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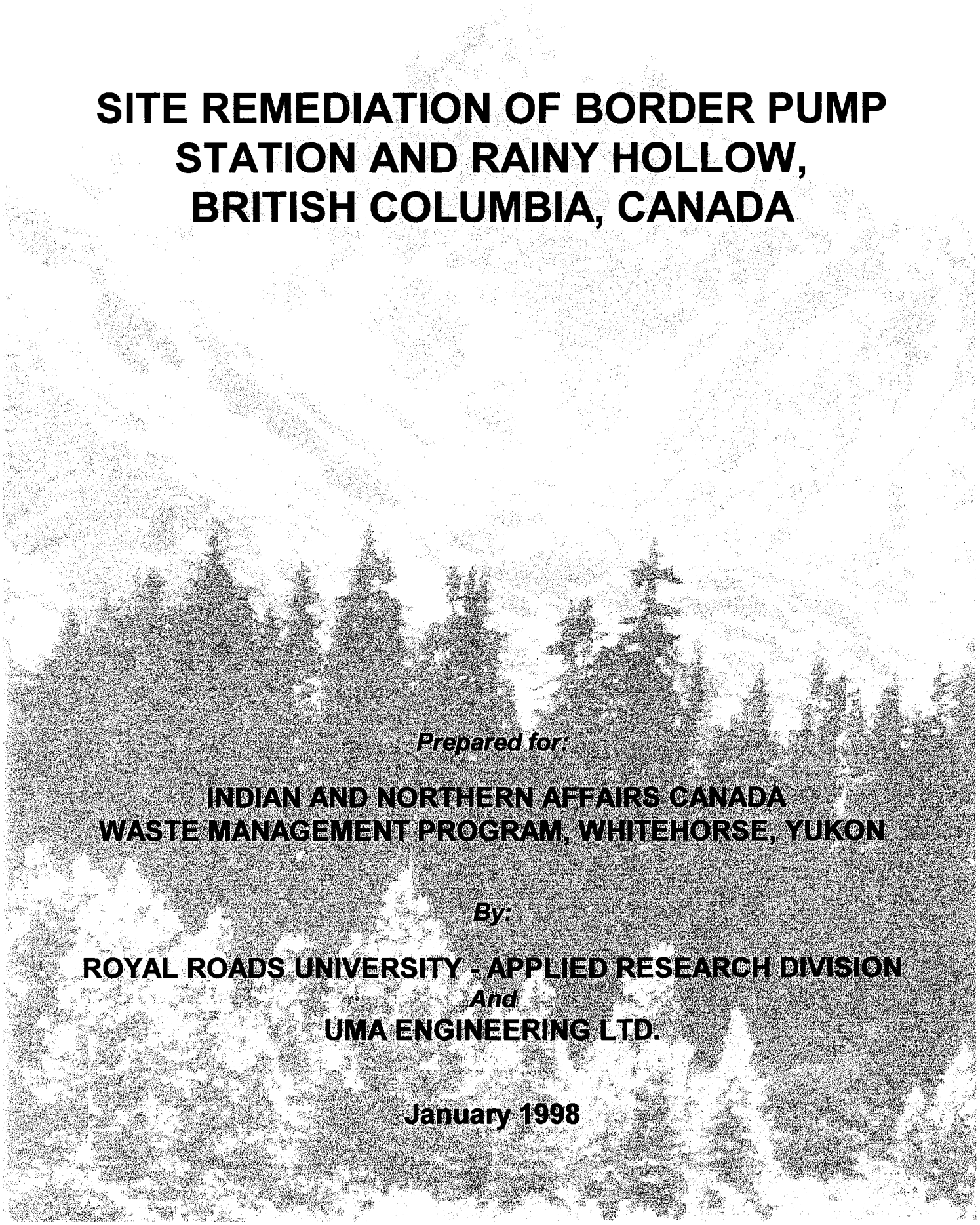
SITE REMEDIATION OF BORDER PUMP STATION AND RAINY HOLLOW, BRITISH COLUMBIA, CANADA



Prepared for:

INDIAN AND NORTHERN AFFAIRS CANADA
WASTE MANAGEMENT PROGRAM, WHITEHORSE, YUKON

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And
UMA ENGINEERING LTD.

January 1998

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EXECUTIVE SUMMARY

Border Pump Station is within northern British Columbia, just north of the U.S. border. The lower bench of the station is known as Rainy Hollow. The site was originally a pump station along the Haines-Fairbanks pipeline, and was operated by the US military from the mid 1950's until it was decommissioned in 1972. Following this, the infrastructure was used as a base camp for the Haines Road re-alignment in 1978 and 1979, and for mineral exploration from 1983 to 1987. The station was finally closed in 1987 at which time a cleanup was conducted by BC Ministry of Forests. All of the buildings and facilities were subsequently demolished by the Department of Public Works under contract to Indian and Northern Affairs (DIAND) in 1992-3.

Buried canisters containing DDTs were found at Rainy Hollow in 1994. This led to an emergency site investigation and clean up. The excavated DDT canisters, along with other materials which were suspected to contain contaminants were shipped off-site for treatment at a facility in the USA. After completion of the excavation, an Arctic grade polyethylene liner was placed in the bottom of the excavation and the "Trench" was filled with surface material. A reinforced polyethylene liner was then placed over the backfilled material to prevent water infiltration and the area was fenced off. DDT contaminated soils removed from the Trench during excavation of the canisters were stored at a Temporary Storage Facility constructed on the upper bench at Border Station. Contaminated materials in this facility were removed and transported to an industrial landfill operated by Waste Management of Canada near Edmonton, Alberta in 1996.

A preliminary environmental investigation was carried out by Golder Associates during the emergency response at Rainy Hollow in 1994. A separate preliminary environmental investigation was conducted at the abandoned Border Pump Station in 1995 by UMA Engineering Ltd. and Ambio Research Associates: Extensive subsurface hydrocarbon contamination was detected in soil samples at depths from the surface to 2 - 24 m. This report provided findings, interpretations and recommendations for a subsequent detailed site investigation and screening-level risk assessment for both Border Station and Rainy Hollow.

The detailed site investigation and screening-level risk assessment of Border Station and Rainy Hollow was undertaken by the Applied Research Division at Royal Roads University, in association with UMA Engineering Ltd., and Golder Associates Ltd. in 1996. The major contaminant sources of concern at Rainy Hollow and Border Station were confirmed to be (a) subsurface soils and groundwater at Border Station and Rainy Hollow contaminated with light, diesel-like hydrocarbons (b) DDTs in subsurface soils and groundwater, arising from the earlier burial of DDT-containing canisters in a trench at Rainy Hollow; and (c) DDTs in surface soils at Rainy Hollow near the trench, at Border Station near the Temporary Storage Facility, and on access roads and tracked areas between them. Recommendations provided in the report included the continuation of the groundwater monitoring program to validate and improve predictions of contaminant fate, removal or isolation of contaminated surface soils with DDT concentrations greater than

10 mg/kg (or ppm), capping of soils with DDT concentrations between 1- 10 mg/kg and site restoration to minimize surface soil erosion.

