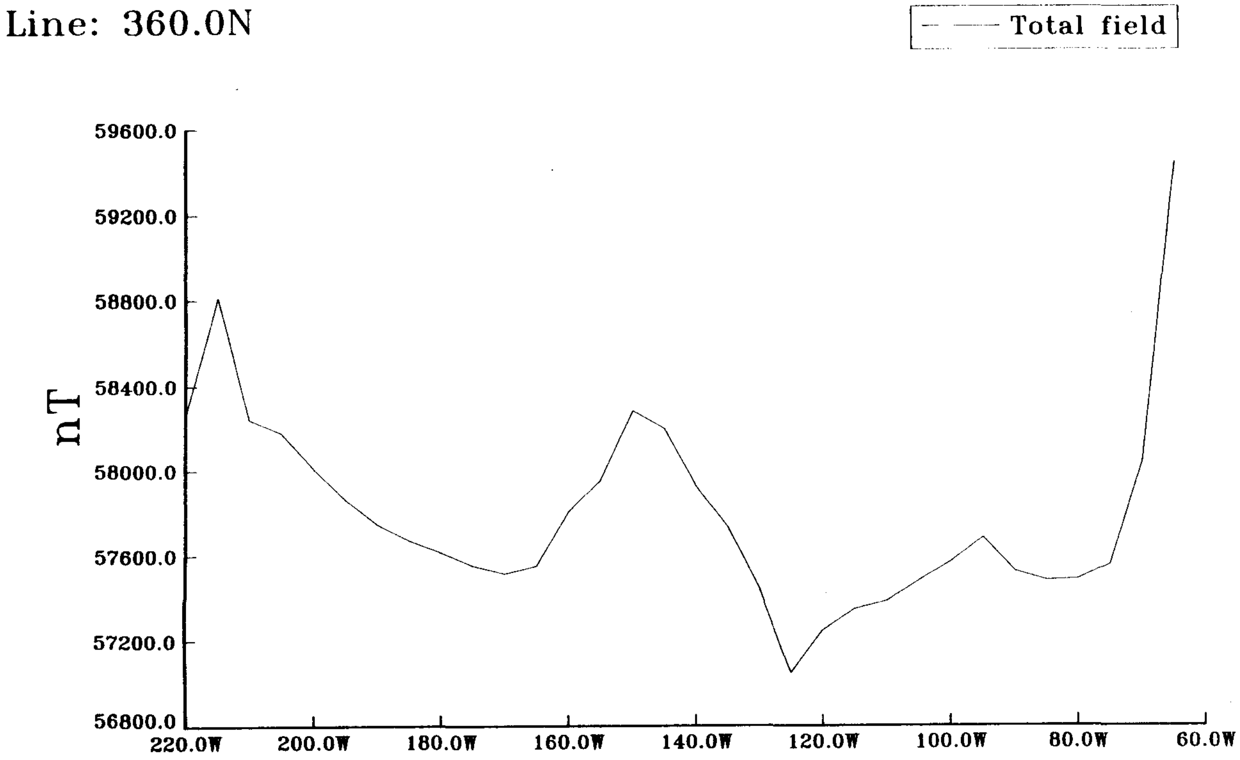


SENTAR	Scale 1: 800	06 FEB 92
Range Road Dump Total Magnetic Field	NTS:	Figure 24.
	AMEROK GEOPHYSICS	



SENTAR
Range Road Dump
Total Magnetic Field

Scale 1: 800
06 FEB 92
NTS:
Figure 25.
AMEROK GEOPHYSICS



SENTAR
Range Road Dump
Total Magnetic Field

Scale 1: 800
06 FEB 92
NTS:
Figure 26.
AMEROK GEOPHYSICS

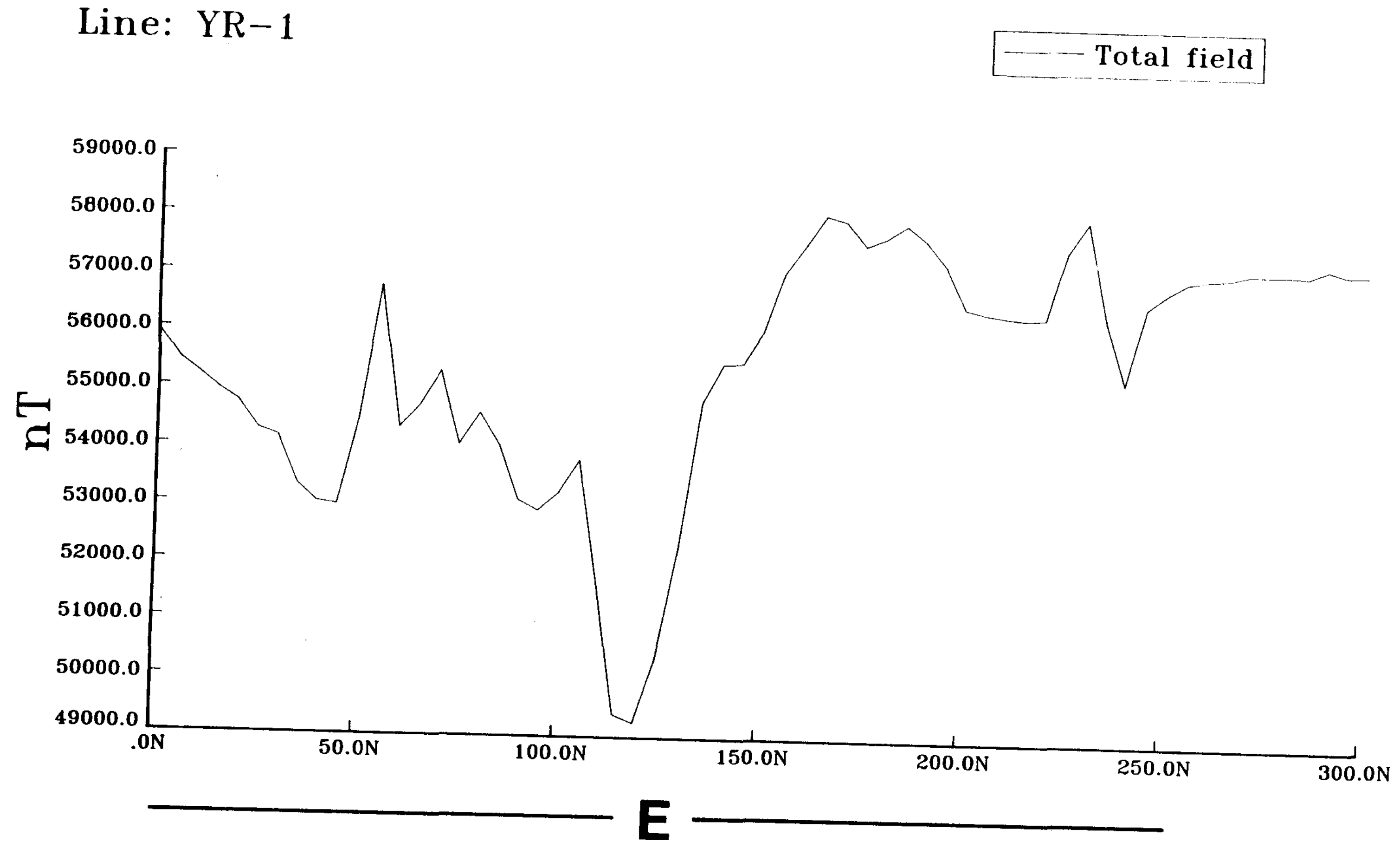


Figure 27. Total magnetic field profile: Line along Yukon River access trail

SENTAR
Range Road Dump
Total Magnetic Field

Scale 1: 900
06 FEB 92
NTS:
Figure 27.
AMEROK GEOPHYSICS

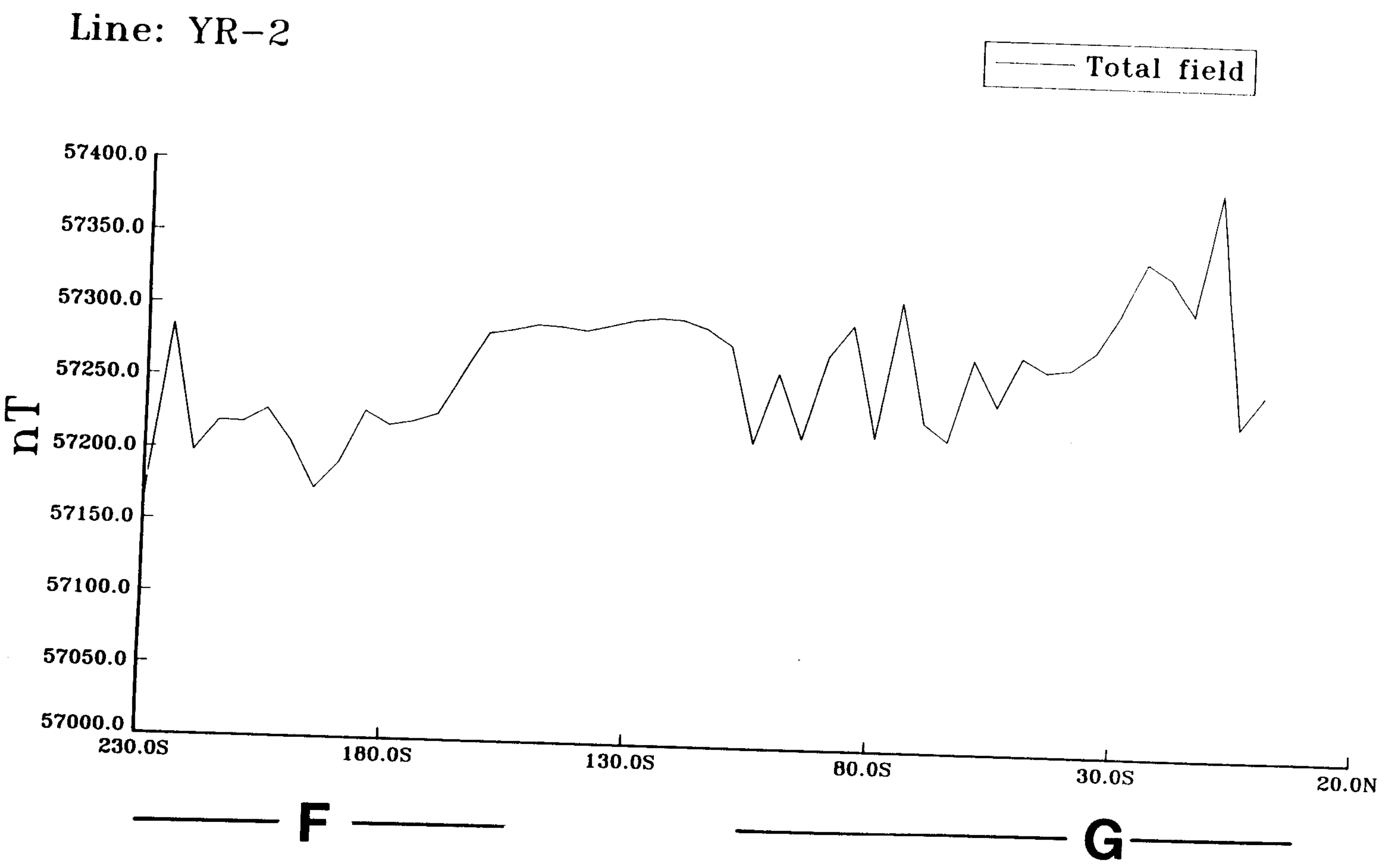


Figure 28. Total magnetic field profile: Line on Yukon River, 50 m from bank.

SENTAR Range Road Dump Total Magnetic Field	Scale 1: 1000	06 FEB 92
	NTS:	Figure 28.
	AMEROK GEOPHYSICS	

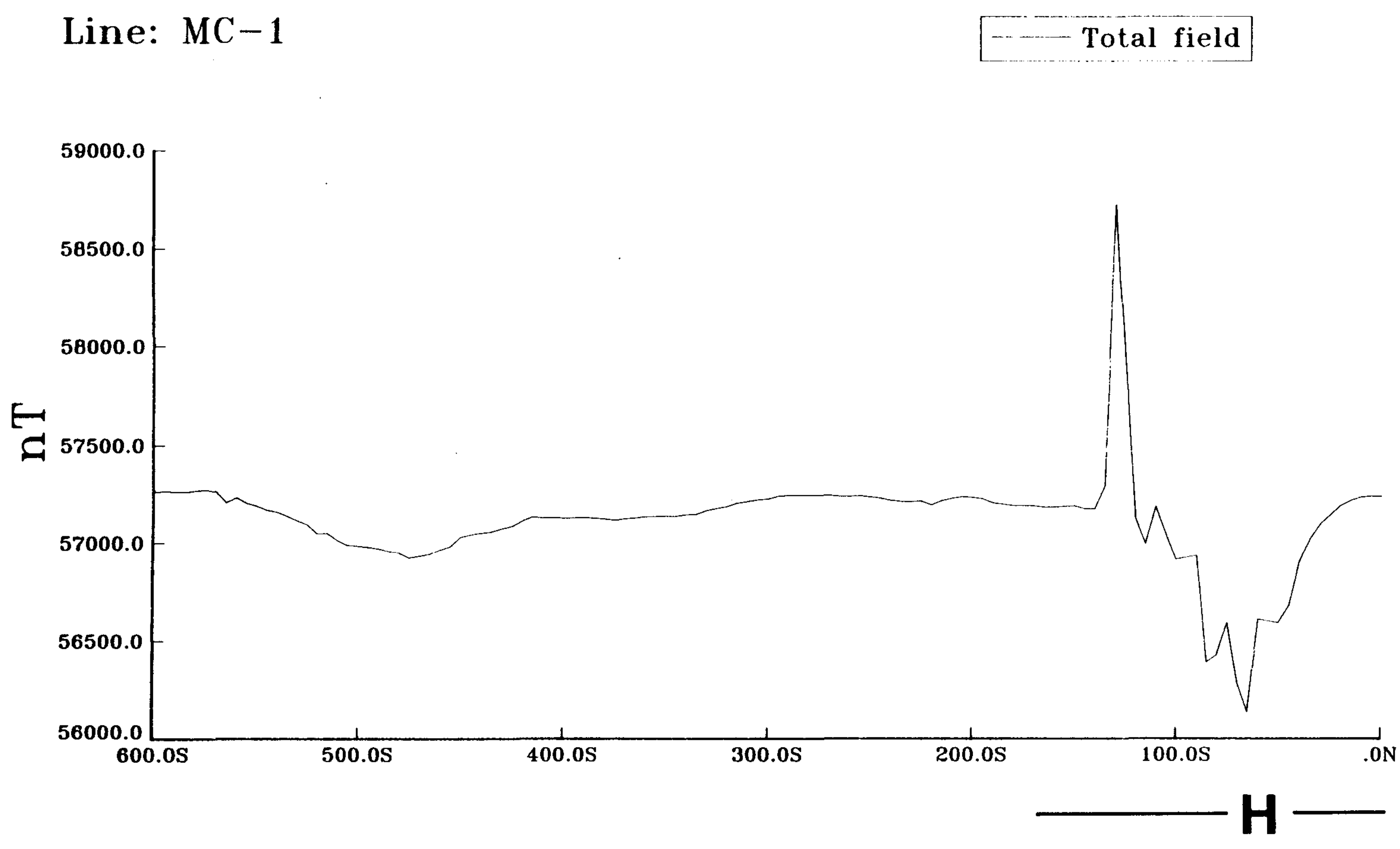


Figure 29. Total magnetic field profile: Line along McIntyre Creek on levee.

SENTAR
Range Road Dump
Total Magnetic Field

Scale 1: 2200
06 FEB 92
NTS:
Figure 29.
AMEROK GEOPHYSICS

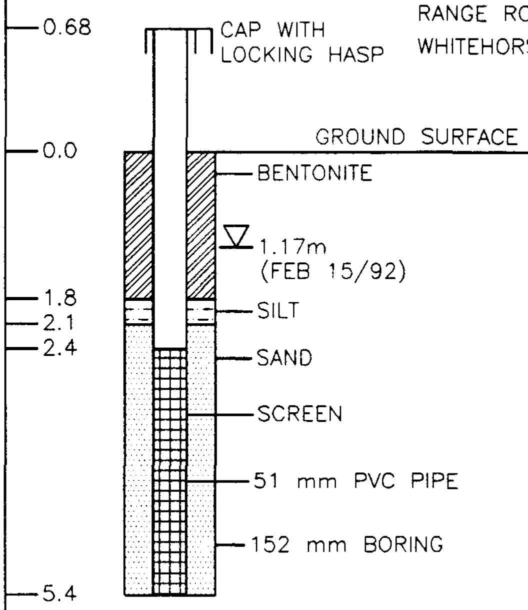
APPENDIX C

BOREHOLE LOGS

DRILL METHOD: AUGER
BY: MIDNIGHT SUN

WELL: 92-1
TYPE: MONITOR
RANGE ROAD DUMP
WHITEHORSE, YUKON

DATE COMPLETED: FEB. 10, 1992
NORTHING: 6382.64
EASTING: 5115.86
ELEVATIONS:
TOP OF CASING: 640.83
GROUND SURFACE: 640.15

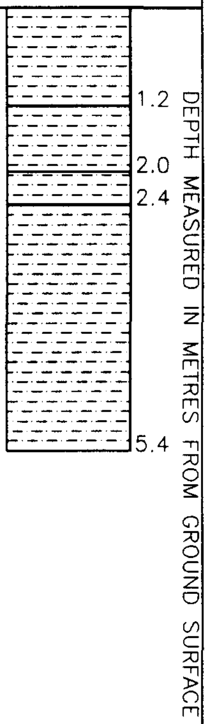


SILT, grey-brown, moist, trace of fine sand, trace of clay

SILT, higher clay content

SILT, trace of iron oxides, saturated

SILT, grey



TOTAL DEPTH = 5.4

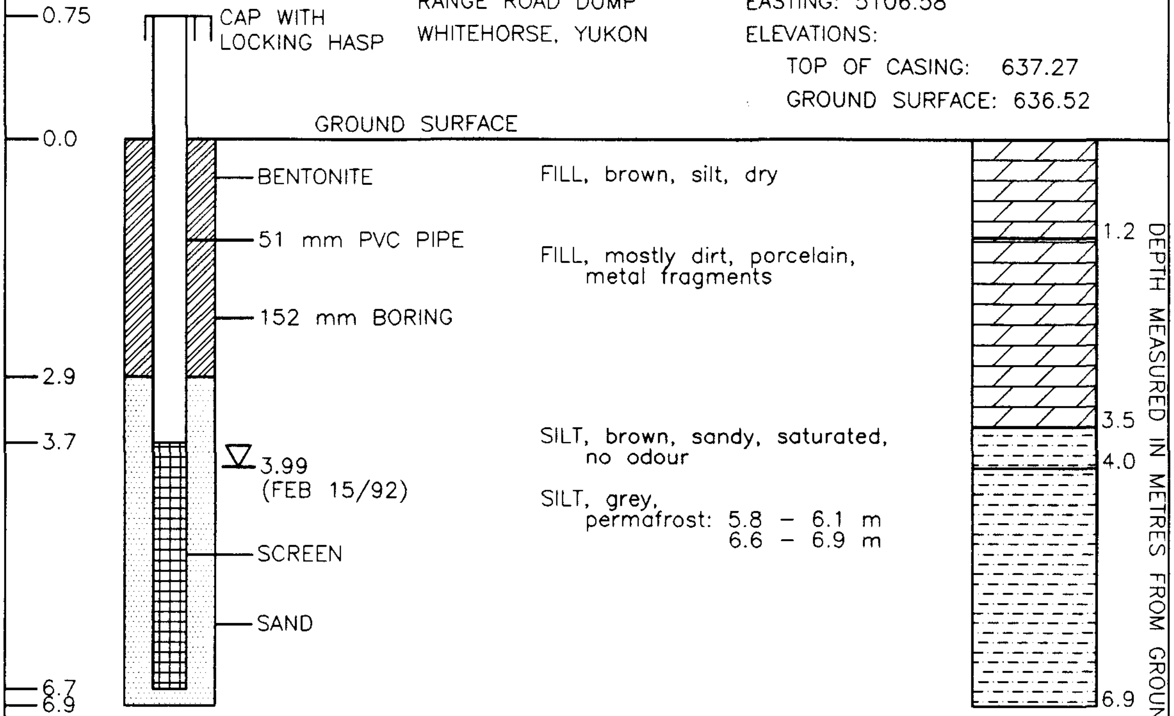
NOTES: Frost to 0.5 m.
Water at 3.7 m at completion.
Waterra pump installed.

STANLEY ASSOCIATES ENGINEERING LTD.
GEOLOGIST: R. JACKSON
MARCH 18, 1992

DRILL METHOD: AUGER
BY: MIDNIGHT SUN

WELL: 92-2
TYPE: MONITOR
RANGE ROAD DUMP
WHITEHORSE, YUKON

DATE COMPLETED: FEB. 10, 1992
NORTHING: 6523.46
EASTING: 5106.58
ELEVATIONS:
TOP OF CASING: 637.27
GROUND SURFACE: 636.52



FILL, brown, silt, dry

FILL, mostly dirt, porcelain, metal fragments

SILT, brown, sandy, saturated, no odour

SILT, grey,
permafrost: 5.8 – 6.1 m
6.6 – 6.9 m

TOTAL DEPTH = 6.9

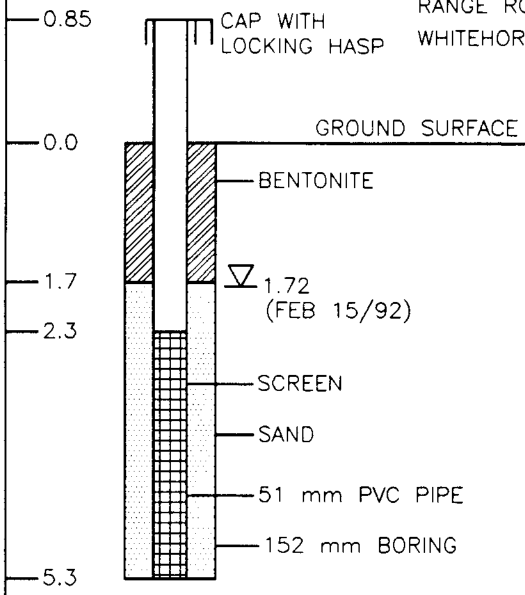
NOTES: Frost to 0.6 m.
Water and slough at 5.8 m at completion.
Waterra pump installed.

STANLEY ASSOCIATES ENGINEERING LTD.
GEOLOGIST: R. JACKSON
MARCH 18, 1992

DRILL METHOD: AUGER
BY: MIDNIGHT SUN

WELL: 92–3
TYPE: MONITOR
RANGE ROAD DUMP
WHITEHORSE, YUKON

DATE COMPLETED: FEB. 10, 1992
NORTHING: 6648.95
EASTING: 5133.03
ELEVATIONS:
TOP OF CASING: 631.95
GROUND SURFACE: 631.10

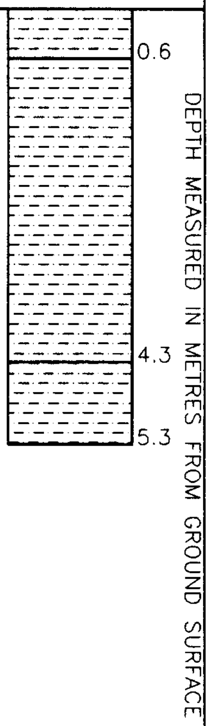


SILT, brown, sandy

SILT, grey, sandy, soft, saturated

SILT, sandier

TOTAL DEPTH = 5.3



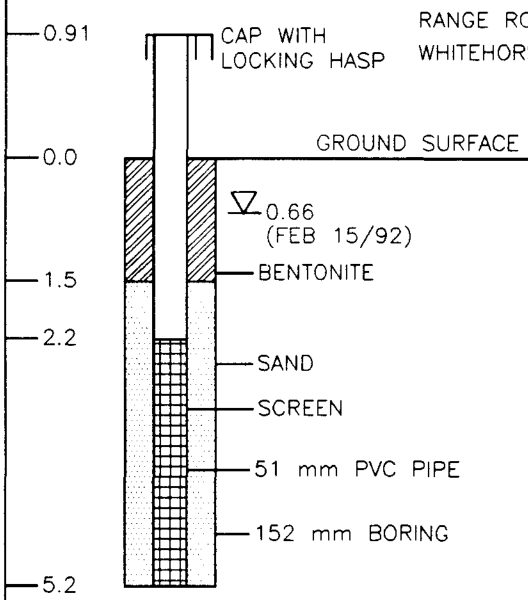
NOTES: Frost to 0.5 m.
Waterra pump installed.

STANLEY ASSOCIATES ENGINEERING LTD,
GEOLOGIST: R. JACKSON
MARCH 19, 1992

DRILL METHOD: AUGER
BY: MIDNIGHT SUN

WELL: 92-4
TYPE: MONITOR
RANGE ROAD DUMP
WHITEHORSE, YUKON

DATE COMPLETED: FEB. 10, 1992
NORTHING: 6740.97
EASTING: 5029.92
ELEVATIONS:
TOP OF CASING: 631.45
GROUND SURFACE: 630.54



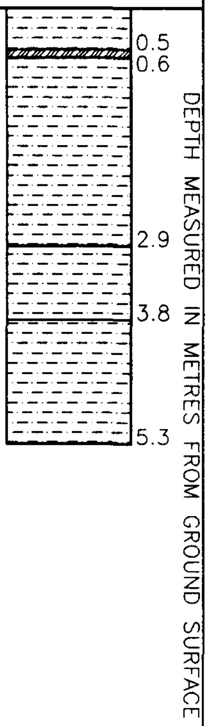
SILT, brown & grey, trace of pebbles

ORGANICS, black, peaty

SILT, brown & grey, pebbles, thin organic seams, moist to saturated

SILT, grey, very sandy, soft, saturated

SILT, grey, thin clay seams, soft



TOTAL DEPTH = 5.3

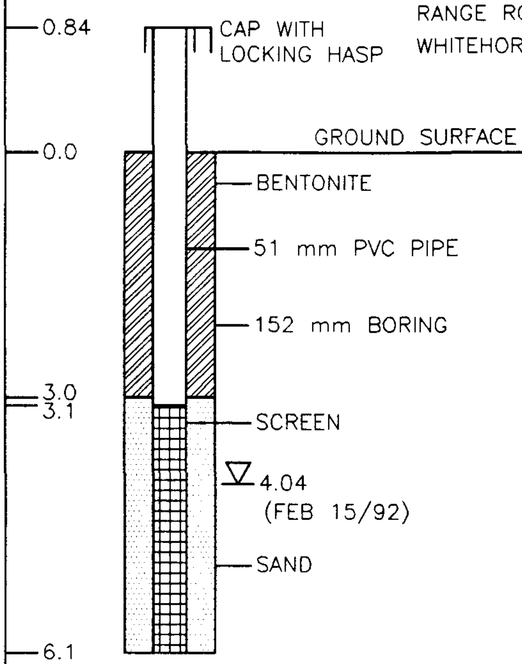
NOTES: Frost to 0.15 m.
Water at 1.5 m at completion.
Slough at 2.7 m at completion.
Waterra pump installed.

STANLEY ASSOCIATES ENGINEERING LTD.
GEOLOGIST: R. JACKSON
MARCH 19, 1992

DRILL METHOD: AUGER
BY: MIDNIGHT SUN

WELL: 92-5
TYPE: MONITOR
RANGE ROAD DUMP
WHITEHORSE, YUKON

DATE COMPLETED: FEB. 11, 1992
NORTHING: 6114.54
EASTING: 4662.09
ELEVATIONS:
TOP OF CASING: 651.31
GROUND SURFACE: 650.47



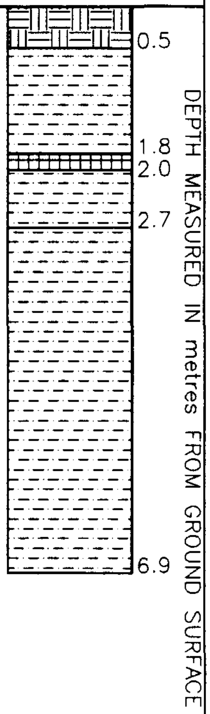
TOP SOIL, brown, silty, organics, disturbed

SILT, grey-brown, clayey, dry, compact

ASH, grey, silty clay, saturated, trace of organics

SILT, grey-brown, clayey, firm, moist to saturated

SILT, grey, thin fine sand seams, trace oxides 2.7 - 3.0, saturated



TOTAL DEPTH = 6.9

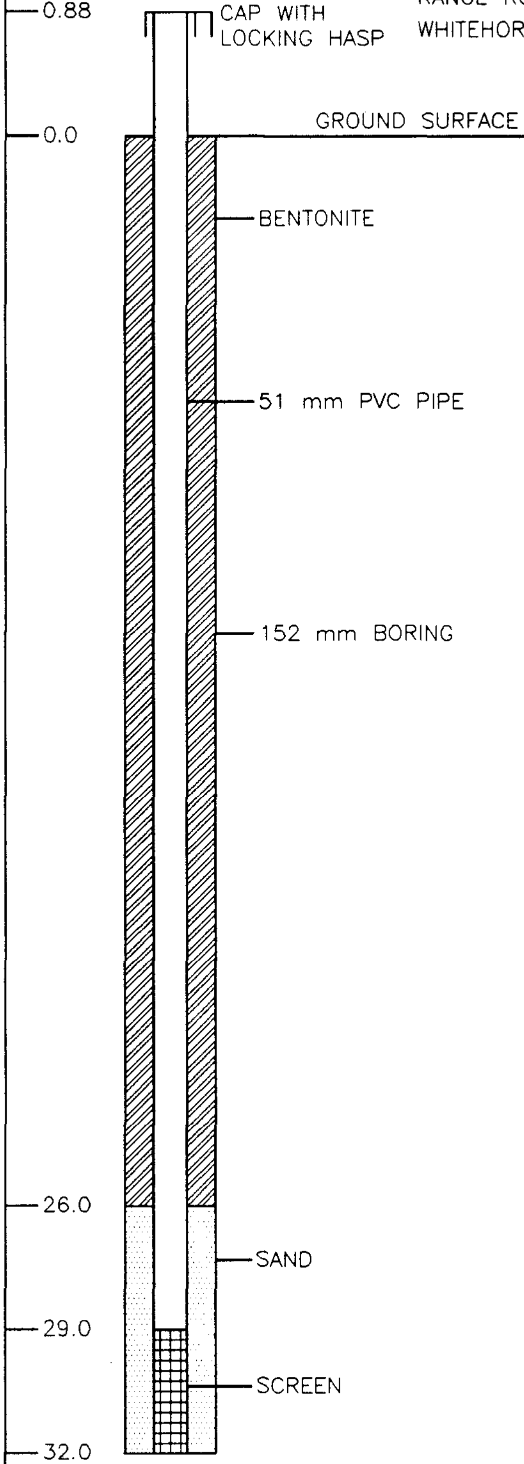
NOTES: Frost to 0.5 m.
Dry at completion.
Waterra pump installed.

STANLEY ASSOCIATES ENGINEERING LTD.
GEOLOGIST: R. JACKSON
MARCH 19, 1992

DRILL METHOD: AUGER
BY: MIDNIGHT SUN

WELL: 92-6
TYPE: MONITOR
RANGE ROAD DUMP
WHITEHORSE, YUKON

DATE COMPLETED: FEB. 11, 1992
NORTHING: 6521.80
EASTING: 4958.51
ELEVATIONS:
TOP OF CASING: 674.95
GROUND SURFACE: 674.07



SILT, brown, compact, dry–moist, alternating sandy & clayey seams

SILT, brown, permafrost

SILT, brown, thin clay & fine sand seams, clay seams are saturated, sand layers are dry

SILT, grey, clayey, saturated; a few widely spaced fine sand seams (dry)

SAND, brown, fine, silty, dry

SILT, grey–brown, clayey, saturated

SILT, grey–brown, sandy, hard, dry

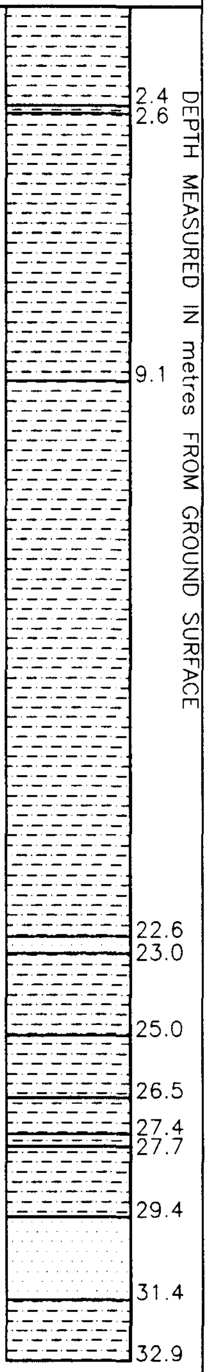
SILT, brown, sandy, saturated

SILT, brown, sand seams (dry)

SILT, grey, clayey to sandy, saturated

SAND, brown, very fine, silty, hard, dry

SILT, grey, clayey – sandy, saturated



TOTAL DEPTH = 32.9

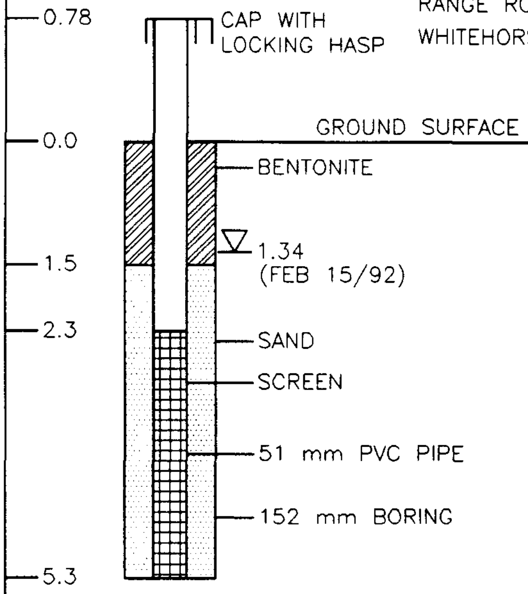
NOTE: Frost ot 0.5 m.
Dry on Feb. 15, 1992.

STANLEY ASSOCIATES ENGINEERING LTD.
GEOLOGIST: R. JACKSON
MARCH 19, 1992

DRILL METHOD: AUGER
BY: MIDNIGHT SUN

WELL: 92-7
TYPE: MONITOR
RANGE ROAD DUMP
WHITEHORSE, YUKON

DATE COMPLETED: FEB. 12, 1992
NORTHING: 6428.35
EASTING: 4828.16
ELEVATIONS:
TOP OF CASING: 714.04
GROUND SURFACE: 636.04



SILT, grey-brown, clayey, moist

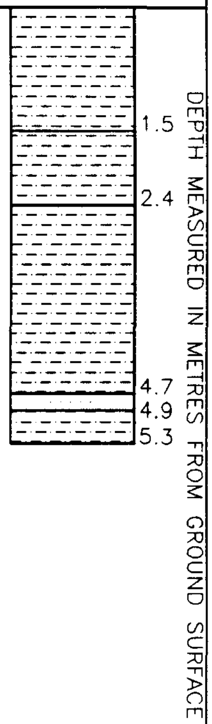
SILT, saturated

SILT, grey, sandy, a few pebbles, clayey seams, soft, saturated

SAND, brown, fine-medium, dense, saturated

SILT, grey, clayey, soft, saturated

TOTAL DEPTH = 5.3



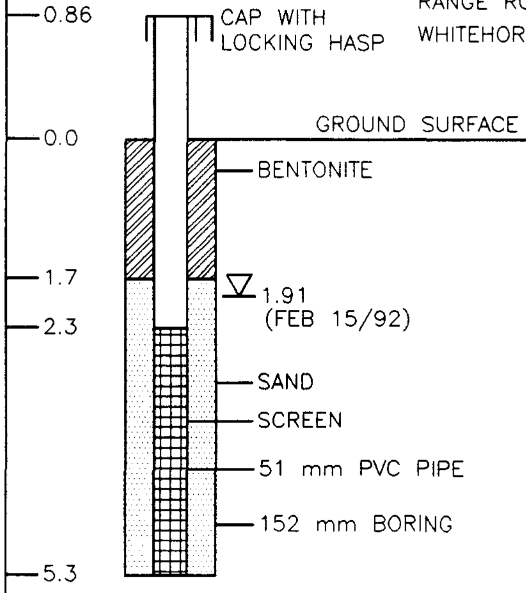
NOTES: Frost to 0.5 m.
Water at 2.7 m at completion.
Slough at 4.9 m at completion.
Waterra pump installed.