The results and recommendations of the Detailed Site Investigation and Risk Assessment were reviewed at a meeting of the Rainy Hollow Working Group held at Royal Roads University on February 21, 1997. The Working Group comprising representatives from Indian and Northern Affairs; Champagne and Aishihik First Nations; BC Ministry of Environment Land and Parks; Royal Roads University; Golder Associates; and UMA Engineering Ltd. verbally approved the cleanup plan proposed in the report. A construction specification for site remediation was subsequently developed by UMA Engineering Ltd.

Using the methodology presented in the construction specification, site remediation activities were carried out between August 20 and September 14, 1997. The clean up project team consisted of representatives from: Indian and Northern Affairs, Waste Management, Whitehorse (Project Authority); Champagne-Aishihik First Nations, Haines Junction, YT (Construction Contractor); Royal Roads University, Applied Research Division (Scientific/Technical Coordinator); and UMA Engineering Ltd. (Engineering Consultant).

A total of 226 tonnes of surface soils contaminated with total DDT concentrations exceeding 10 mg/kg were excavated from the vicinity of the former Temporary Storage Facility and near the Trench at Rainy Hollow. This was to curtail the possible exposure pathways for DDTs in surface soils to wildlife and humans. The excavated soils were taken to the East Peace Industrial Waste Treatment and Disposal Site, Peace River, Alberta for disposal. The remaining DDT-contaminated soils with total DDT concentration in the range of 1 to 10 mg/kg and hydrocarbon-contaminated soils with concentrations exceeding 1000 mg/kg were capped using a minimum of 0.5m of clean granular material. Capping material was hauled in from a borrow area along Haines Highway designated by the Department of Highways, Yukon Territorial Government.

Eighteen monitoring wells required for the long-term monitoring program were reset to below ground surface. The purpose of this task was to reduce the visibility of the monitoring wells at the site and minimize the potential for tampering. In addition, 11 wells which were no longer needed for monitoring purposes were cut off at a depth of 1m below ground surface and sealed. The excavated areas around the wells were backfilled to surface and graded to match existing contours.

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1. INTRODUCTION

1.1 Site Description and History

Border Pump Station is located in British Columbia, 8 km north of the Canada Customs Post at Pleasant Camp. The lower bench of the site, which is situated near the Klehini River is known as Rainy Hollow. A general layout of the site is given on Map 1-1, located at the end of this chapter. The site was originally a pump station along the Haines-Fairbanks pipeline, and was operated by the US military from the mid 1950's until it was decommissioned in 1972. Following this, the infrastructure was used as a base camp for the Haines Road re-alignment in 1978 and 1979, and for mineral exploration from 1983 to 1987. The station was finally closed in 1987 at which time a cleanup was conducted by BC Ministry of Forests. All of the buildings and facilities were subsequently demolished by the Department of Public Works under contract to DIAND in 1992-3, and buried on site. The clean-up activities have been summarized in a report by Applied Research Division, Royal Roads University (Royal Roads, 1996a). A historical review of the sites may be found in a report prepared for Indian and Northern Affairs by K.Bisset and Associates (1995).

1.2 1994 Emergency Action Response and Temporary Storage Facility

In 1994, buried canisters containing DDT (dichlorodiphenyltrichloroethane) pesticide were found at Rainy Hollow, prompting an Emergency Response and clean up (Golder, 1995). These DDT canisters were reported to have been previously buried in a trench there in 1971. The excavated DDT canisters, along with other materials which were suspected to contain contaminants (wastewater, empty barrels, transformer oil, and unknown solids) were placed in overpack barrels and shipped off-site for treatment at a facility in the USA. After completion of the excavation, an Arctic grade polyethylene liner was placed in the bottom of the excavation and the "Trench" was filled with surface material. A reinforced polyethylene liner was placed over the backfilled material to prevent water infiltration and the area was fenced off. DDT contaminated soils removed from the Trench during excavation of the canisters were stored at a temporary storage facility constructed on the upper bench at Border Station.

The concentrations of DDT and it's breakdown products and of hydrocarbons in the materials at the Temporary Storage facility were characterized by the Royal Roads University Applied Research Division on behalf of the Arctic Environmental Strategy - Action on Waste Program (Indian and Northern Affairs) in May-June of 1996. The total volume of the soil pile was estimated to be less than 330 m^3 with DDT (DDT + DDE + DDD) concentrations ranging between 3.6 and 57 mg/kg (ppm). Hydrocarbons in the soil were mostly diesel, with measurable quantities of heavy oils (lubricants and grease) (Royal Roads, 1996b).

A number of remediation scenarios for the Storage Facility were considered by Indian and Northern Affairs, including active and passive (*in-situ*) treatment on site, and removal of the soils off-site to a hazardous waste disposal facility. Off-site removal to a secure facility was chosen as the most viable option from an environmental and economic viewpoint. The

removal was conducted by Champagne and Aishihik First Nations and their sub-contractor Hazco Environmental Services Ltd. on October 15 , 1996. The material was transported to an industrial landfill in Edmonton, Alberta, operated by Waste Management of Canada, Ltd. Subsequent on-site inspections were conducted by Indian and Northern Affairs which confirmed the removal of all materials associated with the facility (Appendix D).

1.3 Preliminary Environmental Investigations

Contamination of subsurface soils and groundwater by DDT and hydrocarbons at the Rainy Hollow site were identified during a preliminary environmental assessment by Golder Associates in conjunction with the Emergency Response effort. In a separate preliminary environmental assessment study conducted the following summer, hydrocarbon contamination of subsurface soil and groundwater at the Border Station site was identified. This study was part of preliminary environmental assessments along the Haines-Fairbanks Pipeline by UMA Engineering and Ambio Research Associates on behalf of Indian and Northern Affairs (UMA/AMBIO, 1995, Royal Roads, 1996c). The study also concluded with the possibility that this contamination may be passing with groundwater down through the Rainy Hollow site to the Klehini River.

In order to obtain a better understanding of subsurface contaminant distribution between the two sites, a review and reassessment of environmental issues at Border Station and Rainy Hollow was carried out (Royal Roads, 1996a). It was recognized that this would be required before impacts could be assessed and further action proposed. All the available site information, including environmental/scientific investigations and clean up activities was collated and synthesized. Outstanding environmental issues at the sites were identified to include: a better understanding of the spatial and vertical distribution of subsurface hydrocarbon contamination; DDT contamination in soil and groundwater; the presence of buried debris which may be potentially contaminated; and the need for a risk assessment in the terrestrial environment around the two sites and the aquatic environment of the Klehini River.

1.4 Detailed Site Investigation and Risk Assessment

A detailed site investigation and screening-level risk assessment of Border Station and Rainy Hollow was undertaken by the Applied Research Division at Royal Roads University, in association with UMA Engineering Ltd., and Golder Associates Ltd. in 1996 (Royal Roads University, 1997).