STANLEY ASSOCIATES ENGINEERING LTD.
GEOLOGIST: R. JACKSON
MARCH 26, 1992

DRILL METHOD: AUGER
BY: MIDNIGHT SUN

WELL: 92-8
TYPE: MONITOR
RANGE ROAD DUMP
WHITEHORSE, YUKON

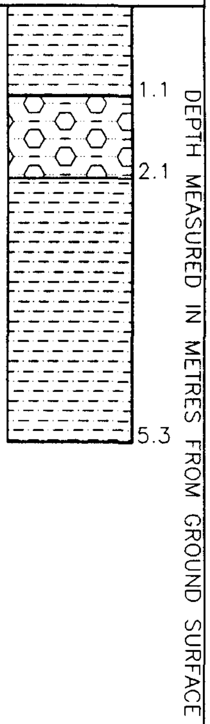
DATE COMPLETED: FEB. 12, 1992
NORTHING: 6607.34
EASTING: 4815.06
ELEVATIONS:
TOP OF CASING: 634.22
GROUND SURFACE: 633.36



SILT, brown, sandy, dry

SAND & GRAVEL, dark brown, silty sand grading to coarse sand matrix, saturated at 2 m

SILT, grey, sandy, thin clay and fine sand seams, saturated



TOTAL DEPTH = 5.3

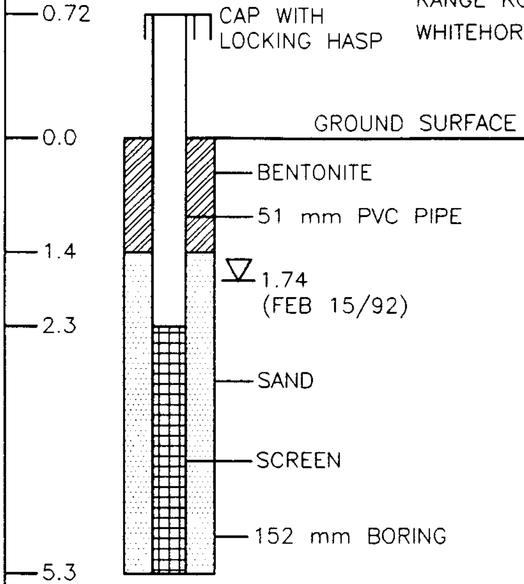
NOTES: Frost to 0.5 m.
Water at 4.9 m at completion.
Waterra pump installed.

STANLEY ASSOCIATES ENGINEERING LTD.
GEOLOGIST: R. JACKSON
MARCH 26, 1992

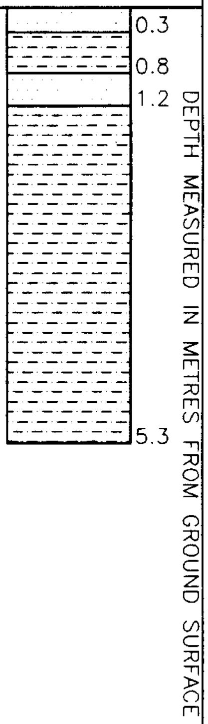
DRILL METHOD: AUGER
BY: MIDNIGHT SUN

WELL: 92-9
TYPE: MONITOR
RANGE ROAD DUMP
WHITEHORSE, YUKON

DATE COMPLETED: FEB. 12, 1992
NORTHING: 6709.87
EASTING: 4842.40
ELEVATIONS:
TOP OF CASING: 633.72
GROUND SURFACE: 633.00



SAND, dark brown, a few stones
SILT, grey-brown, clayey, soft, moist
SAND, dark brown, medium, gravelly, moist
SILT, grey, sandy, soft, clayey seams, saturated



TOTAL DEPTH = 5.3

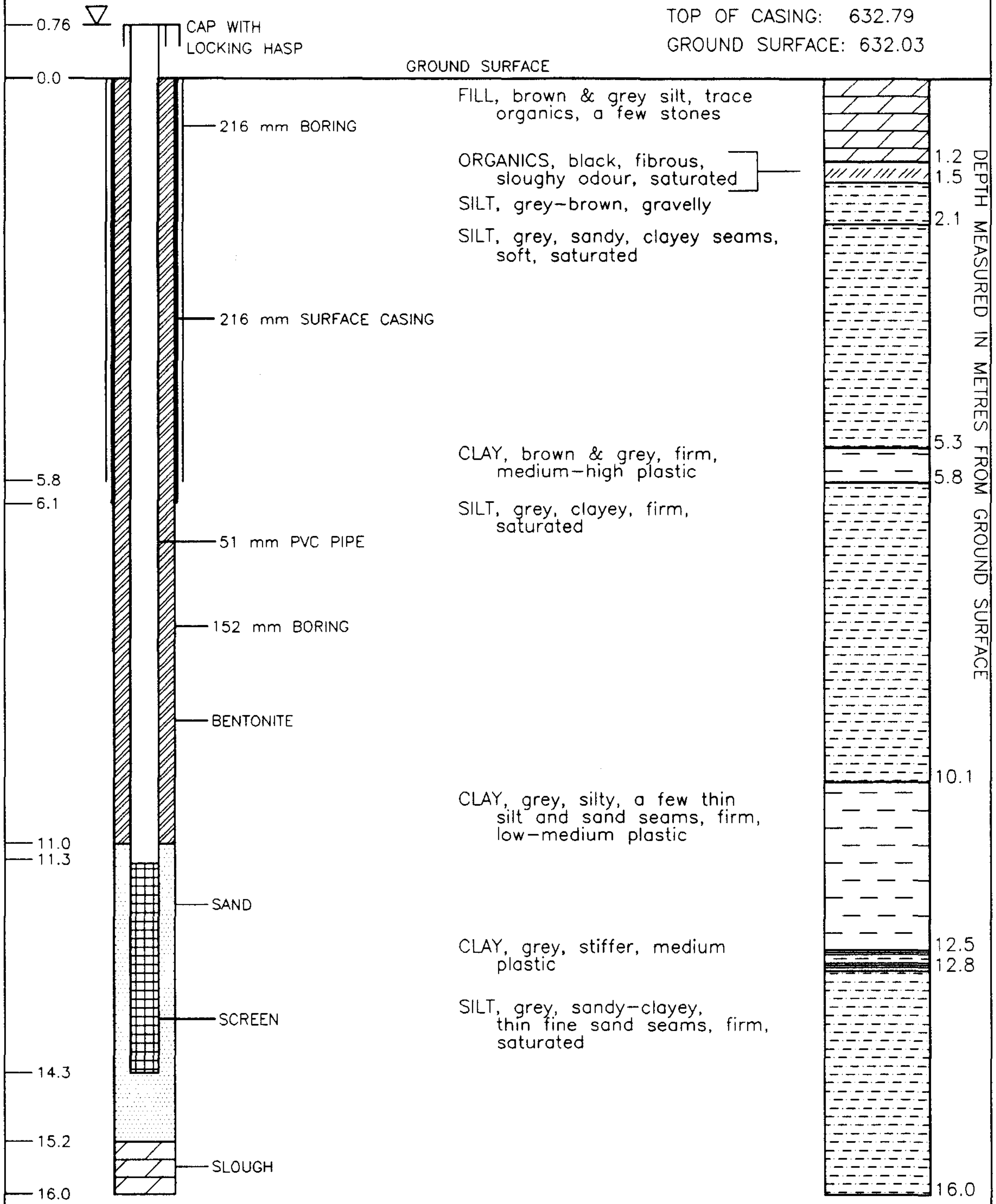
NOTES: Frost to 0.3 m.
Water at 5.0 m at completion.
Waterra pump installed.

STANLEY ASSOCIATE ENGINEERING LTD.
GEOLOGIST: R. JACKSON
MARCH 26, 1992

DRILL METHOD: AUGER
BY: MIDNIGHT SUN

WELL: 92-10A
TYPE: MONITOR
RANGE ROAD DUMP
WHITEHORSE, YUKON

DATE COMPLETED: FEB. 13, 1992
NORTHING: 6743.35
EASTING: 4931.02
ELEVATIONS:
TOP OF CASING: 632.79
GROUND SURFACE: 632.03



FILL, brown & grey silt, trace organics, a few stones

ORGANICS, black, fibrous, sloughy odour, saturated

SILT, grey-brown, gravelly

SILT, grey, sandy, clayey seams, soft, saturated

CLAY, brown & grey, firm, medium-high plastic

SILT, grey, clayey, firm, saturated

CLAY, grey, silty, a few thin silt and sand seams, firm, low-medium plastic

CLAY, grey, stiffer, medium plastic

SILT, grey, sandy-clayey, thin fine sand seams, firm, saturated

TOTAL DEPTH = 16.0

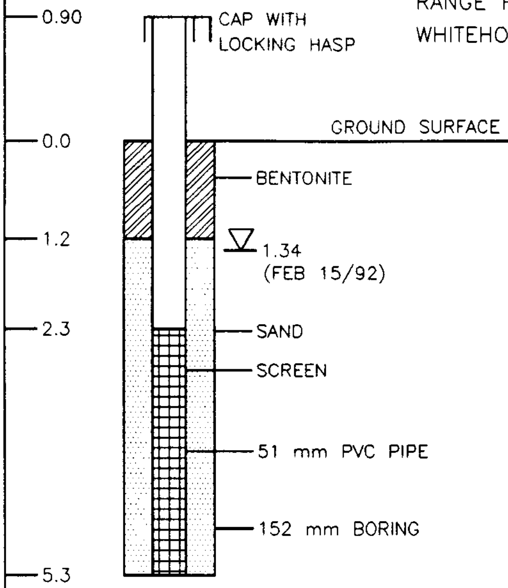
NOTES: Frost to 0.5 m.
Water at 3.7 m at completion.
Slough at 15.2 m at completion.
Waterra pump installed.
* Well was flowing on Feb. 15, 1992. *

STANLEY ASSOCIATES ENGINEERING LTD.
GEOLOGIST: R. JACKSON
MARCH 26, 1992

DRILL METHOD: AUGER
BY: MIDNIGHT SUN

WELL: 92-10B
TYPE: MONITOR
RANGE ROAD DUMP
WHITEHORSE, YUKON

DATE COMPLETED: FEB. 13, 1992
NORTHING: 6744.19
EASTING: 4927.87
ELEVATIONS:
TOP OF CASING: 633.09
GROUND SURFACE: 632.19

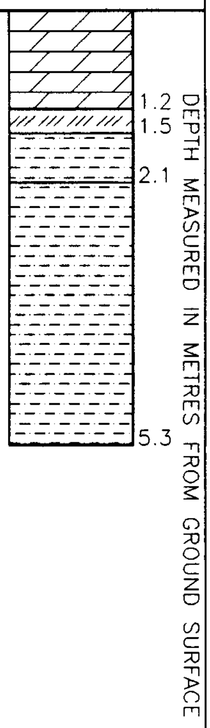


FILL, brown & grey silt, trace organics, a few stones

ORGANICS, black, fibrous, sloughy odour, saturated

SILT, grey-brown, gravelly

SILT, grey, sandy, clayey seams, soft, saturated



TOTAL DEPTH = 5.3

NOTES: Frost to 0.5 m.
Waterra pump installed.

STANLEY ASSOCIATES ENGINEERING LTD.
GEOLOGIST: R. JACKSON
MARCH 26, 1992

DRILL METHOD: AUGER
BY: MIDNIGHT SUN

WELL: TH-1
TYPE: TEST HOLE
RANGE ROAD DUMP
WHITEHORSE, YUKON

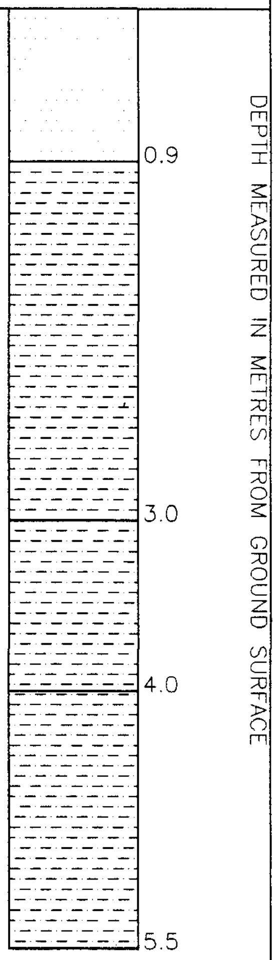
DATE COMPLETED: FEB. 11, 1992
NORTHING: 6285.25
EASTING: 4990.70
ELEVATIONS:
GROUND SURFACE: 678.14

SAND, brown, fine-medium, silty, dry

SILT, brown, compact, slightly moist to moist

SILT, thin saturated seams with dry sandier lenses in between

SILT, brown, saturated, thin clay seams, trace oxides



TOTAL DEPTH = 5.5

NOTE: TEST HOLE SEALED AND ABANDONED.

STANLEY ASSOCIATES ENGINEERING LTD.
GEOLOGIST: R. JACKSON
MARCH 26, 1992

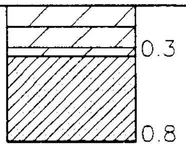
DRILL METHOD: AUGER
BY: MIDNIGHT SUN

WELL: TH-2
TYPE: TEST HOLE
RANGE ROAD DUMP
WHITEHORSE, YUKON

DATE COMPLETED: FEB. 12, 1992
NORTHING: 6582.36
EASTING: 4989.78
ELEVATIONS:
GROUND SURFACE: 674.55

FILL, brown, silt

FILL, metal, concrete;
bit refusal



TOTAL DEPTH = 0.8

DEPTH MEASURED IN METRES FROM GROUND SURFACE

NOTES: Frost to 0.3 m.
Test hole sealed and abandoned.

STANLEY ASSOCIATES ENGINEERING LTD.
GEOLOGIST: R. JACKSON
MARCH 30, 1992

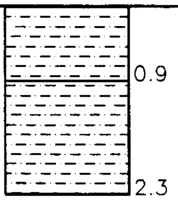
DRILL METHOD: AUGER
BY: MIDNIGHT SUN

WELL: TH-3
TYPE: TEST HOLE
RANGE ROAD DUMP
WHITEHORSE, YUKON

DATE COMPLETED: FEB. 12, 1992
NORTHING: 6478.20
EASTING: 4956.95
ELEVATIONS:
GROUND SURFACE: 674.05

SILT, brown, small pieces of rusted metal in upper 0.15 m.

SILT, brown, clayey, very moist



TOTAL DEPTH = 2.3

DEPTH MEASURED IN METRES FROM GROUND SURFACE

NOTES: Frost to 0.3 m.
Test hole sealed and abandoned.

STANLEY ASSOCIATES ENGINEERING LTD.
GEOLOGIST: R. JACKSON
MARCH 30, 1992

DRILL METHOD: AUGER
BY: MIDNIGHT SUN

WELL: TH-4
TYPE: TEST HOLE
RANGE ROAD DUMP
WHITEHORSE, YUKON

DATE COMPLETED: FEB. 12, 1992
NORTHING: 6406.37
EASTING: 5009.17
ELEVATIONS:
GROUND SURFACE: 677.98

SAND, brown, fine–medium, silty

SILT, brown, clayey, very moist
SAND, brown, very fine, silty, dry
SILT, brown, clayey, very moist

TOTAL DEPTH = 2.3

NOTES: TEST HOLE SEALED AND ABANDONED.

STANLEY ASSOCIATES ENGINEERING LTD.
GEOLOGIST: R JACKSON
MARCH 30, 1992

DRILL METHOD: AUGER
BY: MIDNIGHT SUN

WELL: TH-5
TYPE: TEST HOLE
RANGE ROAD DUMP
WHITEHORSE, YUKON

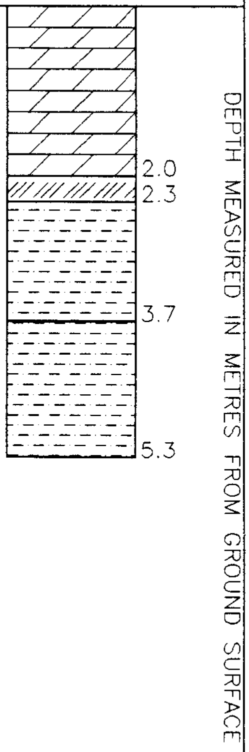
DATE COMPLETED: FEB. 12, 1992
NORTHING: 6730.70
EASTING: 4874.67
ELEVATIONS:
GROUND SURFACE: 632.40

FILL, brown & gry silt, a few stones, trace organics, firm

ORGANICS, black, fibrous, sloughy odour, very moist

SILT, grey-brown, clayey, sandy seams, soft, saturated

SILT, grey



TOTAL DEPTH = 5.3

NOTES: TEST HOLE SEALED AND ABANDONED.

STANLEY ASSOCIATES ENGINEERING LTD.
GEOLOGIST: R. JACKSON
MARCH 30, 1992

DRILL METHOD: AUGER
BY: MIDNIGHT SUN

WELL: TH-6
TYPE: TEST HOLE
RANGE ROAD DUMP
WHITEHORSE, YUKON

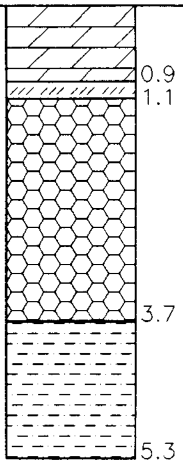
DATE COMPLETED: FEB. 13, 1992
NORTHING: 6612.57
EASTING: 4790.08
ELEVATIONS:
GROUND SURFACE: 634.71

FILL, brown, silt, stoney, wood chunks

PEAT, brown, fibrous, dry

GRAVEL, grey-brown, silt matrix, dry

SILT, grey, sandy, thin clay and sand seams, soft, saturated



DEPTH MEASURED IN METRES FROM GROUND SURFACE

TOTAL DEPTH = 5.3

NOTES: Frost to 0.15 m.
Test hole sealed and abandoned.

STANLEY ASSOCIATES ENGINEERING LTD.
GEOLOGIST: R. JACKSON
MARCH 30, 1992

APPENDIX D

HYDRAULIC CONDUCTIVITY CALCULATIONS

RR 92-1

TIME (seconds)	WATER LEVEL (meters)	DRAWDOWN (meters)	H/HO
30	3.71	2.54	.9236364
60	3.48	2.31	.84
120	3.08	1.91	.6945455
180	2.87	1.70	.6181818
240	2.76	1.59	.5781818
360	2.48	1.31	.4763637
480	2.18	1.01	.3672728
600	1.98	0.81	.2945455

UNCONFINED AQUIFER

K = 0.7E-04 cm/sec
= 1.4 gpd/ft2
= 0.2E-05 ft/sec
= 0.2 ft/day

REGRESSION COEFFICIENT = -.9950146

RR 92-2

TIME (seconds)	WATER LEVEL (meters)	DRAWDOWN (meters)	H/HO
30	5.86	1.86	.9687501
90	5.74	1.74	.9062498
150	5.62	1.62	.8437499
300	5.47	1.47	.7656249
600	5.22	1.22	.6354165
900	5.04	1.04	.5416666
2340	4.65	0.65	.3385417
3720	4.58	0.58	.3020833

UNCONFINED AQUIFER

K = 0.1E-04 cm/sec
= 0.2 gpd/ft2
= 0.4E-06 ft/sec
= 0.0 ft/day

REGRESSION COEFFICIENT = -.9556282

RR 92-3

TIME (seconds)	WATER LEVEL (meters)	DRAWDOWN (meters)	H/HO
30	3.59	1.87	.8657407
60	3.32	1.60	.7407407
90	3.06	1.34	.6203703
120	2.84	1.12	.5185185
150	2.66	0.94	.4351852
180	2.57	0.85	.3935185
210	2.49	0.77	.3564815
240	2.39	0.67	.3101852
300	2.33	0.61	.2824074

UNCONFINED AQUIFER

K = 0.2E-03 cm/sec
= 3.5 gpd/ft2
= 0.5E-05 ft/sec
= 0.5 ft/day

REGRESSION COEFFICIENT = -.982878

RR 92-4

TIME (seconds)	WATER LEVEL (meters)	DRAWDOWN (meters)	H/HO
15	3.66	3.00	.9202454
30	3.3	2.64	.8098159
45	3.02	2.36	.7239264
60	2.74	2.08	.6380368
90	2.21	1.55	.4754601
105	2	1.34	.4110429
120	1.76	1.10	.3374233
135	1.59	0.93	.2852761
150	1.42	0.76	.2331288
165	1.28	0.62	.190184
180	1.15	0.49	.1503067
195	1.06	0.40	.1226994
210	.98	0.32	9.815951E-02

UNCONFINED AQUIFER

K = 0.4E-03 cm/sec
= 9.3 gpd/ft2
= 0.1E-04 ft/sec
= 1.2 ft/day

REGRESSION COEFFICIENT = -.9941039

RR 92-5

TIME (seconds)	WATER LEVEL (meters)	DRAWDOWN (meters)	H/H0
60	5.38	1.34	.8427673
120	5.25	1.21	.7610063
180	5.15	1.11	.6981132
300	5.03	0.99	.6226416
420	4.95	0.91	.5723269
600	4.86	0.82	.5157234
900	4.75	0.71	.4465409
1500	4.58	0.54	.3396226

UNCONFINED AQUIFER

K = 0.2E-04 cm/sec
= 0.5 gpd/ft2
= 0.8E-06 ft/sec
= 0.1 ft/day

REGRESSION COEFFICIENT = -.9771825

RR 92-7

TIME (seconds)	WATER LEVEL (meters)	DRAWDOWN (meters)	H/H0
30	4.2	3.00	.9433961
60	4.08	2.88	.9056603
90	3.98	2.78	.8742138
120	3.91	2.71	.8522012
180	3.76	2.56	.8050315
240	3.65	2.45	.7704403
360	3.45	2.25	.7075471
600	3.14	1.94	.6100629
900	2.83	1.63	.5125786
1620	2.43	1.23	.3867925

UNCONFINED AQUIFER

K = 0.2E-04 cm/sec
= 0.5 gpd/ft2
= 0.7E-06 ft/sec
= 0.1 ft/day

REGRESSION COEFFICIENT = -.9873562

RR 92-8

TIME (seconds)	WATER LEVEL (meters)	DRAWDOWN (meters)	H/HO
30	4.48	2.56	.9446494
60	4.36	2.44	.900369
90	4.23	2.31	.8523985
120	4.11	2.19	.8081181
150	4	2.08	.7675276
180	3.9	1.98	.7306274
240	3.73	1.81	.6678967
360	3.5	1.58	.5830258
480	3.36	1.44	.5313653
600	3.23	1.31	.4833949
900	3	1.08	.398524
1200	2.76	0.84	.3099631

UNCONFINED AQUIFER

K = 0.4E-04 cm/sec
= 0.8 gpd/ft2
= 0.1E-05 ft/sec
= 0.1 ft/day

REGRESSION COEFFICIENT = -.9850751

RR 92-9

TIME (seconds)	WATER LEVEL (meters)	DRAWDOWN (meters)	H/HO
30	4.43	2.69	.914966
60	4.22	2.48	.8435374
90	4.03	2.29	.7789117
120	3.88	2.14	.7278913
150	3.76	2.02	.6870748
180	3.65	1.91	.64966
240	3.5	1.76	.5986395
300	3.41	1.67	.5680273
360	3.32	1.58	.537415
480	3.22	1.48	.5034014
600	3.1	1.36	.4625851
900	2.93	1.19	.404762
1380	2.69	0.95	.3231293

UNCONFINED AQUIFER

K = 0.3E-04 cm/sec
= 0.6 gpd/ft2
= 0.9E-06 ft/sec
= 0.1 ft/day

REGRESSION COEFFICIENT = -.9446347

```
RR 92-10A
------------------------------------------------------

TIME           WATER LEVEL    DRAWDOWN        H/HO
(seconds)       (meters)      (meters)
---------     ------------    --------     --------
   23400           4.26           5.26    .3673185
   25800           3.7            4.70    .3282123
   28980           3              4.00    .2793296
   31020           2.59           3.59    .2506983
   32700           2.17           3.17    .2213687

CONFINED AQUIFER, PARTIALLY PENETRATING CONDITION

K = 0.3E-05 cm/sec
  =      0.1 gpd/ft2
  = 0.1E-06 ft/sec
  =     0.0  ft/day

REGRESSION COEFFICIENT = -.9971441
```

```
RR 92-10B
------------------------------------------------------

TIME           WATER LEVEL    DRAWDOWN        H/HO
(seconds)       (meters)      (meters)
---------     ------------    --------     --------
   60              4.57           3.23    .9847562
   120             4.52           3.18    .9695122
   300             4.39           3.05    .9298781
   600             4.18           2.84    .8658536
   900             3.99           2.65    .807927
   1800            3.5            2.16    .6585366
   2880            2.91           1.57    .4786586
   4980            2.35           1.01    .3079268
   7200            1.95           0.61    .1859756

UNCONFINED AQUIFER

K = 0.9E-05 cm/sec
  =      0.2 gpd/ft2
  = 0.3E-06 ft/sec
  =     0.0  ft/day

REGRESSION COEFFICIENT = -.9993929
```

APPENDIX E

LABORATORY REPORTS

938-67 Avenue
Edmonton,AB
T6E 0P5

NORWEST LABS
(403) 438-5522
(403) 438-0396 fax

DATE 28 FEB 92 16:30
P.O. NO. 45-160-01-01
W.O. NO. 2 49431

SENTAR CONSULTANTS LTD.
STANLEY TECHNOLOGY CENTR
10160 - 112 STREET
EDMONTON, AB
T5K 2L6

REED JACKSON
WHITEHORSE
2/12/92

			PARTICLE SIZE HYDROMETER				SOIL ORGANIC MATTER	
SAMPLE DESCRIPTION			SAND %	SILT %	CLAY %	TEXTURAL CLASS	ORGANIC CARBON %	ORGANIC MATTER %
1	92-1	10-12	23.6	61.4	15.0	Si.LOAM	< 0.05	< 0.09
2	92-3	5-7	35.6	51.4	13.0	Si.LOAM	< 0.05	< 0.09
3	92-5	10-12	17.6	49.4	33.0	Si.C.LOM	< 0.05	< 0.09
4	92-6	11-12	8.6	63.4	28.0	Si.C.LOM	0.17	0.31
5	92-6	35-36	12.6	44.4	43.0	Si.CLAY	< 0.05	< 0.09
6	92-9	10-12	47.6	44.4	8.0	LOAM	< 0.05	< 0.09
7	92-10A	29-30	9.6	67.4	23.0	Si.LOAM	< 0.05	< 0.09
8	92-10B	15-16	22.6	66.4	11.0	Si.LOAM	< 0.05	< 0.09

Lab Manager:

9938-67 Avenue
Edmonton,AB
T6E 0P5

NORWEST LABS

(403) 438-5522
(403) 438-0396 fax

DATE 07 APR 92 09:48
P.O. NO.
W.O. NO. 2 49388

SENTAR CONSULTANTS LTD.
STANLEY TECHNOLOGY CENTR
10160 - 112 STREET
EDMONTON, AB
T5K 2L6

45-160-01-01
REED JACKSON

SAMPLE		1	2	3	4
		RR1	RR2	RR3	RR4
		2/16	2/16	2/16	2/16
ROUTINE WATER					
pH		8.0	7.8	8.0	7.3
ELECTRICAL COND	uS/cm	680	2760	320	1380
CALCIUM	mg/L	86.4	213	29.7	110
MAGNESIUM	mg/L	42.2	177	17.3	69.2
SODIUM	mg/L	12	171	14	103
POTASSIUM	mg/L	4.00	30.3	2.38	17.0
IRON	mg/L	0.22	0.07	0.06	3.24
SULPHATE	mg/L	148	874	41	227
CHLORIDE	mg/L	0.5	220	0.7	104
BICARBONATE	mg/L	306	373	156	489
NITRATE&NITRITE	mg/L	<0.05	39.8	<0.05	<0.05
T ALKALINITY	mg/L	251	306	128	401
HARDNESS	mg/L	390	1260	145	560
T DIS SOLIDS	mg/L	443	1870	182	871
WATER NUTRIENTS					
CYANIDE	mg/L	0.001	<0.005	<0.001	0.004
ORGANICS					
CHEM O2 DEMAND	mg/L	306	800	99	417
TOT ORG CARBON	mg/L	1.2	10.9	4.9	15.4
ICP METALS, DISS					
ALUMINUM	mg/L	0.43	1.77	1.67	1.24
BERYLLIUM	mg/L	<0.001	<0.001	0.001	0.001
BORON	mg/L	<0.01	0.40	0.03	0.08
CADMIUM	mg/L	<0.003	<0.003	<0.003	<0.003
CHROMIUM	mg/L	<0.006	<0.006	<0.006	<0.006
COBALT	mg/L	<0.01	<0.01	<0.01	<0.01
COPPER	mg/L	<0.01	<0.01	<0.01	<0.01
BARIUM	mg/L	0.087	0.039	0.073	0.289
LEAD	mg/L	<0.04	<0.04	<0.04	<0.04
MANGANESE	mg/L	0.381	0.291	0.228	1.23
MOLYBDENUM	mg/L	<0.02	<0.02	<0.02	<0.02
NICKEL	mg/L	<0.02	<0.02	<0.02	<0.02
PHOSPHORUS	mg/L	0.05	0.17	0.17	0.11

Lab Manager:

9938-67 Avenue
Edmonton,AB
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NORWEST LABS

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(403) 438-0396 fax

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STANLEY TECHNOLOGY CENTR
10160 - 112 STREET
EDMONTON, AB
T5K 2L6

45-160-01-01
REED JACKSON

SAMPLE		1 RR1 2/16	2 RR2 2/16	3 RR3 2/16	4 RR4 2/16
ICP METALS, DISS					
SILVER	mg/L	<0.05	<0.05	<0.05	<0.05
SILICON	mg/L	7.98	5.09	6.50	8.85
TITANIUM	mg/L	<0.003	<0.003	<0.003	0.003
THALLIUM	mg/L	<0.1	<0.1	<0.1	<0.1
VANADIUM	mg/L	<0.003	0.011	<0.003	<0.003
ZINC	mg/L	0.008	0.130	0.027	0.022
ARSENIC	mg/L	0.0060	0.0014	0.0121	0.0155
SELENIUM	mg/L	<0.0002	0.0007	<0.0002	0.0002
DISS, COLD VAPOR					
MERCURY	mg/L	<0.0001	<0.0001	<0.0001	<0.0001

Lab Manager:

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45-160-01-01
REED JACKSON

SAMPLE		5	6	7	8
		RR5	RR7	RR8	RR9
		2/16	2/16	2/16	2/16
ROUTINE WATER					
pH		7.8	7.8	7.8	8.1
ELECTRICAL COND	uS/cm	610	450	460	330
CALCIUM	mg/L	94.4	49.2	47.1	26.1
MAGNESIUM	mg/L	29.2	30.1	30.0	24.1
SODIUM	mg/L	11	13	15	11
POTASSIUM	mg/L	2.91	3.17	3.21	2.83
IRON	mg/L	0.16	0.11	0.06	0.05
SULPHATE	mg/L	93	43	34	31
CHLORIDE	mg/L	0.7	0.5	2.6	2.6
BICARBONATE	mg/L	325	261	265	178
NITRATE&NITRITE	mg/L	<0.05	0.08	0.16	0.14
T ALKALINITY	mg/L	266	214	218	146
HARDNESS	mg/L	356	247	241	164
T DIS SOLIDS	mg/L	391	268	262	186
WATER NUTRIENTS					
CYANIDE	mg/L	0.007	0.002	0.002	0.002
ORGANICS					
CHEM O2 DEMAND	mg/L	64	54	64	79
TOT ORG CARBON	mg/L	4.0	7.2	3.0	5.9
ICP METALS,DISS					
ALUMINUM	mg/L	1.67	1.93	0.47	1.53
BERYLLIUM	mg/L	0.001	0.001	0.001	0.001
BORON	mg/L	<0.01	0.02	0.02	0.02
CADMIUM	mg/L	<0.003	<0.003	<0.003	<0.003
CHROMIUM	mg/L	<0.006	<0.006	<0.006	<0.006
COBALT	mg/L	<0.01	<0.01	<0.01	<0.01
COPPER	mg/L	<0.01	<0.01	<0.01	<0.01
BARIUM	mg/L	0.104	0.089	0.034	0.048
LEAD	mg/L	<0.04	<0.04	<0.04	<0.04
MANGANESE	mg/L	0.354	0.473	0.195	0.256
MOLYBDENUM	mg/L	<0.02	<0.02	<0.02	<0.02
NICKEL	mg/L	<0.02	<0.02	<0.02	<0.02

Lab Manager:

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Edmonton,AB
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SENTAR CONSULTANTS LTD.
STANLEY TECHNOLOGY CENTR
10160 - 112 STREET
EDMONTON, AB
T5K 2L6

45-160-01-01
REED JACKSON

SAMPLE		5 RR5 2/16	6 RR7 2/16	7 RR8 2/16	8 RR9 2/16
ICP METALS,DISS					
PHOSPHORUS	mg/L	0.13	0.16	0.13	0.23
SILVER	mg/L	<0.05	<0.05	<0.05	<0.05
SILICON	mg/L	9.03	8.27	7.77	6.35
TITANIUM	mg/L	<0.003	0.004	<0.003	<0.003
THALLIUM	mg/L	<0.1	<0.1	<0.1	<0.1
VANADIUM	mg/L	0.004	<0.003	<0.003	<0.003
ZINC	mg/L	0.030	0.038	0.011	<0.003
ARSENIC	mg/L	0.0162	0.0078	0.0086	0.028
SELENIUM	mg/L	0.0005	<0.0002	0.0003	0.0080
					0.0007
DISS, COLD VAPOR					
MERCURY	mg/L	<0.0001	<0.0001	<0.0001	<0.0001

Lab Manager:

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EDMONTON, AB
T5K 2L6

45-160-01-01
REED JACKSON

SAMPLE		9	10	11
		RR10A	RR10B	RR11
		2/16	2/16	2/16
ROUTINE WATER				
pH		8.0	7.7	7.3
ELECTRICAL COND	uS/cm	360	1160	1410
CALCIUM	mg/L	27.3	73.9	108
MAGNESIUM	mg/L	23.7	73.7	68.6
SODIUM	mg/L	19	88	102
POTASSIUM	mg/L	2.53	6.25	17.0
IRON	mg/L	0.24	0.41	3.26
SULPHATE	mg/L	32	38	211
CHLORIDE	mg/L	1.6	87.5	104
BICARBONATE	mg/L	194	598	485
NITRATE&NITRITE	mg/L	<0.05	<0.05	<0.05
T ALKALINITY	mg/L	159	490	398
HARDNESS	mg/L	166	488	551
T DIS SOLIDS	mg/L	201	662	848
WATER NUTRIENTS				
CYANIDE	mg/L	0.002	0.004	0.026
ORGANICS				
CHEM O2 DEMAND	mg/L	44	147	407
TOT ORG CARBON	mg/L	2.0	13.8	17.0
ICP METALS,DISS				
ALUMINUM	mg/L	3.36	1.81	1.24
BERYLLIUM	mg/L	<0.001	<0.001	<0.001
BORON	mg/L	0.02	0.07	0.08
CADMIUM	mg/L	<0.003	<0.003	<0.003
CHROMIUM	mg/L	<0.006	<0.006	<0.006
COBALT	mg/L	<0.01	<0.01	<0.01
COPPER	mg/L	<0.01	<0.01	<0.01
BARIUM	mg/L	0.108	0.170	0.291
LEAD	mg/L	<0.04	<0.04	<0.04
MANGANESE	mg/L	0.401	0.716	1.21
MOLYBDENUM	mg/L	<0.02	<0.02	<0.02
NICKEL	mg/L	<0.02	<0.02	<0.02