The sampling and analytical program comprised collection and analysis of over 200 surface or subsurface soil samples for hydrocarbons, chlorinated pesticides, PCBs and/or metals, and analysis of large numbers of groundwater samples for hydrocarbons and chlorinated pesticides. Samples of plants and small mammals in the vicinity of the Trench at Rainy Hollow or the Temporary Storage Facility, as well as river water, sediment, and stream bed invertebrates from the Klehini River were also analyzed for the purpose of conducting a screening level risk assessment of human health and ecological receptors.

The major contaminant sources of concern at Rainy Hollow and Border Station were confirmed to be (a) subsurface soils and groundwater at Border Station and Rainy Hollow contaminated with light, diesel-like hydrocarbons (b) DDTs in subsurface soils and groundwater, arising from the earlier burial of DDT-containing canisters in a trench at Rainy Hollow; and (c) DDTs in surface soils at Rainy Hollow near the trench, at Border Station near the Temporary Storage Facility, and on access roads and tracked areas between them.

There was some evidence that both DDT and hydrocarbons were being introduced to the Klehini River through the discharge of contaminated groundwater; however, the actual instantaneous concentrations of these substances in sediment, river water, or stream invertebrates was so low as to preclude any possibility of deleterious biological effects. DDT concentrations were indistinguishable from background levels for sediment and stream invertebrates. Possible risk pathways for contamination of the Klehini River and its inhabitants, therefore, could be confidently ruled out, since the dose to aquatic organisms contributed from contaminated areas at Rainy Hollow *via* sediment or river water was essentially nil. A conceptual model of DDT transport in groundwater at the site was developed.

The screening risk assessment included an evaluation of risks to non-human receptors in the Klehini River due to DDT inputs *via* contaminated groundwater, and to small mammals and their predators in the terrestrial and riparian habitat within ~ 100 m of the Rainy Hollow Trench. The human health risks associated with ingestion of DDT-contaminated soil, inhalation of DDT in the gaseous phase, or dermal absorption were also assessed. The human health risk assessment indicated that in the context of the exposure scenarios considered for this site, there is no risk to humans from exposure to DDT and its related compounds at Rainy Hollow.

Recommendations for follow-up and remedial action were provided on the basis of the premise that the need for any action arises only in situations where there was a possibility of risk to humans and/or other living organisms at present, or some reasonable expectation that risks could occur in the future. Recommendations included the continuation of a groundwater monitoring program to validate and improve predictions of contaminant fate, removal or isolation of contaminated surface soils with DDT concentrations greater than 10 mg/kg, capping of soils with DDT concentrations between 1- 10 mg/kg and site restoration to minimize surface soil erosion. Details of the recommendations and remedial action plans are discussed below.

1.5 Remedial Action Plan and Construction Specifications

The results and recommendations of the Border Station/Rainy Hollow Detailed Site Investigation and Risk Assessment were reviewed at a meeting of the Rainy Hollow Working Group held at Royal Roads University on February 21, 1997. The Working Group comprising representatives from Indian and Northern Affairs; Champagne and Aishihik First Nations; BC Ministry of Environment Land and Parks; Royal Roads

University; Golder Associates; and UMA Engineering Ltd. verbally approved the cleanup plan proposed in the report. Further remedial action should include:

- The curtailment of the possible exposure pathways for DDTs in surface soils to wildlife and humans by the removal and off-site disposal of soils with total DDT concentrations exceeding 10 mg/kg.

- The isolation of the remaining DDT-contaminated soils with total DDT concentration in the range of 1 to 10 mg/kg and hydrocarbon-contaminated soils with concentrations exceeding 1000 mg/kg by capping using a minimum of 0.5m of clean granular material.

- The development of a long term groundwater monitoring program to validate and improve predictions of contaminant fate. This included the monitoring of groundwater levels and DDT concentrations in the existing wells, in addition to the verification of the DDT contaminant transport model used.

- The modifications of existing wells required for the long-term monitoring program to below grade and sealing and abandoning the remaining wells.

The recommendations above were used in the development of construction specifications for the site remediation by UMA Engineering (UMA, 1997). The conceptual model of DDT transport was also expanded and evaluated in a follow up document (Woodbury, 1997).

1.6 Objectives of this Report

Using the methodology presented in the construction specification, site remediation activities were carried out between August 20 and September 14, 1997. The clean up project team consisted of representatives from:

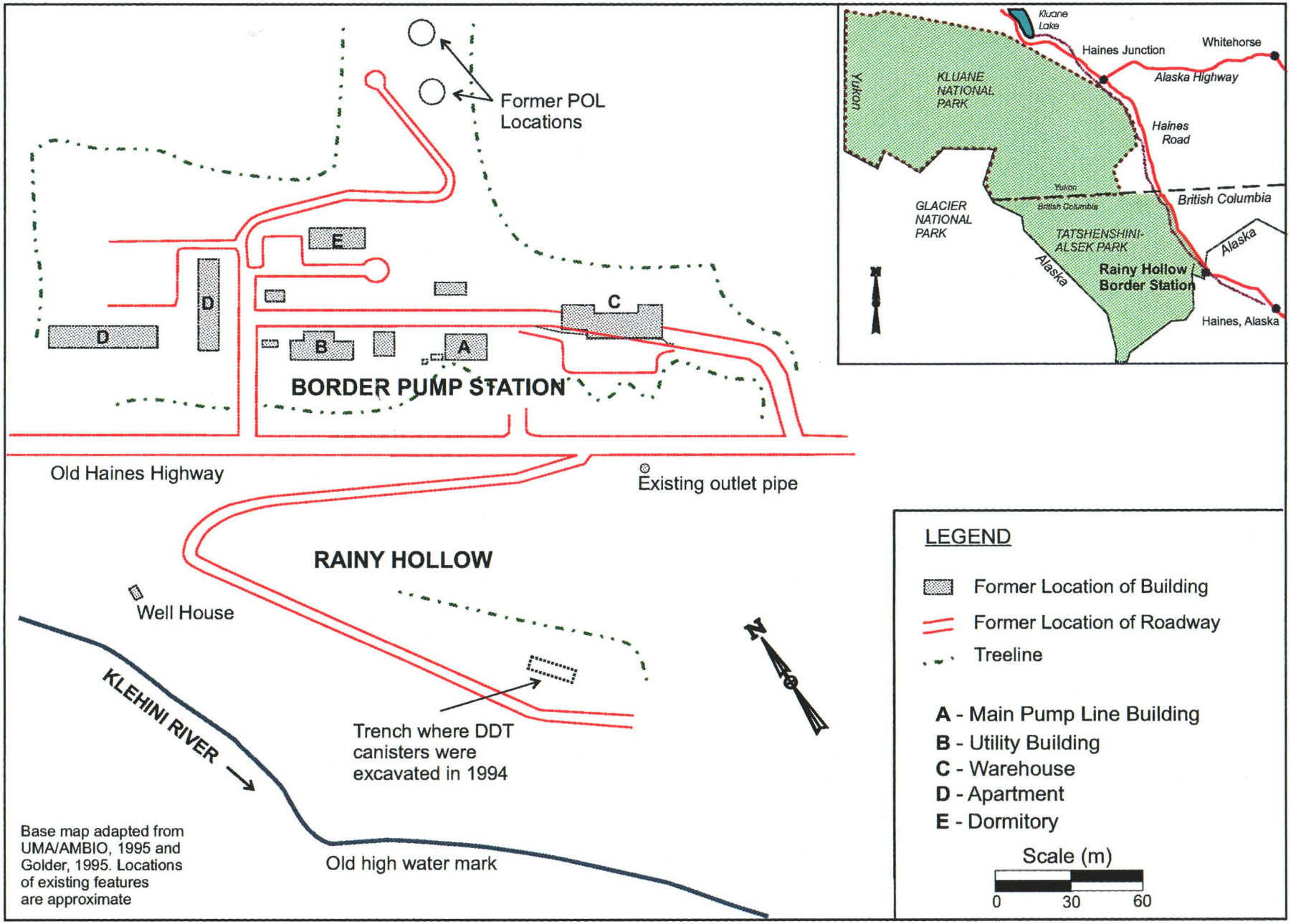
- Indian and Northern Affairs, Waste Management - Project Authority

- Champagne-Aishihik First Nations, Haines Junction, YT - Construction Contractor

- Royal Roads University, Applied Research Division - Scientific/Technical Coordinator; and

- UMA Engineering Ltd. - Engineering Consultant.

This report presents a summary of the results and the methodology employed.



Map 1-1: General layout of Border Pump Station and Rainy Hollow

2. EXCAVATION AND DISPOSAL OF CONTAMINATED SOILS

2.1 Methodology

2.1.1 Excavation

Excavation and stockpiling for off-site disposal of soils contaminated with DDT at concentrations greater than 10 mg/kg or ppm was completed using an excavator and dump trucks by the Champagne and Aishihik First Nation, Haines Junction, YT.

Personnel from UMA Engineering Ltd., with the assistance of Indian and Northern Affairs, Waste Management representatives, laid out the limits of the area to be excavated based on the drawings presented in the Construction Specifications (UMA, 1997). Soils samples were then collected from locations around the periphery of the demarcated area by RRU personnel. These samples were analyzed on-site for either DDTs or PAHs using EnviroGard™ immunoassay test kits. Sampling locations and analytical results are given in the sections below. Details of the sampling and analytical procedures are provided in Appendix C. Based on the results of the analysis, the excavation limits were adjusted to include areas where additional excavation was required.

To facilitate calculation of excavation volumes for payment purposes, the ground surface was surveyed using a rod and level before and after the excavation was completed. These elevations were then used to plot cross sections of the excavation and from these the excavation volumes were calculated (Appendix B).

During the excavation process protective dust masks were worn by all workers in the area. An effort was also made to keep workers up wind of the excavation while work was in progress. The excavator was kept out of the excavation area and worked from the outside of the marked area inwards. Haul trucks were also kept out of the limits of excavation to minimize the chance for tracking contaminated soil over other clean areas of the site.

Excavated soil was hauled to the upper bench (former Temporary Storage Facility) and temporarily stockpiled. The soil was placed on tarps laid out in the area already designated for capping to eliminate the possibility of contaminating a new area at the site. The tarps were taken from the old excavation area on the Rainy Hollow site and turned so that the clean side was facing down. After all of the excavated soil was placed on the tarp, the soil was covered with additional tarps prior to removal off-site (Photograph 1).

2.1.2 Field Test Kits

The validation of the immunoassay test kits as a possible analytical method for confirmatory testing was carried out during the Detailed Site Investigation and Risk Assessment (Royal Roads, 1997). A total of 42 surface soil samples were analyzed for DDTs using field test kits; 13 of these were then re-analyzed in the laboratory by gas chromatography with electron capture detection (GC/ECD). The field test kits accurately estimated the 'true' concentration as determined by GC/ECD for ten of the samples. For the remaining three samples, the DDT concentration was over-estimated by the field test

kits. While some analyses were over-sensitive (i.e., over-estimate the true total DDT concentration), in no case did a sample determined to contain less than 1 mg/kg DDT using the field test kits have a real total DDT concentration greater than 1 mg/kg. It was concluded that the DDT field test kit data would provide a good indication of soil samples at the sites with DDT concentrations above or below 1 mg/kg.

The correlation between the field test kits results and laboratory analytical data, as determined by gas chromatography with flame ionization detection (GC/FID), was very poor for total petroleum hydrocarbons (TPH). The calibrations standards provided with the TPH kits were made up from home heating oil. Diesel fuel which was undoubtedly the source of the hydrocarbon contamination at Rainy Hollow and Border Station has been shown to have a different response to the test kits than home heating oil (Millipore, 1995) and this may have accounted for the discrepancy. In light of the uncertainty regarding the accuracy of the TPH field test kit results, the kits were not used during remediation in 1997. Instead, EnviroGard™ polynuclear aromatic hydrocarbon (PAH) in soil test kits were used as a surrogate measure of hydrocarbon contamination. This kit has been shown to give a positive interpretation of 75 mg/kg of diesel contamination using the 1 mg/kg PAH calibrator supplied (EnSys, 1995) as such, a concentration of less than 10 mg/kg PAH was used to indicate remediation.

2.2 Lower Level (Rainy Hollow)

2.2.1 Delineation and Excavation

The area of surface soil affected with DDTs at concentrations exceeding 10 mg/kg was excavated for off site disposal on August 21 and 22, 1997 under generally fair weather conditions with minimal or no precipitation.

The area to be excavated was laid out on the basis of the drawings in the Construction Specifications (UMA, 1997). Sampling locations (denoted by L- and M- prefix) and concentrations of total DDTs in the samples used to generate this drawing are indicated on Map 2-1. Fifteen additional soil samples (A1-A15) were collected and analyzed on site to further demarcate the contaminated area. As part of the Quality Assurance/Quality Control (QA/QC) process, three of the soil samples were submitted to Axys Analytical Services for laboratory analysis. On the basis of the field test kit results (Table 2-1), the area laid out for excavation was increased slightly from that originally estimated. The demarcated area, sampling locations and total DDT concentrations are shown on Map 2-1.

Table 2-1: Concentration of total DDTs in soil samples collected to further delineate contamination in the vicinity of the Trench at Rainy Hollow.