Lab Manager:

9938-67 Avenue
Edmonton,AB
T6E 0P5

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SENTAR CONSULTANTS LTD.
STANLEY TECHNOLOGY CENTR
10160 - 112 STREET
EDMONTON, AB
T5K 2L6

45-160-01-01
REED JACKSON

SAMPLE		9	10	11
		RR10A	RR10B	RR11
		2/16	2/16	2/16
ICP METALS,DISS				
PHOSPHORUS	mg/L	0.27	0.11	0.09
SILVER	mg/L	<0.05	<0.05	<0.05
SILICON	mg/L	7.65	11.9	8.95
TITANIUM	mg/L	0.006	0.004	0.003
THALLIUM	mg/L	<0.1	<0.1	<0.1
VANADIUM	mg/L	0.008	0.005	<0.003
ZINC	mg/L	0.054	0.053	0.022
ARSENIC	mg/L	0.0133	0.0346	0.0154
SELENIUM	mg/L	0.0003	0.0003	0.0005
DISS, COLD VAPOR				
MERCURY	mg/L	<0.0001	<0.0001	<0.0001

note* ELECTRICAL COND 'ELECTRICAL COND' (EC) is in microsiemens/cm and is a measure of solids in solution
note T ALKALINITY 'ALKALINITY' is CARBONATE/BICARBONATE expressed as CALCIUM CARBONATE
note* HARDNESS 'HARDNESS' is calcium and magnesium expressed as CALCIUM CARBONATE
note T DIS SOLIDS 'T DIS SOLIDS' is a calculated sum of dissolved constituents

Lab Manager:

938-67 Avenue
Edmonton,AB
T6E 0P5

NORWEST LABS
(403) 438-5522
(403) 438-0396 fax

DATE 07 APR 92 09:48
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W.O. NO. 2 49388

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10160 - 112 STREET
EDMONTON, AB
T5K 2L6

45-160-01-01
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5021 10301L pH
Electrometric (pH meter)
Ref. APHA 4500-H+
5022 02041L ELECTRICAL COND
Conductance meter
Ref. APHA 2510 B
5023 20103 CALCIUM
ICP spectroscopy @ 317.9 nm
Ref. APHA 3120 B
5024 12102L MAGNESIUM
ICP spectroscopy @ 285.2 nm
Ref. APHA 3120 B
5025 11102L SODIUM
ICP spectroscopy @ 589.5 nm
Ref. APHA 3120 B
5026 19103L POTASSIUM
ICP spectroscopy @ 769.8 nm
Ref. APHA 3120 B
5027 26304L IRON
ICP spectroscopy @ 259.94 nm
Acid extractable
Ref. APHA 3120 B
5028 16306L SULPHATE
ICP spectroscopy @ 180.7 nm
Ref. APHA 3120 B
5029 17203L CHLORIDE
Automated colorimetry, Thiocyanate
Ref. APHA 4500 Cl-,E
5031 06201L BICARBONATE
Potentiometric titration with standard
acid to pH 8.3 and pH 4.5
Ref. APHA 2320 B

5032 07105L NITRATE&NITRITE
Automated colorimetry Cadmium reduction
Ref. APHA 4500-NO3-,F
4997 10101 T ALKALINITY
Potentiometric titration with standard
acid to pH 4.5 & pH 8.3. Report as CaCO3
Ref. APHA 2320 B
4995 10602 HARDNESS
Calculation from 2.5*Ca + 4.1*Mg
Reported as CaCO3
Ref. APHA 2340 B
4996 00203 T DIS SOLIDS
SUM OF IONS CALCULATION
Ca + Mg + K + Na + SO4 + Cl + 0.6*T Alk
Ref. APHA 1030 F
4994 NWL 4994 IONIC BALANCE
% (Sum Cation meq/L/Sum Anion meq/L)
5083 06606 CYANIDE
Manual distillation, auto. colorimetry
with barbituric acid
Ref. EPA 335.3
5036 08304 CHEM O2 DEMAND
Dichromate digestion in culture tubes at
150C in hot block, colorimetry at 600 nm
Ref.APHA 5220 D
5038 06005L TOT ORG CARBON
Auto persulphate/UV digest. Colorimetric
Ref. MOE(Ontario Environment)
4400 13111 ALUMINUM
Dissolved by ICP spectroscopy @ 308.2 nm
Ref.APHA 3120 B
4404 04103 BERYLLIUM

Method References:

1. APHA Standard Methods for the Examination of Water and Wastewater,
American Public Health Assoc., 17th ed.
2. EPA a. Test Methods for Evaluating Solid Waste, Physical/Chemical
Methods SW-846, 3rd ed., US EPA, 1986
b. Methods for Chemical Analysis ofWater and Wastewater, US EPA, 1983
3. MSS Manual on Soil Sampling and Methods of Analysis, Cdn. Soc. of
Soil Science, J. A. McKeague, 2nd ed.

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for specific tests registered with the COUNCIL.

Lab Manager: ____________________

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Ref 3120 B

4405 05111 BORON
Dissolved by ICP spectroscopy @ 249.8 nm
Ref APHA 3120 B

4406 48111 CADMIUM
Dissolved by ICP spectroscopy @ 214.4 nm
Ref. APHA 3120 B

4408 24111 CHROMIUM
Dissolved by ICP spectroscopy @ 267.7 nm
Ref.APHA 3120 B

4409 27111 COBALT
Dissolved by ICP spectroscopy @ 238.9 nm
Ref.APHA 3120 B

4410 29111 COPPER
Dissolved by ICP spectroscopy @ 324.7 nm
Ref.APHA 3120 B

4403 56109 BARIUM
Dissolved by ICP spectroscopy @ 455.40nm
Ref. APHA 3120 B

4412 82111 LEAD
Dissolved by ICP spectroscopy @ 220.3nmR
Ref. APHA 3120 B

4415 25111 MANGANESE
Dissolved by ICP spectroscopy @ 257.6 nm
Ref. APHA 3120 B

4417 42111 MOLYBDENUM
Dissolved by ICP spectroscopy @ 202.0 nm
Ref. APHA 3120 B

4418 28111 NICKEL
Dissolved by ICP spectroscopy @ 231.06 n
Ref. APHA 3120 B

4419 NWL 4419 PHOSPHORUS
Dissolved by ICP spectroscopy @ 178.3 nm
Ref APHA 3120 B

4422 47101 SILVER
Dissolved by ICP spectroscopy @ 328.1 nm
Ref. APHA 3120 B

4423 14111 SILICON
Dissolved by ICP spectroscopy @ 251.6 nm
Ref. APHA 3120 B

4426 22111 TITANIUM
Dissolved by ICP spectroscopy @ 334.9 nm
Ref. APHA 3120 B

4427 NWL 4427 THALLIUM
Dissolved by ICP spectroscopy @ 190.9 nm
Ref. APHA 3120 B

4429 23111 VANADIUM
Dissolved by Icp spectroscopy @ 309.3 nm
Ref. APHA 3120 B

4430 30111 ZINC
Dissolved by ICP spectroscopy @ 309.3 nm
Ref. APHA 3120 B

4132 33004 ARSENIC
Dissolved, perchloric acid digest, auto.
hydride atomic absorption spectroscopy
Ref. APHA 3113 C

4133 34102 SELENIUM
Dissolved, perchloric acid digest, auto.
hydride atomic absorption spectroscopy
Ref. APHA 3113 C

4131 80016 MERCURY
Dissolved, cold vapor atomic absorption
spectroscopy, with H2SO4/K2S208 digest

Method References:

1. APHA Standard Methods for the Examination of Water and Wastewater, American Public Health Assoc., 17th ed.
2. EPA a. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods SW-846, 3rd ed., US EPA, 1986
   b. Methods for Chemical Analysis ofWater and Wastewater, US EPA, 1983
3. MSS Manual on Soil Sampling and Methods of Analysis, Cdn. Soc. of Soil Science, J. A. McKeague, 2nd ed.

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2. EPA
   a. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods SW-846, 3rd ed., US EPA, 1986
   b. Methods for Chemical Analysis ofWater and Wastewater, US EPA, 1983
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Lab Manager: ______________________

ETL Enviro·Test

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CHEMICAL ANALYSIS REPORT

SENTAR CONSULTANTS LTD.
10130 112 STREET
EDMONTON, ALBERTA
T6K 2L6

Date: March 24, 1992

ATTN: REED JACKSON

Lab Sample #: 92-E1158 Sampled By: CLIENT

Customer #: ______ Date Received: February 21, 1992

Sample Description: 11 water samples for Adsorbable Organic Halides, Total purgeables, Base/Neutral-Acid extraction, Daphnia analysis, Cyanide, Routine, Metals, Nutrients, Mercury, Pesticides, & PCB's.

PART 1: AOX RESULTS

LAB SAMPLE #	SAMPLE I.D.	RESULTS mg/L (ppm)
92-E1158-1	RR-1 2/16	ND
92-E1158-2	RR2 2/16	ND
92-E1158-3	RR3 2/16	ND
92-E1158-4	RR4 2/16	ND
92-E1158-5	RR5 2/16	0.11
92-E1158-6	RR7 2/16	ND
92-E1158-7	RR8 2/16	ND
92-E1158-8	RR9 2/16	ND
92-E1158-9	RR 10A 2/16	ND
92-E1158-10	RR 10B 2/16	ND
92-E1158-11	RR 11 2/16	ND
Detection Limit -		0.025

ND - not detectable, less than detection limit.

AOX analysis - the term "AOX" encompasses both semi-volatile and non-volatile halogenated organics. The presence of volatile halogenated organics would have been indicated during the purgeable analysis at a detection limit of 50 ppb.

92-E1158 (cont'd)

METHOD REFERENCE

"Organically Bound Chlorine by the AOX Method",
Scandinavian Pulp, Paper and Board Testing Committee
Standard Method Scan-W 9:89, (1989)

PART 2: TOTAL PURGEABLE RESULTS

LAB SAMPLE #	SAMPLE I.D.	RESULTS μg/L (ppb)
92-E1158-1	RR-1 2/16	ND
92-E1158-2	RR2 2/16	ND
92-E1158-3	RR3 2/16	ND
92-E1158-4	RR4 2/16	ND
92-E1158-5	RR5 2/16	ND
92-E1158-6	RR7 2/16	ND
92-E1158-7	RR8 2/16	ND
92-E1158-8	RR9 2/16	ND
92-E1158-9	RR 10A 2/16	ND
92-E1158-10	RR 10B 2/16	ND
92-E1158-11	RR 11 2/16	ND
Detection Limit -		50

ND: No petroleum hydrocarbons were detectable at or above the detection limit.

Total Purgeables: This semi-quantitative result is a summation from the C_3 to C_6 carbon range (including benzene) and is calculated against a calibrated gasoline standard.

BTEX METHOD REFERENCE: EPA SW 846 METHOD-5030/8015
TOTAL EXTRACTABLE METHOD REFERENCE: EPA SW 846 METHOD-3510/8000

92-E1158 (cont'd)

QA/QC:

SUMMARY PERIOD: January 1, 1991 to June 30, 1991

TEST	ACCURACY	PRECISION
BTEX (WATER)	100% ±9.8%	±17%
TOTAL EXTRACTABLES (WATER)	88% ±20%	±11%

Note: Accuracy is expressed as the average % recovery ± the relative standard deviation(RSD) of standard reference materials or in-house spikes.
Precision is expressed as the standard deviation of duplicate analysis.

PART 3: BASE/NEUTRAL-ACID EXTRACTABLE RESULTS

LAB SAMPLE #	SAMPLE I.D.	RESULTS μg/L (ppb)	
		Acid	Base/Neutral
92-E1158-1	RR-1 2/16	ND	ND
92-E1158-2	RR2 2/16	ND	ND
92-E1158-3	RR3 2/16	ND	ND
92-E1158-4	RR4 2/16	ND	ND
92-E1158-5	RR5 2/16	ND	ND
92-E1158-6	RR7 2/16	ND	ND
92-E1158-7	RR8 2/16	ND	ND
92-E1158-8	RR9 2/16	ND	ND
92-E1158-9	RR 10A 2/16	ND	ND
92-E1158-10	RR 10B 2/16	ND	ND
92-E1158-11	RR 11 2/16	ND	ND
Detection Limit -		10	10

ND: No petroleum hydrocarbons were detectable at or above the detection limit.

METHOD REFERENCE: Modified EPA 3510, ESOP's 22.00/16.00/37.01

QA/QC: SURROGATE RECOVERIES
Naphthalene d8 - 89.2%
2 - Fluorobiphenyl - 105%

92-E1158 (cont'd)

PART 4: DAPHNIA RESULTS

See attached for results.

PART 5: PCB's

LAB SAMPLE #	SAMPLE I.D.	RESULTS μg/L (ppb)
92-E1158-1	RR-1 2/16	ND
92-E1158-2	RR2 2/16	ND
92-E1158-3	RR3 2/16	ND
92-E1158-4	RR4 2/16	ND
92-E1158-5	RR5 2/16	ND
92-E1158-6	RR7 2/16	ND
92-E1158-7	RR8 2/16	ND
92-E1158-8	RR9 2/16	ND
92-E1158-9	RR 10A 2/16	ND
92-E1158-10	RR 10B 2/16	ND
92-E1158-11	RR 11 2/16	ND
Detection Limit -		0.1

ND - Not detected, less than detection limit.

92-E1158 (cont'd)

PART 6: PESTICIDE RESULTS

SPIKE RECOVERIES FOR ORGANOCHLORINE COMPOUNDS

SPK 1	FORTIFICATION LEVEL (PPB)	AMOUNT RECOVERED (PPB)	% RECOVERY
HCB	0.232	0.153	66%
RONNEL	0.241	0.160	66%
LINDANE	0.242	0.200	83%
HEPTACHLOR EPOXIDE	0.261	0.178	68%
DDE	0.227	0.162	71%
DIELDRIN	0.234	0.164	70%
DDD	0.232	0.191	82%
DDT	0.286	0.236	83%
METHOXYCHLOR	0.284	0.295	104%
AVERAGE % RECOVERY FOR OC'S	NA	NA	77%

METHOD OVERVIEW: Approximately 1L of sample was extracted with dichloromethane and brought to a 1 mL final volume. Half of the extract was then cleaned on a florosil column and run by GC/ECD for organochlorines; and the other half was run by GC/NPD for the organophosphates. All analyses were performed using high performance capillary columns.

ORGANOPHOSPHOSPHATE RESULTS (PPB)

LAB SAMPLE #	CLIENT ID	PARATHION	CHLORPYRIFOS	PHORATE	DIAZINON	ETHION	MALATHION	IMIDANE	FENITROTHION
92-E1158-1	RR1 2/16	ND	ND	ND	ND	ND	ND	ND	ND
92-E1158-2	RR2 2/16	ND	ND	ND	ND	ND	ND	ND	ND
92-E1158-3	RR3 2/16	ND	ND	ND	ND	ND	ND	ND	ND
92-E1158-4	RR4 2/16	ND	ND	ND	ND	ND	ND	ND	ND
92-E1158-5	RR5 2/16	ND	ND	ND	ND	ND	ND	ND	ND
92-E1158-6	RR7 2/16	ND	ND	ND	ND	ND	ND	ND	ND
92-E1158-7	RR8 2/16	ND	ND	ND	ND	ND	ND	ND	ND
92-E1158-9	RR10A 2/16	ND	ND	ND	ND	ND	ND	ND	ND
92-E1158-10	RR10B 2/16	ND	ND	ND	ND	ND	ND	ND	ND
92-E1158-11	RR11 2/16	ND	ND	ND	ND	ND	ND	ND	ND

DETECTION LIMIT - 0.10PPB
NO INTERFERENCES WERE PRESENT IN THE GLASSWARE BLANK

SPIKE RECOVERIES FOR ORGANOPHOSPHATE COMPOUNDS

SPK 2	PHORATE	DIAZINON	MALATHION	FENITROTHION
FORTIFICATION LEVEL (PPB)	0.338	0.278	0.400	0.524
AMOUNT RECOVERED (PPB)	0.208	0.190	0.273	0.338
% RECOVERY	62%	68%	68%	64%

92-E1158 (cont'd)

ORGANOCHLORINE RESULTS (PPB)

LAB SAMPLE #	E1158 -1	E1158 -2	E1158 -3	E1158 -4	E1158 -5	E1158 -6	E1158 -7	E1158-9	E1158-10	E1158 -11
CLIENT ID	RR1 2/16	RR2 2/16	RR3 2/16	RR4 2/16	RR5 2/16	RR7 2/16	RR8 2/16	RR10A 2/16	RR10B 2/16	RR11 2/16
HCB	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
RONNEL	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
LINDANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
HEPTACHLOR EPOXIDE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DDE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DIELDRIN	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DDD	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DDT	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
METHOXYCHLOR	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
HEPTACHLOR	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ALDRIN	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MIREX	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ENDRIN	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CHLORDANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ENDOSULFAN I	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ENDOSULFAN II	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
TOXAPHENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCNB	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
KELTHANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CAPTAN	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

DETECTION LIMIT - 0.025PPB

92-E1158 (cont'd)

CERTIFIED BY: ______________________
Rod Roy, Residue Analyst

APPROVED BY: ______________________
Gordon Nelson, Project Manager

ALL SAMPLES WILL BE DISPOSED OF AFTER 30 DAYS FOLLOWING ANALYSIS. PLEASE CONTACT THE LAB IF YOU REQUIRE ADDITIONAL SAMPLE STORAGE TIME.

ACCREDITED BY THE: **AMERICAN INDUSTRIAL HYGIENE ASSOCIATION (AIHA)** - Industrial Hygiene analysis
STANDARDS COUNCIL OF CANADA - Organic & Industrial Hygiene analysis.

HydroQual
Laboratories Ltd.