Sample Number	Concentration of Total DDTs (mg/kg or ppm)	
	Field Test Kit	Laboratory Analysis
A1	1-10	-
A2	<1.0	-
A3	<1.0	-
A4	<1.0	-
A5	<1.0	-
A6	>10	-
A7	>10	-
A8	<1.0	-
A9	~1.0	0.2
A10	<1.0	-
A11	~1.0	-
A12	~1.0	0.33
A13	<1.0	-
A14	~1.0	-
A15	1-10	1.6

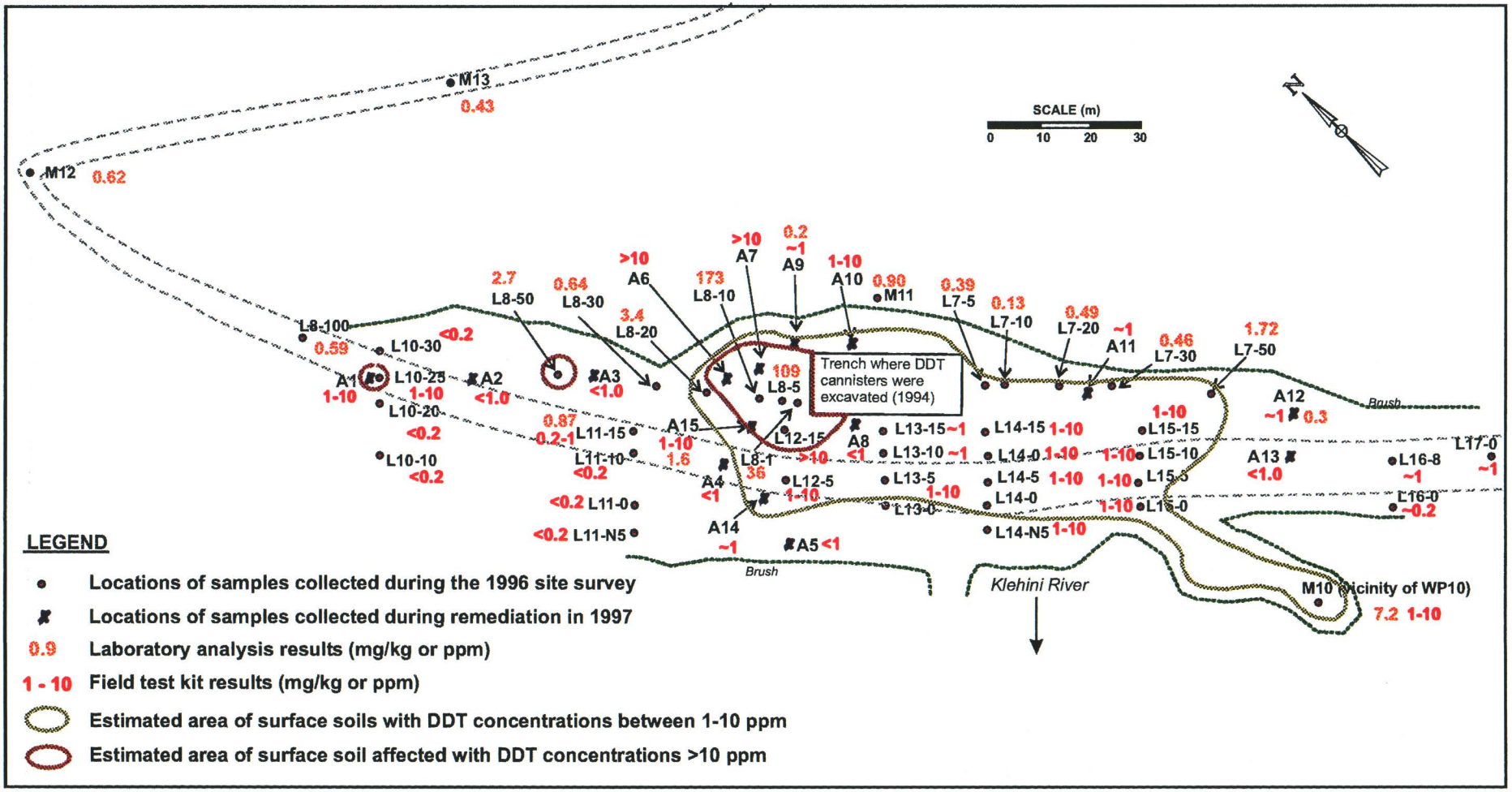
2.2.2 Confirmatory Testing

Following the initial excavation to a depth of up to 0.15m, confirmatory samples (AA1 - AA8) were collected from the excavated area. Samples AA1, AA2 and AA5 contained DDTs at concentrations exceeding 10 mg/kg while the remaining samples had levels between 1-10 mg/kg (Table 2.2). This suggested additional excavation was needed in the vicinities of AA1, AA2 and AA5. As such, soils in these locations were removed to a maximum depth of 0.25m. Samples AA9 and AA10 collected after the second series of excavations contained 1-10 and <1.0 mg/kg DDT, respectively. This indicated the successful removal of soils affected with DDTs exceeding 10 mg/kg. The entire area was then capped with clean gravel borrow as described in Section 3.2.

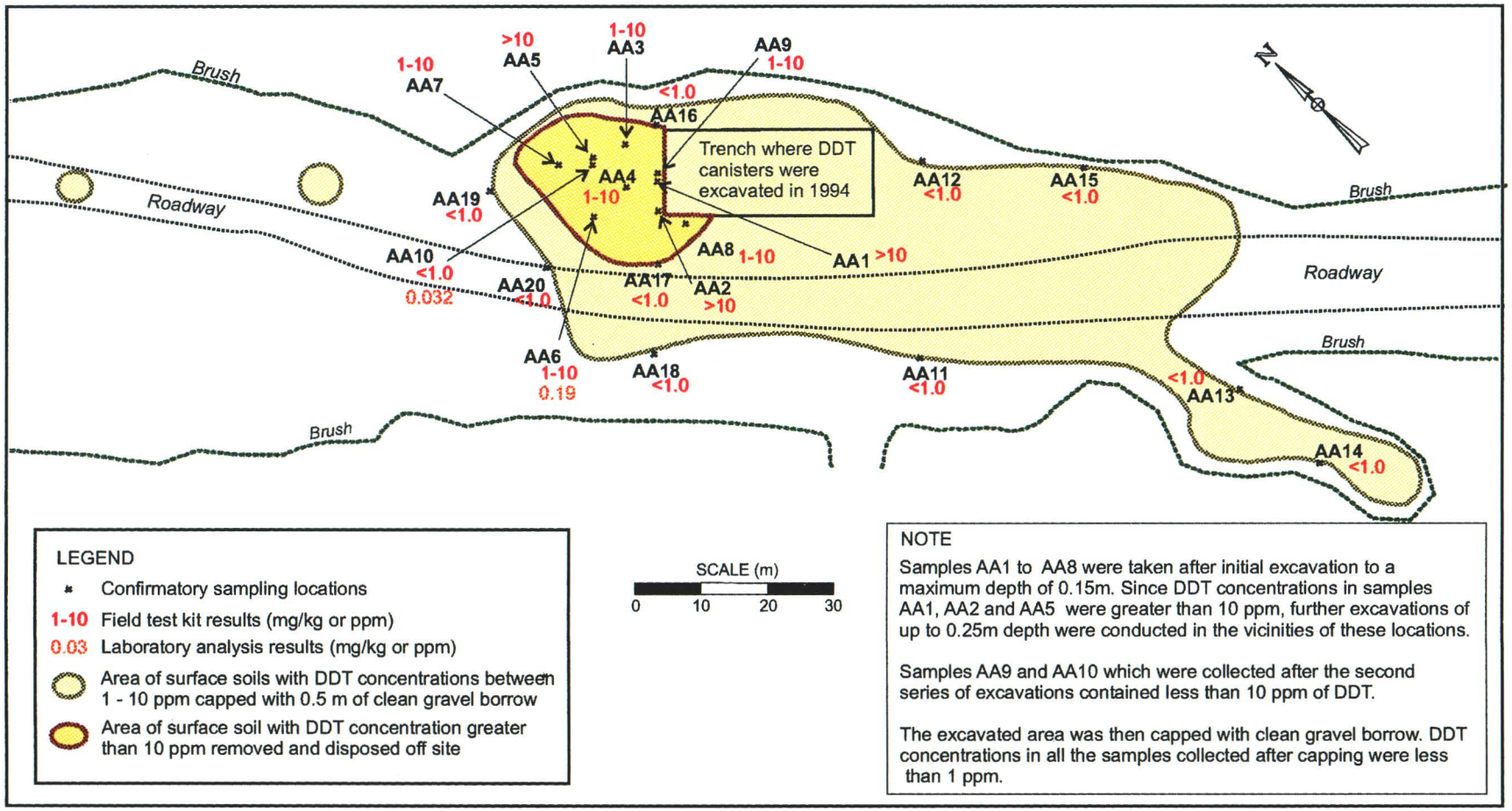
Table 2-2: Concentration of total DDTs in confirmatory soil samples collected after excavation of contaminated soils in the vicinity of the Trench at Rainy Hollow.

Sample Number	Concentration of Total DDTs (mg/kg or ppm)	
	Field Test Kit	Laboratory Analysis
AA1	>10	-
AA2	>10	-
AA3	1-10	-
AA4	1-10	-
AA5	>10	-
AA6	1-10	0.19
AA7	1-10	-
AA8	1-10	-
AA9	1-10	-
AA10	<1.0	0.032

Confirmatory sampling locations and DDT concentrations are given on Map 2-2. The excavated area is shown on Drawing 02 (Appendix B) and Photographs 2 and 2a. The total in place volume of soil excavated from the lower level (Rainy Hollow) for off site disposal was 110.5 m^3.



Map 2-1: Locations and concentrations of DDTs soil samples collected to delineate the extent of contamination at the Lower Site, Rainy Hollow prior to excavation of contaminated soil or capping



Map 2-2: Locations and concentrations of DDTs in confirmatory samples taken after excavation or capping at the Lower Site, Rainy Hollow

2.3 Upper Level (Former Temporary Storage Facility)

2.3.1 Delineation and Excavation

Soils containing DDTs at concentrations exceeding 10 mg/kg were excavated from the vicinity of the former Temporary Storage Facility[1] on August 25, 1997 under fair weather conditions with minimal or no precipitation. Data obtained from samples collected during the 1996 Detail Site Investigation indicated excavation was required at a depression along the road to the Temporary Storage Facility (location M14). In order to define the contaminated area, four soil samples (B1-B4) were collected near M14 and analyzed on-site (Table 2-3). Additional samples (C1-C12) were also taken from other locations near the former Temporary Storage Facility to delineate the extent of contamination over the entire area. As part of the QA/QC process, three of the soil samples were submitted to Axys Analytical Services for laboratory analysis. Sampling locations and concentrations of total DDT in the samples are included in Map 2-3.

Table 2-3: Concentration of total DDTs in soil samples collected to further delineate contamination in the vicinity of the Temporary Storage Facility at Border Station

Sample Number	Concentration of Total DDTs (mg/kg or ppm)	
	Field Test Kit	Laboratory Analysis
C1	1-10	-
C2	1-10	-
C3	1-10	5.7
C4	1-10	-
C5	>>10	-
C6	>>10	-
C7	1-10	-
C8	1-10	9.4
C9	<1.0	-
C10	>10	-
C11	>10	-
C12	1-10	-
B1	>10	-
B2	>10	15
B3	1-10	-
B4	>10	-

[1] DDT contaminated soils, fence and berm in the Temporary Storage Facility were removed in October 1996 (see Appendix D).

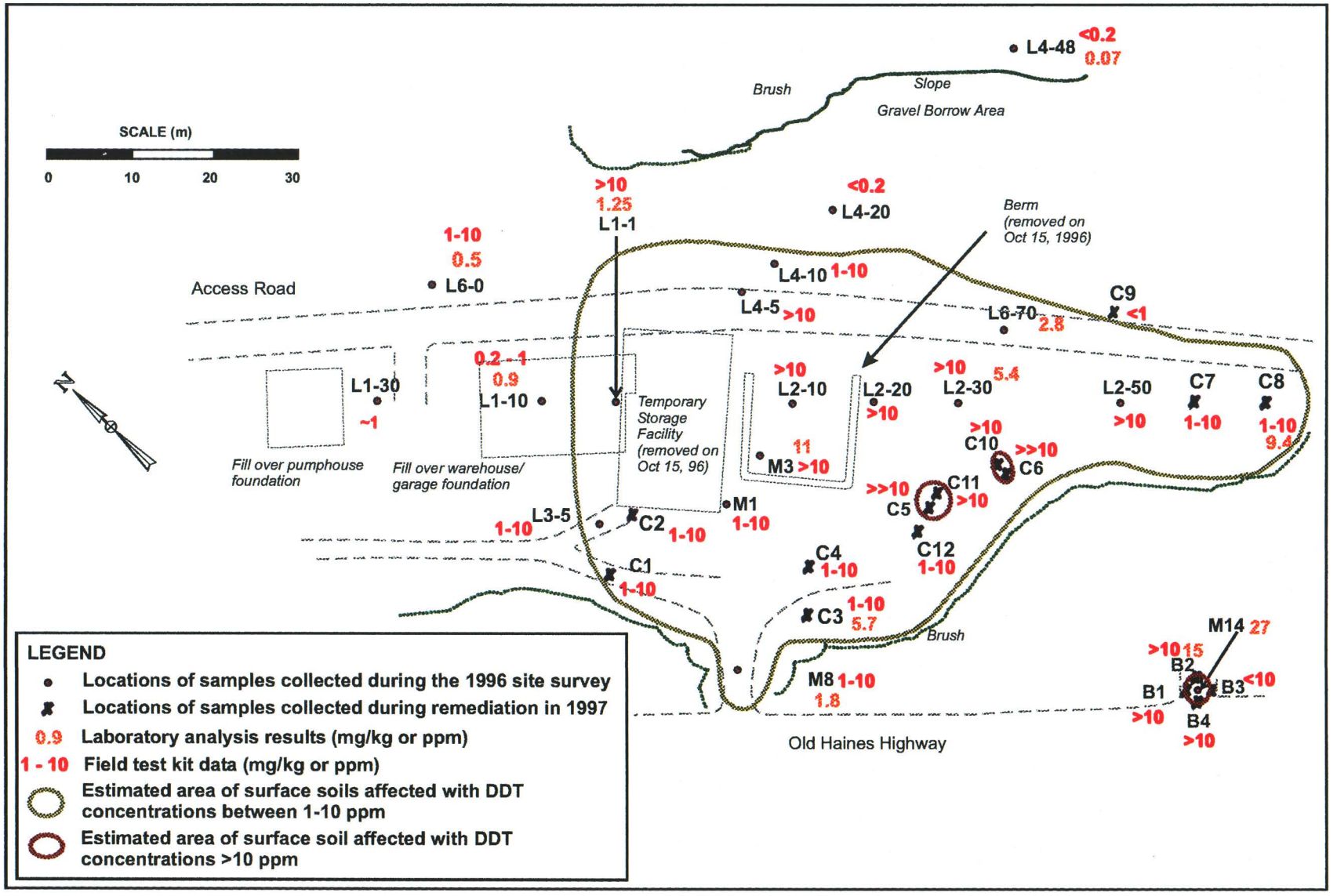
This data indicated the concentration of DDTs in soils near locations C5 and C6 far exceeded 10 mg/kg. Substrate from these two areas, in addition to that from the originally identified location (M14) were excavated. The total volume of soil excavated from these three locations and stockpiled for disposal off site was 14.5 m^3. The areas excavated are shown on Drawing 02 (Appendix B); Photograph 3 depicts location M14 after excavation of the DDT contaminated soil and capping with clean gravel borrow.