DATE: 92/02/27
REF: 920449/458
PROJ #: 92-006-6
SAMPLE: 92089-1

TOXICITY TEST RESULTS

TEST: Daphnia, 48h LC50 Acute Test (TP002Ab)

SAMPLE REF: ETL 92-E1158-1; SAEL RR1 2/16 1

PROTOCOL: Daphnia magna 48h Static Acute Toxicity Test. In: Standard Operating Procedures, Vol. 1. 1990. Aquatic Biology Branch. Alberta Environmental Centre. Vegreville, AB. AECV90-M1.

RESULTS:

DATE INITIATED	ENDPOINT (% SAMPLE STRENGTH)		95% CONFIDENCE LIMITS		METHOD OF CALCULATION
			LOWER	UPPER	
92/02/25	LC50	THE UNDILUTED SAMPLE WAS NOT TOXIC			
	NOEL				

REF. TOXICANTS:

DATE INITIATED	ZINC LC50 (mg/L)	0.52	0.36	0.74	PROBIT
92/02/25	internal control limits for zinc are 0.1 and 0.9 mg/L				

COMMENTS:
- the sample was a grey colour and contained sediment
- see reverse side for monitoring data

VERIFIED BY: **ON:** 92/3/5

MONITORING DATA

92089-1

TIME	0h				48h			
SAMPLE STRENGTH (%)	MORTALITY (%)	pH (units)	D.O. (mg/L)	COND. (uS/cm)	MORTALITY (%)	pH (units)	D.O. (mg/L)	COND. (uS/cm)
CONTROL	0	8.3	8.0	487	0	8.5	7.4	445
3.125	0	8.4	8.4	473	0	8.4	7.4	443
6.25	0	8.4	8.4	489	0	8.4	7.4	445
12.5	0	8.4	8.5	505	0	8.4	7.4	464
25	0	8.4	8.5	538	0	8.4	7.4	491
50	0	8.4	8.5	612	0	8.4	7.4	545
100	0	8.4	8.3	743	0	8.3	7.4	669

HydroQual
Laboratories Ltd.

DATE: 92/02/27
REF: 920449/459
PROJ #: 92-006-6
SAMPLE: 92089-2

TOXICITY TEST RESULTS

TEST: Daphnia, 48h LC50 Acute Test (TP002Ab)

SAMPLE REF: ETL 92-E1158-2; SAEL RR 2/16 2

PROTOCOL: Daphnia magna 48h Static Acute Toxicity Test. In: Standard Operating Procedures, Vol. 1. 1990. Aquatic Biology Branch. Alberta Environmental Centre. Vegreville, AB. AECV90-M1.

RESULTS:

DATE INITIATED	ENDPOINT (% SAMPLE STRENGTH)	95% CONFIDENCE LIMITS		METHOD OF CALCULATION
		LOWER	UPPER	
92/02/25	LC50	**THE UNDILUTED SAMPLE WAS NOT TOXIC**		
	NOEL			

REF. TOXICANTS:

DATE INITIATED	ZINC LC50 (mg/L)	0.52	0.36	0.74	PROBIT
92/02/25	internal control limits for zinc are 0.1 and 0.9 mg/L				

COMMENTS:
- the sample was a grey colour and contained sediment
- see reverse side for monitoring data

VERIFIED BY: **ON:** 92/3/7

MONITORING DATA

92089-2

TIME	0h				48h			
SAMPLE STRENGTH (%)	MORTALITY (%)	pH (units)	D.O. (mg/L)	COND. (uS/cm)	MORTALITY (%)	pH (units)	D.O. (mg/L)	COND. (uS/cm)
CONTROL	0	8.3	8.0	487	0	8.5	7.4	440
3.125	0	8.3	8.4	501	0	8.5	7.4	518
6.25	0	8.4	8.6	584	0	8.5	7.4	596
12.5	0	8.4	8.6	720	0	8.5	7.4	741
25	0	8.4	8.6	997	0	8.5	7.4	1024
50	0	8.4	8.6	1501	0	8.5	7.3	1547
100	0	8.4	8.5	2500	0	8.4	7.3	2540

HydroQual
Laboratories Ltd.

DATE: 92/02/27
REF: 920449/460
PROJ #: 92-006-6
SAMPLE: 92089-3

TOXICITY TEST RESULTS

TEST: Daphnia, 48h LC50 Acute Test (TP002Ab)

SAMPLE REF: ETL 92-E1158-3; SAEL RR 2/16 3

PROTOCOL: Daphnia magna 48h Static Acute Toxicity Test. In: Standard Operating Procedures, Vol. 1. 1990. Aquatic Biology Branch. Alberta Environmental Centre. Vegreville, AB. AECV90-M1.

RESULTS:

DATE INITIATED	ENDPOINT (% SAMPLE STRENGTH)		95% CONFIDENCE LIMITS		METHOD OF CALCULATION
			LOWER	UPPER	
92/02/25	LC50	**THE UNDILUTED SAMPLE WAS NOT TOXIC**			
	NOEL				

REF. TOXICANTS:

DATE INITIATED	ZINC LC50 (mg/L)	0.52	0.36	0.74	PROBIT
92/02/25	internal control limits for zinc are 0.1 and 0.9 mg/L				

COMMENTS:
- the sample was a grey colour and contained sediment
- see reverse side for monitoring data

VERIFIED BY: **ON:** 92/3/5

MONITORING DATA

92089-3

TIME	0h				48h			
SAMPLE STRENGTH (%)	MORTALITY (%)	pH (units)	D.O. (mg/L)	COND. (uS/cm)	MORTALITY (%)	pH (units)	D.O. (mg/L)	COND. (uS/cm)
CONTROL	0	8.3	8.0	487	0	8.5	7.4	443
3.125	0	8.4	8.5	425	0	8.5	7.4	440
6.25	0	8.4	8.5	427	0	8.5	7.4	434
12.5	0	8.4	8.5	420	0	8.5	7.4	430
25	0	8.4	8.6	411	0	8.5	7.4	417
50	0	8.4	8.5	382	0	8.5	7.3	387
100	0	8.4	8.2	331	0	8.5	7.3	329

HydroQual
Laboratories Ltd.

DATE: 92/02/27
REF: 920449/461
PROJ #: 92-006-6
SAMPLE: 92089-4

TOXICITY TEST RESULTS

TEST: Daphnia, 48h LC50 Acute Test (TP002Ab)

SAMPLE REF: ETL 92-E1158-4; SAEL RR 2/16 4

PROTOCOL: Daphnia magna 48h Static Acute Toxicity Test. In: Standard Operating Procedures, Vol. 1. 1990. Aquatic Biology Branch. Alberta Environmental Centre. Vegreville, AB. AECV90-M1.

RESULTS:

DATE INITIATED	ENDPOINT (% SAMPLE STRENGTH)		95% CONFIDENCE LIMITS		METHOD OF CALCULATION
			LOWER	UPPER	
92/02/25	LC50	**THE UNDILUTED SAMPLE WAS NOT TOXIC**			
	NOEL				

REF. TOXICANTS:

DATE INITIATED	ZINC LC50 (mg/L)	0.52	0.36	0.74	PROBIT
92/02/25	internal control limits for zinc are 0.1 and 0.9 mg/L				

COMMENTS:
- the sample was a grey colour and contained sediment
- see reverse side for monitoring data

VERIFIED BY: **ON:** 92/3/5

MONITORING DATA

92089-4

TIME	0h				48h			
SAMPLE STRENGTH (%)	MORTALITY (%)	pH (units)	D.O. (mg/L)	COND. (uS/cm)	MORTALITY (%)	pH (units)	D.O. (mg/L)	COND. (uS/cm)
CONTROL	0	8.3	8.0	487	0	8.5	7.4	443
3.125	0	8.4	8.4	457	0	8.5	7.5	476
6.25	0	8.4	8.4	494	0	8.5	7.5	505
12.5	0	8.4	8.5	551	0	8.6	7.5	565
25	0	8.4	8.5	666	0	8.6	7.4	682
50	0	8.3	8.5	888	0	8.6	7.4	914
100	0	8.2	8.0	1330	0	8.6	7.3	1322

HydroQual
Laboratories Ltd.

DATE: 92/02/27
REF: 920449/462
PROJ #: 92-006-6
SAMPLE: 92089-5

TOXICITY TEST RESULTS

TEST: Daphnia, 48h LC50 Acute Test (TP002Ab)

SAMPLE REF: ETL 92-E1158-5; SAEL RR 2/16 5

PROTOCOL: Daphnia magna 48h Static Acute Toxicity Test. In: Standard Operating Procedures, Vol. 1. 1990. Aquatic Biology Branch. Alberta Environmental Centre. Vegreville, AB. AECV90-M1.

RESULTS:

DATE INITIATED	ENDPOINT (% SAMPLE STRENGTH)		95% CONFIDENCE LIMITS		METHOD OF CALCULATION
			LOWER	UPPER	
92/02/25	LC50	**THE UNDILUTED SAMPLE WAS NOT TOXIC**			
	NOEL				

REF. TOXICANTS:

DATE INITIATED	ZINC LC50 (mg/L)	0.52	0.36	0.74	PROBIT
92/02/25	internal control limits for zinc are 0.1 and 0.9 mg/L				

COMMENTS:
- the sample was a grey colour and contained sediment
- see reverse side for monitoring data

VERIFIED BY: **ON:** 92/3/5

MONITORING DATA

92089-5

TIME	0h				48h			
SAMPLE STRENGTH (%)	MORTALITY (%)	pH (units)	D.O. (mg/L)	COND. (uS/cm)	MORTALITY (%)	pH (units)	D.O. (mg/L)	COND. (uS/cm)
CONTROL	0	8.3	8.0	487	0	8.5	7.6	435
3.125	0	8.4	8.3	431	0	8.5	7.6	446
6.25	0	8.4	8.4	448	0	8.5	7.5	447
12.5	0	8.4	8.4	457	0	8.4	7.5	458
25	0	8.4	8.4	474	0	8.4	7.5	470
50	0	8.4	8.4	511	0	8.3	7.4	482
100	0	8.3	8.3	567	0	8.2	7.3	525

HydroQual
Laboratories Ltd.

DATE: 92/02/27
REF: 920449/463
PROJ #: 92-006-6
SAMPLE: 92089-6

TOXICITY TEST RESULTS

TEST: Daphnia, 48h LC50 Acute Test (TP002Ab)

SAMPLE REF: ETL 92-E1158-6; SAEL RR 2/16 7

PROTOCOL: Daphnia magna 48h Static Acute Toxicity Test. In: Standard Operating Procedures, Vol. 1. 1990. Aquatic Biology Branch. Alberta Environmental Centre. Vegreville, AB. AECV90-M1.

RESULTS:

DATE INITIATED	ENDPOINT (% SAMPLE STRENGTH)	95% CONFIDENCE LIMITS		METHOD OF CALCULATION
		LOWER	UPPER	
92/02/25	LC50	**THE UNDILUTED SAMPLE WAS NOT TOXIC**		
	NOEL			

REF. TOXICANTS:

DATE INITIATED	ZINC LC50 (mg/L)	0.52	0.36	0.74	PROBIT
92/02/25	internal control limits for zinc are 0.1 and 0.9 mg/L				

COMMENTS:
- the sample was a grey colour and contained sediment
- see reverse side for monitoring data

VERIFIED BY: **ON:** 92/3/5

MONITORING DATA

92089-6

TIME	0h				48h			
SAMPLE STRENGTH (%)	MORTALITY (%)	pH (units)	D.O. (mg/L)	COND. (uS/cm)	MORTALITY (%)	pH (units)	D.O. (mg/L)	COND. (uS/cm)
CONTROL	0	8.3	8.0	487	0	8.5	7.5	437
3.125	0	8.3	8.1	435	0	8.5	7.5	447
6.25	0	8.4	8.2	445	0	8.5	7.4	445
12.5	0	8.4	8.2	447	0	8.5	7.4	447
25	0	8.4	8.2	449	0	8.5	7.4	448
50	0	8.4	8.1	452	0	8.5	7.4	449
100	0	8.4	7.9	466	0	8.6	7.3	454

HydroQual
Laboratories Ltd.

DATE: 92/02/28
REF: 920449/465
PROJ #: 92-006-6
SAMPLE: 92089-7

TOXICITY TEST RESULTS

TEST: Daphnia, 48h LC50 Acute Test (TP002Ab)

SAMPLE REF: ETL 92-E1158-7; SAEL RR 2/16 8

PROTOCOL: Daphnia magna 48h Static Acute Toxicity Test. In: Standard Operating Procedures, Vol. 1. 1990. Aquatic Biology Branch. Alberta Environmental Centre. Vegreville, AB. AECV90-M1.

RESULTS:

DATE INITIATED	ENDPOINT (% SAMPLE STRENGTH)		95% CONFIDENCE LIMITS		METHOD OF CALCULATION
			LOWER	UPPER	
92/02/26	LC50	**THE UNDILUTED SAMPLE WAS NOT TOXIC**			
	NOEL				

REF. TOXICANTS:

DATE INITIATED	ZINC LC50 (mg/L)	0.52	0.36	0.74	PROBIT
92/02/25	internal control limits for zinc are 0.1 and 0.9 mg/L				

COMMENTS:
- the sample was a cloudy grey colour and contained sediment
- see reverse side for monitoring data

VERIFIED BY: **ON:** 92/3/5

MONITORING DATA

92089-7

TIME	0h				48h			
SAMPLE STRENGTH (%)	MORTALITY (%)	pH (units)	D.O. (mg/L)	COND. (uS/cm)	MORTALITY (%)	pH (units)	D.O. (mg/L)	COND. (uS/cm)
CONTROL	0	8.3	8.0	487	0	8.5	7.8	442
6.25	0	8.3	7.7	429	0	8.5	7.6	437
12.5	0	8.3	7.7	447	0	8.5	7.5	439
25	0	8.3	7.8	447	0	8.5	7.5	440
50	0	8.3	7.8	447	0	8.6	7.5	440
100	0	8.3	7.8	453	0	8.6	7.4	442

HydroQual
Laboratories Ltd.

DATE: 92/02/28
REF: 920449/466
PROJ #: 92-006-6
SAMPLE: 92089-8

TOXICITY TEST RESULTS

TEST: Daphnia, 48h LC50 Acute Test (TP002Ab)

SAMPLE REF: ETL 92-E1158-8; SAEL RR 2/16 9

PROTOCOL: Daphnia magna 48h Static Acute Toxicity Test. In: Standard Operating Procedures, Vol. 1. 1990. Aquatic Biology Branch. Alberta Environmental Centre. Vegreville, AB. AECV90-M1.

RESULTS:

DATE INITIATED	ENDPOINT (% SAMPLE STRENGTH)		95% CONFIDENCE LIMITS		METHOD OF CALCULATION
			LOWER	UPPER	
92/02/26	LC50	**THE UNDILUTED SAMPLE WAS NOT TOXIC**			
	NOEL				

REF. TOXICANTS:

DATE INITIATED	ZINC LC50 (mg/L)	0.52	0.36	0.74	PROBIT
92/02/25	internal control limits for zinc are 0.1 and 0.9 mg/L				

COMMENTS:
- the sample was a cloudy grey colour and contained sediment
- see reverse side for monitoring data

VERIFIED BY: **ON:** 92/3/5

MONITORING DATA

92089-8

TIME	0h				48h			
SAMPLE STRENGTH (%)	MORTALITY (%)	pH (units)	D.O. (mg/L)	COND. (uS/cm)	MORTALITY (%)	pH (units)	D.O. (mg/L)	COND. (uS/cm)
CONTROL	0	8.3	8.0	487	0	8.5	7.8	442
3.125	0	8.3	7.8	450	20*	8.5	7.2	434
6.25	0	8.3	7.7	456	0	8.5	7.2	437
12.5	0	8.4	7.7	446	0	8.5	7.2	429
25	0	8.4	7.7	431	0	8.5	7.2	421
50	0	8.4	7.7	401	0	8.5	7.2	393
100	0	8.4	7.4	346	0.	8.5	7.2	338

* Note: organism caught in debris

HydroQual
Laboratories Ltd.

DATE: 92/02/28
REF: 920449/467
PROJ #: 92-006-6
SAMPLE: 92089-9

TOXICITY TEST RESULTS

TEST: Daphnia, 48h LC50 Acute Test (TP002Ab)

SAMPLE REF: ETL 92-E1158-9; SAEL RR 2/16 10A

PROTOCOL: Daphnia magna 48h Static Acute Toxicity Test. In: Standard Operating Procedures, Vol. 1. 1990. Aquatic Biology Branch. Alberta Environmental Centre. Vegreville, AB. AECV90-M1.

RESULTS:

DATE INITIATED	ENDPOINT (% SAMPLE STRENGTH)		95% CONFIDENCE LIMITS		METHOD OF CALCULATION
			LOWER	UPPER	
92/02/26	LC50	**THE UNDILUTED SAMPLE WAS NOT TOXIC**			
	NOEL				

REF. TOXICANTS:

DATE INITIATED	ZINC LC50 (mg/L)	0.52	0.36	0.74	PROBIT
92/02/25	internal control limits for zinc are 0.1 and 0.9 mg/L				

COMMENTS:

- the sample was a cloudy grey colour
- see reverse side for monitoring data

VERIFIED BY: **ON:** 92/3/5

MONITORING DATA

92089-9

TIME	0h				48h			
SAMPLE STRENGTH (%)	MORTALITY (%)	pH (units)	D.O. (mg/L)	COND. (uS/cm)	MORTALITY (%)	pH (units)	D.O. (mg/L)	COND. (uS/cm)
CONTROL	0	8.3	8.0	487	0	8.5	7.8	442
6.25	0	8.3	7.6	428	0	8.5	7.4	429
12.5	0	8.3	7.6	434	0	8.5	7.3	430
25	0	8.3	7.6	423	0	8.5	7.4	423
50	0	8.3	7.6	404	10*	8.5	7.3	403
100	0	8.3	7.3	362	0	8.6	7.3	366

* Note: organism trapped in air bubble

HydroQual
Laboratories Ltd.

DATE: 92/02/28
REF: 920449/468
PROJ #: 92-006-6
SAMPLE: 92089-10

TOXICITY TEST RESULTS

TEST: Daphnia, 48h LC50 Acute Test (TP002Ab)

SAMPLE REF: ETL 92-E1158-10; SAEL RR 2/16 10B

PROTOCOL: Daphnia magna 48h Static Acute Toxicity Test. In: Standard Operating Procedures, Vol. 1. 1990. Aquatic Biology Branch. Alberta Environmental Centre. Vegreville, AB. AECV90-M1.