2.3.2 Confirmatory Testing

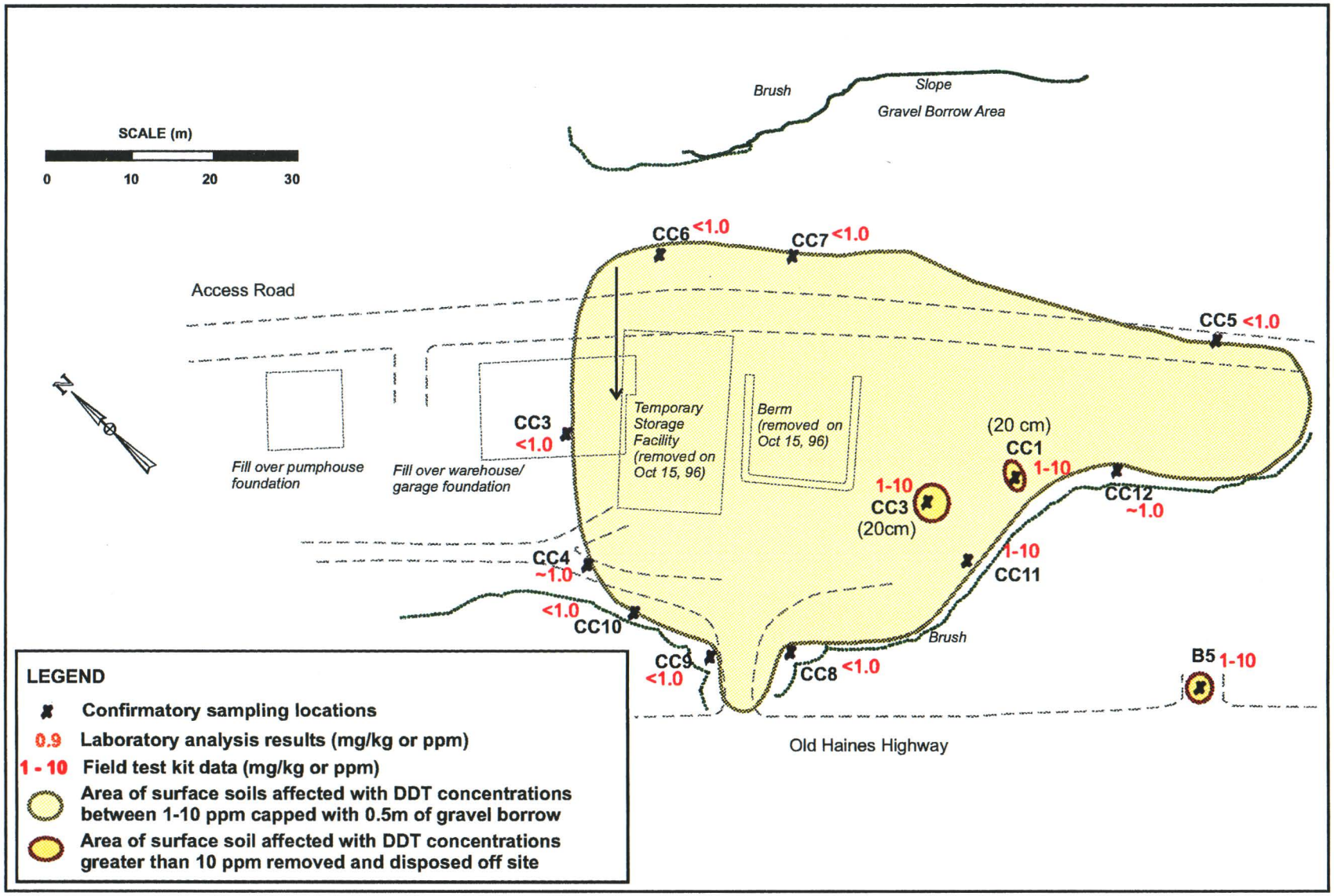
One soil sample was collected at 0.20 m depth from each of the three excavated areas and analyzed with the field test kit. The concentration of DDT in these samples (B5, CC1 and CC2) were between 1-10 mg/kg (Table 2-4). This indicated the successful removal of soils with contaminants exceeding 10 mg/kg. Sampling locations and concentrations are shown on Map 3-4.

Table 2-4: Concentration of total DDTs in confirmatory soil samples collected after excavation of contaminated soils in the vicinity of the Former Temporary Storage Facility at Border Station.

Sample Number	Concentration of Total DDTs (mg/kg or ppm)
B5	1-10
CC1	1-10
CC2	1-10



Map 2-3: Locations and concentrations of DDTs in soil samples collected to delineate the extent of contamination in the vicinity of the former Temporary Storage Facility, prior to excavation and capping



Map 2-4: Locations and concentrations of DDTs in confirmatory soil samples collected after excavation or capping in the vicinity of the former Temporary Storage Facility

2.4 Disposal of Contaminated Soils

The excavated soil was placed on tarps laid out in the area already designated for capping and covered with additional tarps prior to removal off-site (Photograph 1). The stockpiled material was removed by Champagne and Aishihik First Nations and Hazco Environmental Services Ltd. of Calgary, Alberta on September 14, 1997 under the supervision of DIAND-Waste Management personnel.