RESULTS:

DATE INITIATED	ENDPOINT (% SAMPLE STRENGTH)		95% CONFIDENCE LIMITS		METHOD OF CALCULATION
			LOWER	UPPER	
92/02/26	LC50	**THE UNDILUTED SAMPLE WAS NOT TOXIC**			
	NOEL				

REF. TOXICANTS:

DATE INITIATED	ZINC LC50 (mg/L)	0.52	0.36	0.74	PROBIT
92/02/25	internal control limits for zinc are 0.1 and 0.9 mg/L				

COMMENTS:
- the sample was a cloudy grey colour
- see reverse side for monitoring data

VERIFIED BY: **ON:** 92/5/5

MONITORING DATA

92089-10

TIME	0h				48h			
SAMPLE STRENGTH (%)	MORTALITY (%)	pH (units)	D.O. (mg/L)	COND. (uS/cm)	MORTALITY (%)	pH (units)	D.O. (mg/L)	COND. (uS/cm)
CONTROL	0	8.3	8.0	487	0	8.5	7.2	429
6.25	0	8.3	7.6	476	0	8.5	7.2	475
12.5	0	8.3	7.6	528	0	8.5	7.2	513
25	0	8.3	7.6	612	0	8.4	7.3	579
50	0	8.2	7.5	759	0	8.4	7.2	716
100	0	8.1	6.8	1083	0	8.5	7.1	1005

HydroQual
Laboratories Ltd.

DATE: 92/02/28
REF: 920449/469
PROJ #: 92-006-6
SAMPLE: 92089-11

TOXICITY TEST RESULTS

TEST: Daphnia, 48h LC50 Acute Test (TP002Ab)

SAMPLE REF: ETL 92-E1158-11; SAEL RR 2/16 11

PROTOCOL: Daphnia magna 48h Static Acute Toxicity Test. In: Standard Operating Procedures, Vol. 1. 1990. Aquatic Biology Branch. Alberta Environmental Centre. Vegreville, AB. AECV90-M1.

RESULTS:

DATE INITIATED	ENDPOINT (% SAMPLE STRENGTH)		95% CONFIDENCE LIMITS		METHOD OF CALCULATION
			LOWER	UPPER	
92/02/26	LC50	**THE UNDILUTED SAMPLE WAS NOT TOXIC**			
	NOEL				

REF. TOXICANTS:

DATE INITIATED	ZINC LC50 (mg/L)	0.52	0.36	0.74	PROBIT
92/02/25	internal control limits for zinc are 0.1 and 0.9 mg/L				

COMMENTS:
- the sample was a cloudy grey colour and contained sediments
- see reverse side for monitoring data

VERIFIED BY: **ON:** 92/3/5

MONITORING DATA

92089-11

TIME	0h				48h			
SAMPLE STRENGTH (%)	MORTALITY (%)	pH (units)	D.O. (mg/L)	COND. (uS/cm)	MORTALITY (%)	pH (units)	D.O. (mg/L)	COND. (uS/cm)
CONTROL	0	8.3	8.0	487	0	8.5	7.3	429
6.25	0	8.2	7.6	495	0	8.5	7.3	500
12.5	0	8.2	7.6	562	0	8.6	7.3	556
25	0	8.1	7.6	677	0	8.6	7.4	672
50	0	7.9	7.4	873	0	8.6	7.2	867
100	0	7.8	6.8	1280	0	8.6	7.2	1277

APPENDIX F

GROUNDWATER QUALITY SUMMARY TABLES

RANGE ROAD DUMP
GROUNDWATER QUALITY

TARGET PESTICIDES

PARAMETER	UNITS	FEB/92	CDWQG*	
ORGANOCHLORINES		Detection Limit 0.000025 mg/L	MAC	AO
HCB	mg/L	N.D.		
Ronnel	mg/L	N.D.		
Lindane	mg/L	N.D.	0.004	
Heptachlor Epoxide	mg/L	N.D.	0.003	
Dieldrin	mg/L	N.D.	0.0007	
DDT	mg/L	N.D.	0.03	
DDD	mg/L	N.D.		
DDE	mg/L	N.D.		
Methoxychlor	mg/L	N.D.	0.9	
Heptachlor	mg/L	N.D.	0.003	
Aldrin	mg/L	N.D.	0.0007	
Mirex	mg/L	N.D.		
Endrin	mg/L	N.D.		
Chlordane	mg/L	N.D.	0.007	
Endosulfan I	mg/L	N.D.		
Endosulfan II	mg/L	N.D.		
Toxaphene	mg/L	N.D.		
PCNB	mg/L	N.D.		
Kelthane	mg/L	N.D.		
Captan	mg/L	N.D.		
ORGANOPHOSPHATES		Detection Limit 0.00010 mg/L		
Parathion	mg/L	N.D.	0.05	
Chlorpyrifos	mg/L	N.D.	0.09	
Phorate	mg/L	N.D.	0.002	
Diazinon	mg/L	N.D.	0.02	
Ethion	mg/L	N.D.		
Malathion	mg/L	N.D.	0.19	
Imidane	mg/L	N.D.		
Fenitrothion	mg/L	N.D.		

* Canadian Drinking Water Quality Guidelines - Shaded Values Exceed Guidelines
MAC - Maximum Acceptable Concentrations
AO - Aesthetic Objectives

RANGE ROAD DUMP
GROUNDWATER QUALITY

MONITOR 92-1

PARAMETER	UNITS		FEB/92	CDWQG*	
INORGANICS				MAC	AO
pH			8	6.5 - 8.5	
Elec. Conductivity	uS/cm		680		
Calcium	mg/L		86.4		
Magnesium	mg/L		42.2		
Sodium	mg/L		12		200
Potassium	mg/L		4		
Iron	mg/L		0.22		0.3
Sulphate	mg/L		148		500
Chloride	mg/L		0.5		250
Bicarbonate	mg/L		306		
Nitrate & Nitrite	mg/L		<0.05	10 mg/L nitrate as N, 1.0 mg/L nitrite as N	
T. Alkalinity	mg/L		251		
Hardness	mg/L		390	500	
T. Dis. Solids	mg/L		443	500	
Cyanide	mg/L		0.001	0.2	
C.O.D.	mg/L		306		
METALS					
Aluminum	mg/L		0.43		
Beryllium	mg/L		<0.001		
Boron	mg/L		<0.01	5	
Cadmium	mg/L		<0.003	0.005	
Chromium	mg/L		<0.006	0.05	
Cobalt	mg/L		<0.01		
Copper	mg/L		<0.01	1	
Barium	mg/L		0.087	1	
Lead	mg/L		<0.04	0.01	
Manganese	mg/L		0.381		0.05
Molybdenum	mg/L		<0.02		
Nickel	mg/L		<0.02		
Phosphorus	mg/L		0.05		
Silver	mg/L		<0.05		
Silicon	mg/L		7.98		
Titanium	mg/L		<0.003		
Thallium	mg/L		<0.1		
Vanadium	mg/L		<0.003		
Zinc	mg/L		0.008		5
Arsenic	mg/L		0.006	0.05	
Selenium	mg/L		<0.0002	0.01	
Mercury	mg/L		<0.0001	0.001	
ORGANICS		Detection Limit			
Tot. Org. Carbon	mg/L		1.2		
PCB's **	mg/L	0.0001 mg/L	N.D.		
Pesticides ***					
- Organochlorines	mg/L	0.000025 mg/L	N.D.		
- Organophosphates	mg/L	0.0001 mg/L	N.D.		
Total Organics					
- Base/Neutral	mg/L	0.01 mg/L	N.D.		
- Acid	mg/L	0.01 mg/L	N.D.		
AOX	mg/L	0.025 mg/L	N.D.		
Total Purgables	mg/L	0.05 mg/L	N.D.		
TOXICITY					
Daphnia magna	LC50		N.T.		

* Canadian Drinking Water Quality Guidelines - Shaded Values Exceed Guidelines
MAC - Maximum Acceptable Concentrations
AO - Aesthetic Objectives
** Aroclor 1242-1270
*** See Table of Target Pesticides

N.D. - Not Detected
N.T. - Not Toxic

RANGE ROAD DUMP
GROUNDWATER QUALITY

MONITOR 92-2

PARAMETER	UNITS		FEB/92	CDWQG*	
				MAC	AO
INORGANICS					
pH			7.8	6.5 - 8.5	
Elec. Conductivity	uS/cm		2760		
Calcium	mg/L		213		
Magnesium	mg/L		177		
Sodium	mg/L		171		200
Potassium	mg/L		30.3		
Iron	mg/L		0.07		0.3
Sulphate	mg/L		874		500
Chloride	mg/L		220		250
Bicarbonate	mg/L		373		
Nitrate & Nitrite	mg/L		39.8	10 mg/L nitrate as N, 1.0 mg/L nitrite as N	
T. Alkalinity	mg/L		306		
Hardness	mg/L		1260	500	
T. Dis. Solids	mg/L		1870	500	
Cyanide	mg/L		<0.005	0.2	
C.O.D.	mg/L		800		
METALS					
Aluminum	mg/L		1.77		
Beryllium	mg/L		<0.001		
Boron	mg/L		0.4	5	
Cadmium	mg/L		<0.003	0.005	
Chromium	mg/L		<0.006	0.05	
Cobalt	mg/L		<0.01		
Copper	mg/L		<0.01	1	
Barium	mg/L		0.039	1	
Lead	mg/L		<0.04	0.01	
Manganese	mg/L		0.291		0.05
Molybdenum	mg/L		<0.02		
Nickel	mg/L		<0.02		
Phosphorus	mg/L		0.17		
Silver	mg/L		<0.05		
Silicon	mg/L		5.09		
Titanium	mg/L		<0.003		
Thallium	mg/L		<0.1		
Vanadium	mg/L		0.011		
Zinc	mg/L		0.13		5
Arsenic	mg/L		0.0014	0.05	
Selenium	mg/L		0.0007	0.01	
Mercury	mg/L		<0.0001	0.001	
ORGANICS		Detection Limit			
Tot. Org. Carbon	mg/L		10.9		
PCB's **	mg/L	0.0001 mg/L	N.D.		
Pesticides ***					
- Organochlorines	mg/L	0.000025 mg/L	N.D.		
- Organophosphates	mg/L	0.0001 mg/L	N.D.		
Total Organics					
- Base/Neutral	mg/L	0.01 mg/L	N.D.		
- Acid	mg/L	0.01 mg/L	N.D.		
AOX	mg/L	0.025 mg/L	N.D.		
Total Purgables	mg/L	0.05 mg/L	N.D.		
TOXICITY					
Daphnia magna	LC50		N.T.		

* Canadian Drinking Water Quality Guidelines - Shaded Values Exceed Guidelines
MAC - Maximum Acceptable Concentrations
AO - Aesthetic Objectives
** Aroclor 1242-1270
*** See Table of Target Pesticides

N.D. - Not Detected
N.T. - Not Toxic

RANGE ROAD DUMP
GROUNDWATER QUALITY

MONITOR 92-3

PARAMETER	UNITS		FEB/92	CDWQG*	
INORGANICS				MAC	AO
pH			8	6.5 - 8.5	
Elec. Conductivity	uS/cm		320		
Calcium	mg/L		29.7		
Magnesium	mg/L		17.3		
Sodium	mg/L		14		200
Potassium	mg/L		2.38		
Iron	mg/L		0.06		0.3
Sulphate	mg/L		41		500
Chloride	mg/L		0.7		250
Bicarbonate	mg/L		156		
Nitrate & Nitrite	mg/L		<0.05	10 mg/L nitrate as N, 1.0 mg/L nitrite as N	
T. Alkalinity	mg/L		128		
Hardness	mg/L		145	500	
T. Dis. Solids	mg/L		182	500	
Cyanide	mg/L		<0.001	0.2	
C.O.D.	mg/L		99		
METALS					
Aluminum	mg/L		1.67		
Beryllium	mg/L		0.001		
Boron	mg/L		0.03	5	
Cadmium	mg/L		<0.003	0.005	
Chromium	mg/L		<0.006	0.05	
Cobalt	mg/L		<0.01		
Copper	mg/L		<0.01	1	
Barium	mg/L		0.073	1	
Lead	mg/L		<0.04	0.01	
Manganese	mg/L		0.228		0.05
Molybdenum	mg/L		<0.02		
Nickel	mg/L		<0.02		
Phosphorus	mg/L		0.17		
Silver	mg/L		<0.05		
Silicon	mg/L		6.5		
Titanium	mg/L		<0.003		
Thallium	mg/L		<0.1		
Vanadium	mg/L		<0.003		
Zinc	mg/L		0.027		5
Arsenic	mg/L		0.0121	0.05	
Selenium	mg/L		<0.0002	0.01	
Mercury	mg/L		<0.0001	0.001	
ORGANICS		Detection Limit			
Tot. Org. Carbon	mg/L		4.9		
PCB's **	mg/L	0.0001 mg/L	N.D.		
Pesticides ***					
- Organochlorines	mg/L	0.000025 mg/L	N.D.		
- Organophosphates	mg/L	0.0001 mg/L	N.D.		
Total Organics					
- Base/Neutral	mg/L	0.01 mg/L	N.D.		
- Acid	mg/L	0.01 mg/L	N.D.		
AOX	mg/L	0.025 mg/L	N.D.		
Total Purgables	mg/L	0.05 mg/L	N.D.		
TOXICITY					
Daphnia magna	LC50		N.T.		

* Canadian Drinking Water Quality Guidelines - Shaded Values Exceed Guidelines
MAC - Maximum Acceptable Concentrations
AO - Aesthetic Objectives
** Aroclor 1242-1270
*** See Table of Target Pesticides

N.D. - Not Detected
N.T. - Not Toxic

RANGE ROAD DUMP
GROUNDWATER QUALITY

MONITOR 92-4

PARAMETER	UNITS		FEB/92	CDWQG*	
INORGANICS				MAC	AO
pH			7.3	6.5 - 8.5	
Elec. Conductivity	uS/cm		1380		
Calcium	mg/L		110		
Magnesium	mg/L		69.2		
Sodium	mg/L		103		200
Potassium	mg/L		17		
Iron	mg/L		3.24		0.3
Sulphate	mg/L		227		500
Chloride	mg/L		104		250
Bicarbonate	mg/L		489		
Nitrate & Nitrite	mg/L		<0.05	10 mg/L nitrate as N, 1.0 mg/L nitrite as N	
T. Alkalinity	mg/L		401		
Hardness	mg/L		560	500	
T. Dis. Solids	mg/L		871	500	
Cyanide	mg/L		0.004	0.2	
C.O.D.	mg/L		417		
METALS					
Aluminum	mg/L		1.24		
Beryllium	mg/L		0.001		
Boron	mg/L		0.08	5	
Cadmium	mg/L		<0.003	0.005	
Chromium	mg/L		<0.006	0.05	
Cobalt	mg/L		<0.01		
Copper	mg/L		<0.01	1	
Barium	mg/L		0.289	1	
Lead	mg/L		<0.04	0.01	
Manganese	mg/L		1.23		0.05
Molybdenum	mg/L		<0.02		
Nickel	mg/L		<0.02		
Phosphorus	mg/L		0.11		
Silver	mg/L		<0.05		
Silicon	mg/L		8.85		
Titanium	mg/L		0.003		
Thallium	mg/L		<0.1		
Vanadium	mg/L		<0.003		
Zinc	mg/L		0.022		5
Arsenic	mg/L		0.0155	0.05	
Selenium	mg/L		0.0002	0.01	
Mercury	mg/L		<0.0001	0.001	
ORGANICS		Detection Limit			
Tot. Org. Carbon	mg/L		15.4		
PCB's **	mg/L	0.0001 mg/L	N.D.		
Pesticides ***					
- Organochlorines	mg/L	0.000025 mg/L	N.D.		
- Organophosphates	mg/L	0.0001 mg/L	N.D.		
Total Organics					
- Base/Neutral	mg/L	0.01 mg/L	N.D.		
- Acid	mg/L	0.01 mg/L	N.D.		
AOX	mg/L	0.025 mg/L	N.D.		
Total Purgables	mg/L	0.05 mg/L	N.D.		
TOXICITY					
Daphnia magna	LC50		N.T.		

* Canadian Drinking Water Quality Guidelines - Shaded Values Exceed Guidelines
MAC - Maximum Acceptable Concentrations
AO - Aesthetic Objectives
** Aroclor 1242-1270
*** See Table of Target Pesticides

N.D. - Not Detected
N.T. - Not Toxic

RANGE ROAD DUMP
GROUNDWATER QUALITY

MONITOR 92-5

PARAMETER	UNITS		FEB/92	CDWQG*	
INORGANICS				MAC	AO
pH			7.8	6.5 - 8.5	
Elec. Conductivity	uS/cm		610		
Calcium	mg/L		94.4		
Magnesium	mg/L		29.2		
Sodium	mg/L		11		200
Potassium	mg/L		2.91		
Iron	mg/L		0.16		0.3
Sulphate	mg/L		93		500
Chloride	mg/L		0.7		250
Bicarbonate	mg/L		325		
Nitrate & Nitrite	mg/L		<0.05	10 mg/L nitrate as N, 1.0 mg/L nitrite as N	
T. Alkalinity	mg/L		266		
Hardness	mg/L		356	500	
T. Dis. Solids	mg/L		391	500	
Cyanide	mg/L		0.007	0.2	
C.O.D.	mg/L		64		
METALS					
Aluminum	mg/L		1.67		
Beryllium	mg/L		0.001		
Boron	mg/L		<0.01	5	
Cadmium	mg/L		<0.003	0.005	
Chromium	mg/L		<0.006	0.05	
Cobalt	mg/L		<0.01		
Copper	mg/L		<0.01	1	
Barium	mg/L		0.104	1	
Lead	mg/L		<0.04	0.01	
Manganese	mg/L		0.354		0.05
Molybdenum	mg/L		<0.02		
Nickel	mg/L		<0.02		
Phosphorus	mg/L		0.13		
Silver	mg/L		<0.05		
Silicon	mg/L		9.03		
Titanium	mg/L		<0.003		
Thallium	mg/L		<0.1		
Vanadium	mg/L		0.004		
Zinc	mg/L		0.03		5
Arsenic	mg/L		0.0162	0.05	
Selenium	mg/L		0.0005	0.01	
Mercury	mg/L		<0.0001	0.001	
ORGANICS		Detection Limit			
Tot. Org. Carbon	mg/L		4		
PCB's **	mg/L	0.0001 mg/L	N.D.		
Pesticides ***					
- Organochlorines	mg/L	0.000025 mg/L	N.D.		
- Organophosphates	mg/L	0.0001 mg/L	N.D.		
Total Organics					
- Base/Neutral	mg/L	0.01 mg/L	N.D.		
- Acid	mg/L	0.01 mg/L	N.D.		
AOX	mg/L	0.025 mg/L	0.11		
Total Purgables	mg/L	0.05 mg/L	N.D.		
TOXICITY					
Daphnia magna	LC50		N.T.		

* Canadian Drinking Water Quality Guidelines - Shaded Values Exceed Guidelines
MAC - Maximum Acceptable Concentrations
AO - Aesthetic Objectives
** Aroclor 1242-1270
*** See Table of Target Pesticides

N.D. - Not Detected
N.T. - Not Toxic

RANGE ROAD DUMP
GROUNDWATER QUALITY

MONITOR 92-7

PARAMETER	UNITS		FEB/92	CDWQG*	
INORGANICS				**MAC**	**AO**
pH			7.8	6.5 - 8.5	
Elec. Conductivity	uS/cm		450		
Calcium	mg/L		49.2		
Magnesium	mg/L		30.1		
Sodium	mg/L		13		200
Potassium	mg/L		3.17		
Iron	mg/L		0.11		0.3
Sulphate	mg/L		43		500
Chloride	mg/L		0.5		250
Bicarbonate	mg/L		261		
Nitrate & Nitrite	mg/L		0.08	10 mg/L nitrate as N, 1.0 mg/L nitrite as N	
T. Alkalinity	mg/L		214		
Hardness	mg/L		247	500	
T. Dis. Solids	mg/L		268	500	
Cyanide	mg/L		0.002	0.2	
C.O.D.	mg/L		54		
METALS					
Aluminum	mg/L		1.93		
Beryllium	mg/L		0.001		
Boron	mg/L		0.02	5	
Cadmium	mg/L		<0.003	0.005	
Chromium	mg/L		<0.006	0.05	
Cobalt	mg/L		<0.01		
Copper	mg/L		<0.01	1	
Barium	mg/L		0.089	1	
Lead	mg/L		<0.04	0.01	
Manganese	mg/L		0.473		0.05
Molybdenum	mg/L		<0.02		
Nickel	mg/L		<0.02		
Phosphorus	mg/L		0.16		
Silver	mg/L		<0.05		
Silicon	mg/L		8.27		
Titanium	mg/L		0.004		
Thallium	mg/L		<0.1		
Vanadium	mg/L		<0.003		
Zinc	mg/L		0.038		5
Arsenic	mg/L		0.0078	0.05	
Selenium	mg/L		<0.0002	0.01	
Mercury	mg/L		<0.0001	0.001	
ORGANICS		Detection Limit			
Tot. Org. Carbon	mg/L		7.2		
PCB's **	mg/L	0.0001 mg/L	N.D.		
Pesticides ***					
- Organochlorines	mg/L	0.000025 mg/L	N.D.		
- Organophosphates	mg/L	0.0001 mg/L	N.D.		
Total Organics					
- Base/Neutral	mg/L	0.01 mg/L	N.D.		
- Acid	mg/L	0.01 mg/L	N.D.		
AOX	mg/L	0.025 mg/L	N.D.		
Total Purgables	mg/L	0.05 mg/L	N.D.		
TOXICITY					
Daphnia magna	LC50		N.T.		

* Canadian Drinking Water Quality Guidelines - Shaded Values Exceed Guidelines
MAC - Maximum Acceptable Concentrations
AO - Aesthetic Objectives
** Aroclor 1242-1270
*** See Table of Target Pesticides

N.D. - Not Detected
N.T. - Not Toxic

RANGE ROAD DUMP
GROUNDWATER QUALITY

MONITOR 92-8

PARAMETER	UNITS		FEB/92	CDWQG*	
INORGANICS				MAC	AO
pH			7.8	6.5 - 8.5	
Elec. Conductivity	uS/cm		460		
Calcium	mg/L		47.1		
Magnesium	mg/L		30		
Sodium	mg/L		15		200
Potassium	mg/L		3.21		
Iron	mg/L		0.06		0.3
Sulphate	mg/L		34		500
Chloride	mg/L		2.6		250
Bicarbonate	mg/L		265		
Nitrate & Nitrite	mg/L		0.16	10 mg/L nitrate as N, 1.0 mg/L nitrite as N	
T. Alkalinity	mg/L		218		
Hardness	mg/L		241	500	
T. Dis. Solids	mg/L		262	500	
Cyanide	mg/L		0.002	0.2	
C.O.D.	mg/L		64		
METALS					
Aluminum	mg/L		0.47		
Beryllium	mg/L		0.001		
Boron	mg/L		0.02	5	
Cadmium	mg/L		<0.003	0.005	
Chromium	mg/L		<0.006	0.05	
Cobalt	mg/L		<0.01		
Copper	mg/L		<0.01	1	
Barium	mg/L		0.034	1	
Lead	mg/L		<0.04	0.01	
Manganese	mg/L		0.195		0.05
Molybdenum	mg/L		<0.02		
Nickel	mg/L		<0.02		
Phosphorus	mg/L		0.13		
Silver	mg/L		<0.05		
Silicon	mg/L		7.77		
Titanium	mg/L		<0.003		
Thallium	mg/L		<0.1		
Vanadium	mg/L		<0.003		
Zinc	mg/L		0.011		5
Arsenic	mg/L		0.0086	0.05	
Selenium	mg/L		0.0003	0.01	
Mercury	mg/L		<0.0001	0.001	
ORGANICS		Detection Limit			
Tot. Org. Carbon	mg/L		3		
PCB's **	mg/L	0.0001 mg/L	N.D.		
Pesticides ***					
- Organochlorines	mg/L	0.000025 mg/L	N.D.		
- Organophosphates	mg/L	0.0001 mg/L	N.D.		
Total Organics					
- Base/Neutral	mg/L	0.01 mg/L	N.D.		
- Acid	mg/L	0.01 mg/L	N.D.		
AOX	mg/L	0.025 mg/L	N.D.		
Total Purgables	mg/L	0.05 mg/L	N.D.		
TOXICITY					
Daphnia magna	LC50		N.T.		

* Canadian Drinking Water Quality Guidelines - Shaded Values Exceed Guidelines
MAC - Maximum Acceptable Concentrations
AO - Aesthetic Objectives
** Aroclor 1242-1270
*** See Table of Target Pesticides

N.D. - Not Detected
N.T. - Not Toxic

RANGE ROAD DUMP GROUNDWATER QUALITY

MONITOR 92-9

PARAMETER	UNITS		FEB/92	CDWQG*	
INORGANICS				MAC	AO
pH			8.1	6.5 - 8.5	
Elec. Conductivity	uS/cm		330		
Calcium	mg/L		26.1		
Magnesium	mg/L		24.1		
Sodium	mg/L		11		200
Potassium	mg/L		2.83		
Iron	mg/L		0.05		0.3
Sulphate	mg/L		31		500
Chloride	mg/L		2.6		250
Bicarbonate	mg/L		178		
Nitrate & Nitrite	mg/L		0.14	10 mg/L nitrate as N, 1.0 mg/L nitrite as N	
T. Alkalinity	mg/L		146		
Hardness	mg/L		164	500	
T. Dis. Solids	mg/L		186	500	
Cyanide	mg/L		0.002	0.2	
C.O.D.	mg/L		79		
METALS					
Aluminum	mg/L		1.53		
Beryllium	mg/L		0.001		
Boron	mg/L		0.02	5	
Cadmium	mg/L		<0.003	0.005	
Chromium	mg/L		<0.006	0.05	
Cobalt	mg/L		<0.01		
Copper	mg/L		<0.01	1	
Barium	mg/L		0.048	1	
Lead	mg/L		<0.04	0.01	
Manganese	mg/L		0.256		0.05
Molybdenum	mg/L		<0.02		
Nickel	mg/L		<0.02		
Phosphorus	mg/L		0.23		
Silver	mg/L		<0.05		
Silicon	mg/L		6.35		
Titanium	mg/L		<0.003		
Thallium	mg/L		<0.1		
Vanadium	mg/L		<0.003		
Zinc	mg/L		0.028		5
Arsenic	mg/L		0.008	0.05	
Selenium	mg/L		0.0007	0.01	
Mercury	mg/L		<0.0001	0.001	
ORGANICS		Detection Limit			
Tot. Org. Carbon	mg/L		5.9		
PCB's **	mg/L	0.0001 mg/L	N.D.		
Pesticides ***					
- Organochlorines	mg/L	0.000025 mg/L	N.D.		
- Organophosphates	mg/L	0.0001 mg/L	N.D.		
Total Organics					
- Base/Neutral	mg/L	0.01 mg/L	N.D.		
- Acid	mg/L	0.01 mg/L	N.D.		
AOX	mg/L	0.025 mg/L	N.D.		
Total Purgables	mg/L	0.05 mg/L	N.D.		
TOXICITY					
Daphnia magna	LC50		N.T.		

* Canadian Drinking Water Quality Guidelines - Shaded Values Exceed Guidelines
MAC - Maximum Acceptable Concentrations
AO - Aesthetic Objectives
** Aroclor 1242-1270
*** See Table of Target Pesticides

N.D. - Not Detected
N.T. - Not Toxic

RANGE ROAD DUMP
GROUNDWATER QUALITY

MONITOR 92-10A

PARAMETER	UNITS		FEB/92	CDWQG*	
INORGANICS				MAC	AO
pH			8	6.5 - 8.5	
Elec. Conductivity	uS/cm		360		
Calcium	mg/L		27.3		
Magnesium	mg/L		23.7		
Sodium	mg/L		19		200
Potassium	mg/L		2.53		
Iron	mg/L		0.24		0.3
Sulphate	mg/L		32		500
Chloride	mg/L		1.6		250
Bicarbonate	mg/L		194		
Nitrate & Nitrite	mg/L		<0.05	10 mg/L nitrate as N, 1.0 mg/L nitrite as N	
T. Alkalinity	mg/L		159		
Hardness	mg/L		166	500	
T. Dis. Solids	mg/L		201	500	
Cyanide	mg/L		0.002	0.2	
C.O.D.	mg/L		44		
METALS					
Aluminum	mg/L		3.36		
Beryllium	mg/L		<0.001		
Boron	mg/L		0.02	5	
Cadmium	mg/L		<0.003	0.005	
Chromium	mg/L		<0.006	0.05	
Cobalt	mg/L		<0.01		
Copper	mg/L		<0.01	1	
Barium	mg/L		0.108	1	
Lead	mg/L		<0.04	0.01	
Manganese	mg/L		0.401		0.05
Molybdenum	mg/L		<0.02		
Nickel	mg/L		<0.02		
Phosphorus	mg/L		0.27		
Silver	mg/L		<0.05		
Silicon	mg/L		7.65		
Titanium	mg/L		0.006		
Thallium	mg/L		<0.1		
Vanadium	mg/L		0.008		
Zinc	mg/L		0.054		5
Arsenic	mg/L		0.0133	0.05	
Selenium	mg/L		0.0003	0.01	
Mercury	mg/L		<0.0001	0.001	
ORGANICS		Detection Limit			
Tot. Org. Carbon	mg/L		2		
PCB's **	mg/L	0.0001 mg/L	N.D.		
Pesticides ***					
- Organochlorines	mg/L	0.000025 mg/L	N.D.		
- Organophosphates	mg/L	0.0001 mg/L	N.D.		
Total Organics					
- Base/Neutral	mg/L	0.01 mg/L	N.D.		
- Acid	mg/L	0.01 mg/L	N.D.		
AOX	mg/L	0.025 mg/L	N.D.		
Total Purgables	mg/L	0.05 mg/L	N.D.		
TOXICITY					
Daphnia magna	LC50		N.T.		

* Canadian Drinking Water Quality Guidelines - Shaded Values Exceed Guidelines
MAC - Maximum Acceptable Concentrations
AO - Aesthetic Objectives

** Aroclor 1242-1270

*** See Table of Target Pesticides

N.D. - Not Detected
N.T. - Not Toxic

RANGE ROAD DUMP
GROUNDWATER QUALITY

MONITOR 92-10B

PARAMETER	UNITS		FEB/92	CDWQG*	
INORGANICS				MAC	AO
pH			7.7	6.5 - 8.5	
Elec. Conductivity	uS/cm		1160		
Calcium	mg/L		73.9		
Magnesium	mg/L		73.7		
Sodium	mg/L		88		200
Potassium	mg/L		6.25		
Iron	mg/L		0.41		0.3
Sulphate	mg/L		38		500
Chloride	mg/L		87.5		250
Bicarbonate	mg/L		598		
Nitrate & Nitrite	mg/L		<0.05	10 mg/L nitrate as N, 1.0 mg/L nitrite as N	
T. Alkalinity	mg/L		490		
Hardness	mg/L		488	500	
T. Dis. Solids	mg/L		662	500	
Cyanide	mg/L		0.004	0.2	
C.O.D.	mg/L		147		
METALS					
Aluminum	mg/L		1.81		
Beryllium	mg/L		<0.001		
Boron	mg/L		0.07	5	
Cadmium	mg/L		<0.003	0.005	
Chromium	mg/L		<0.006	0.05	
Cobalt	mg/L		<0.01		
Copper	mg/L		<0.01	1	
Barium	mg/L		0.17	1	
Lead	mg/L		<0.04	0.01	
Manganese	mg/L		0.716		0.05
Molybdenum	mg/L		<0.02		
Nickel	mg/L		<0.02		
Phosphorus	mg/L		0.11		
Silver	mg/L		<0.05		
Silicon	mg/L		11.9		
Titanium	mg/L		0.004		
Thallium	mg/L		<0.1		
Vanadium	mg/L		0.005		
Zinc	mg/L		0.053		5
Arsenic	mg/L		0.0346	0.05	
Selenium	mg/L		0.0003	0.01	
Mercury	mg/L		<0.0001	0.001	
ORGANICS		Detection Limit			
Tot. Org. Carbon	mg/L		13.8		
PCB's **	mg/L	0.0001 mg/L	N.D.		
Pesticides ***					
- Organochlorines	mg/L	0.000025 mg/L	N.D.		
- Organophosphates	mg/L	0.0001 mg/L	N.D.		
Total Organics					
- Base/Neutral	mg/L	0.01 mg/L	N.D.		
- Acid	mg/L	0.01 mg/L	N.D.		
AOX	mg/L	0.025 mg/L	N.D.		
Total Purgables	mg/L	0.05 mg/L	N.D.		
TOXICITY					
Daphnia magna	LC50		N.T.		

* Canadian Drinking Water Quality Guidelines - Shaded Values Exceed Guidelines
MAC - Maximum Acceptable Concentrations
AO - Aesthetic Objectives

** Aroclor 1242-1270

*** See Table of Target Pesticides

N.D. - Not Detected
N.T. - Not Toxic

RANGE ROAD DUMP
GROUNDWATER QUALITY

MONITOR 92-11 (Duplicate of Monitor 92-4)

PARAMETER	UNITS		FEB/92		
INORGANICS			92-11	92-4	
pH			7.3	7.3	
Elec. Conductivity	uS/cm		1410	1380	
Calcium	mg/L		108	110	
Magnesium	mg/L		68.6	69.2	
Sodium	mg/L		102	103	
Potassium	mg/L		17	17	
Iron	mg/L		3.26	3.24	
Sulphate	mg/L		211	227	
Chloride	mg/L		104	104	
Bicarbonate	mg/L		485	489	
Nitrate & Nitrite	mg/L		<0.05	<0.05	
T. Alkalinity	mg/L		398	401	
Hardness	mg/L		551	560	
T. Dis. Solids	mg/L		848	871	
Cyanide	mg/L		0.026	0.004	Checked and Confirmed
C.O.D.	mg/L		407	417	
METALS					
Aluminum	mg/L		1.24	1.24	
Beryllium	mg/L		<0.001	0.001	
Boron	mg/L		0.08	0.08	
Cadmium	mg/L		<0.003	<0.003	
Chromium	mg/L		<0.006	<0.006	
Cobalt	mg/L		<0.01	<0.01	
Copper	mg/L		<0.01	<0.01	
Barium	mg/L		0.291	0.289	
Lead	mg/L		<0.04	<0.04	
Manganese	mg/L		1.21	1.23	
Molybdenum	mg/L		<0.02	<0.02	
Nickel	mg/L		<0.02	<0.02	
Phosphorus	mg/L		0.09	0.11	
Silver	mg/L		<0.05	<0.05	
Silicon	mg/L		8.95	8.85	
Titanium	mg/L		0.003	0.003	
Thallium	mg/L		<0.1	<0.1	
Vanadium	mg/L		<0.003	<0.003	
Zinc	mg/L		0.022	0.022	
Arsenic	mg/L		0.0154	0.0155	
Selenium	mg/L		0.0005	0.0002	
Mercury	mg/L		<0.0001	<0.0001	
ORGANICS		Detection Limit			
Tot. Org. Carbon	mg/L		17	15.4	
PCB's *	mg/L	0.0001 mg/L	N.D.	N.D.	
Pesticides **					
- Organochlorines	mg/L	0.000025 mg/L	N.D.	N.D.	
- Organophosphates	mg/L	0.0001 mg/L	N.D.	N.D.	
Total Organics					
- Base/Neutral	mg/L	0.01 mg/L	N.D.	N.D.	
- Acid	mg/L	0.01 mg/L	N.D.	N.D.	
AOX	mg/L	0.025 mg/L	N.D.	N.D.	
Total Purgables	mg/L	0.05 mg/L	N.D.	N.D.	
TOXICITY					
Daphnia magna	LC50		N.T.	N.T.	

* Aroclor 1242-1270
** See Table of Target Pesticides

N.D. - Not Detected
N.T. - Not Toxic