A total of 226.8 tonnes of contaminated soil was removed and loaded onto eight special waste transport units. These were then taken to the East Peace Industrial Waste Treatment and Disposal Site, Peace River, Alberta for disposal. Details of the removal and disposal procedures are given in correspondence attached in Appendix D.

2.5 Quality Assurance/Quality Control

Eight soil samples were submitted to Axys Analytical Services and analyzed for DDTs by Gas Chromatography coupled to a mass spectrometer (GC-MS). The laboratory analytical method and report are included in Appendix C. A comparison of the field test kit and laboratory result is given in Table 2-5. Generally, there was good agreement between the field results and the laboratory data. However, concentrations for A9, A12 and AA6 as determined by the field test kits were higher than those obtained by GC-MS. This result is consistent with the test kit validation results made during the 1996 Detail Site Investigation (Royal Roads, 1997).

Table 2-5: Concentration of DDTs in soil samples as determined by immunoassay test kits and laboratory GC-MS analysis

Sample Number	Concentration of Total DDTs (mg/kg or ppm)	
	Field Test Kit	Laboratory Analysis
A9	~1.0	0.2
A12	~1.0	0.33
A15	1-10	1.6
AA6	1-10	0.19
AA10	<1.0	0.032
C3	1-10	5.7
C8	1-10	9.4
B2	>10	15

3. CAPPING AND GRADING

3.1 Methodology

Placement and grading of the cap over the designated areas at Rainy Hollow/Border Pump Station was completed using a D7 Bulldozer. Capping material was hauled from a borrow area along kilometer 75 of Haines Road designated by the Yukon Territorial Government (YTG) Department of Highways. The borrow area was located on the east side of the Haines Road approximately 5 km north of the Rainy Hollow/Border Pump Station turn off. The material was hauled to the site using two belly dump and up to three end dump trucks. All equipment used was supplied by the Champagne and Aishihik First Nation of Haines Junction, Yukon. Photograph 4 shows the borrow area after removal of fill material. At the request of YTG Department of Highway's personnel, no re-grading was done after removal of fill material. The Department of Highway had planned to borrow gravel from this location for road maintenance activities and final landscaping will follow the completion of these operations.

Personnel from UMA Engineering Ltd., with assistance from Indian and Northern Affairs, Action on Waste representatives, laid out the limits of the area to be capped on the basis of the results of the 1996 Detailed Site Investigations and as presented in the Construction Specifications. Samples from locations where information was limited, within and outside the contaminated areas, were collected by Royal Roads University staff and analyzed with field test kits. Based on the results of these analyses, the cap limits were adjusted.

All equipment was kept outside of the area designated for capping. Clean fill was dumped at the edges of the cap area and pushed in by the bulldozer, creating a working platform as it proceeded inwards.

To facilitate calculation of cap volumes for payment purposes, the ground surface was surveyed using a rod and level before and after the capping was completed. These elevations were then used to plot cross sections of the cap and from these the cap volumes were calculated. Copies of the cross section plots are given in Appendix B.

3.2 Lower Level (Rainy Hollow)

The limits of the area to be capped were laid out on the basis of the results of the 1996 Detailed Site Investigations and as presented in the Construction Specifications. Samples were then collected from the periphery of this area, especially in locations where information was limited. These samples were analyzed with the test kits and the data obtained was used to revise the cap limits. Sampling locations and concentration of DDT in all the samples used to define the capping limits are shown on Map 2-1.

The capping of this area commenced on August 22 and was completed on August 26, 1997. The final limits of the capped area are shown on Drawing 02. The total volume of soil placed in the lower level cap was approximately 1600 m^3. Photographs 5 and 5A show the final layout of the lower level cap. Two localized areas at the northwestern end of the lower level were also capped and these are depicted on Photograph 6.

Confirmatory soil samples (A11 - A20) were collected from the periphery of the capped area and analyzed with the field test kits. The concentrations of total DDTs in all the samples were less than 1 ppm (Table 3-1). Sampling locations and DDT concentrations are indicated on Map 2-2.

Table 3-1: Concentration (mg/kg or ppm) of DDTs in samples collected after capping at the Lower Site, Rainy Hollow

Sample Number	Concentration	Sample Number	Concentration
A11	<1.0	A16	<1.0
A12	<1.0	A17	<1.0
A13	<1.0	A18	<1.0
A14	<1.0	A19	<1.0
A15	<1.0	A20	<1.0

3.3 Upper Level (Former Temporary Storage Facility)

The area covered by the cap was revised from the Construction Specifications on the basis of the results obtained from additional sampling and field test kit analysis. Sampling locations and concentration of DDT in all the samples used to define the capping limits are shown on Map 2-4.

A greater portion of the cap was placed during August 24 - 30. Contaminated soils excavated during the cleanup were temporary stock piled in this area and that delayed completion of the cap. Photograph 1 shows the partially placed cap in the upper level, the stock pile of clean fill required to complete the cap, and the tarp covering the temporary stock pile of contaminated soil awaiting off site disposal. The cap was completed on September 14 after removal of the contaminated soils from the site. The total volume of this cap was 1650 m^3. The final limits of the cap are shown on Drawing 03 which is located in Appendix B.

Ten confirmatory soil samples (CC3 - CC12) were collected from the area and analyzed with the field test kits. The concentrations of total DDTs in these samples were generally less than 1.0 ppm except for CC11 which had 1-10 ppm (Table 3-2). Sample CC11 was collected from a wooded area along the southern edge. No further action was taken at this location since the brush was well established and the test kits had been shown to overestimate the total DDT concentrations (Section 2.5).

Table 3-2: Concentration of DDTs in samples collected after capping at Border Station

Sample Number	Concentration	Sample Number	Concentration
CC3	<1.0	CC8	<1.0
CC4	~1.0	CC9	<1.0
CC5	<1.0	CC10	<1.0
CC6	<1.0	CC11	1 - 10
CC7	<1.0	CC12	~1.0

3.4 Former POL Locations

The placement of the gravel cap at the former POL storage area took place from August 25 to 29, 1997. The limits of the area to be capped were laid out on the basis of the results of the 1996 Detailed Site Investigations and as presented in the Construction Specifications. The steep nature of the temporary roadway leading to this area, as well as the confined space for maneuvering required the use of only the small end dump trucks to haul clean fill to this location. This increased the time required to complete the cap. Once the cap was completed, the temporary roadway was graded to blend with the natural slope of the hillside. The total volume of soil placed in the former POL locations was approximately 1450 m^3. The final layout of the cap is shown on Drawing 04 and Photograph 7. Confirmatory samples were collected and analyzed with the test kits. The data obtained and sampling locations are given on Map 3-1.

Table 3-3: Concentration of total PAHs (mg/kg or ppm) in samples collected after capping at the former POL storage area at Border Station

Sample Number	Concentration	Sample Number	Concentration
D1	<1.0	D7	<1.0
D2	<1.0	D8	<1.0
D3	<1.0	D9	<1.0
D4	<1.0	D10	<1.0
D5	<1.0	D11	<1.0
D6	<1.0	D12	<1.0

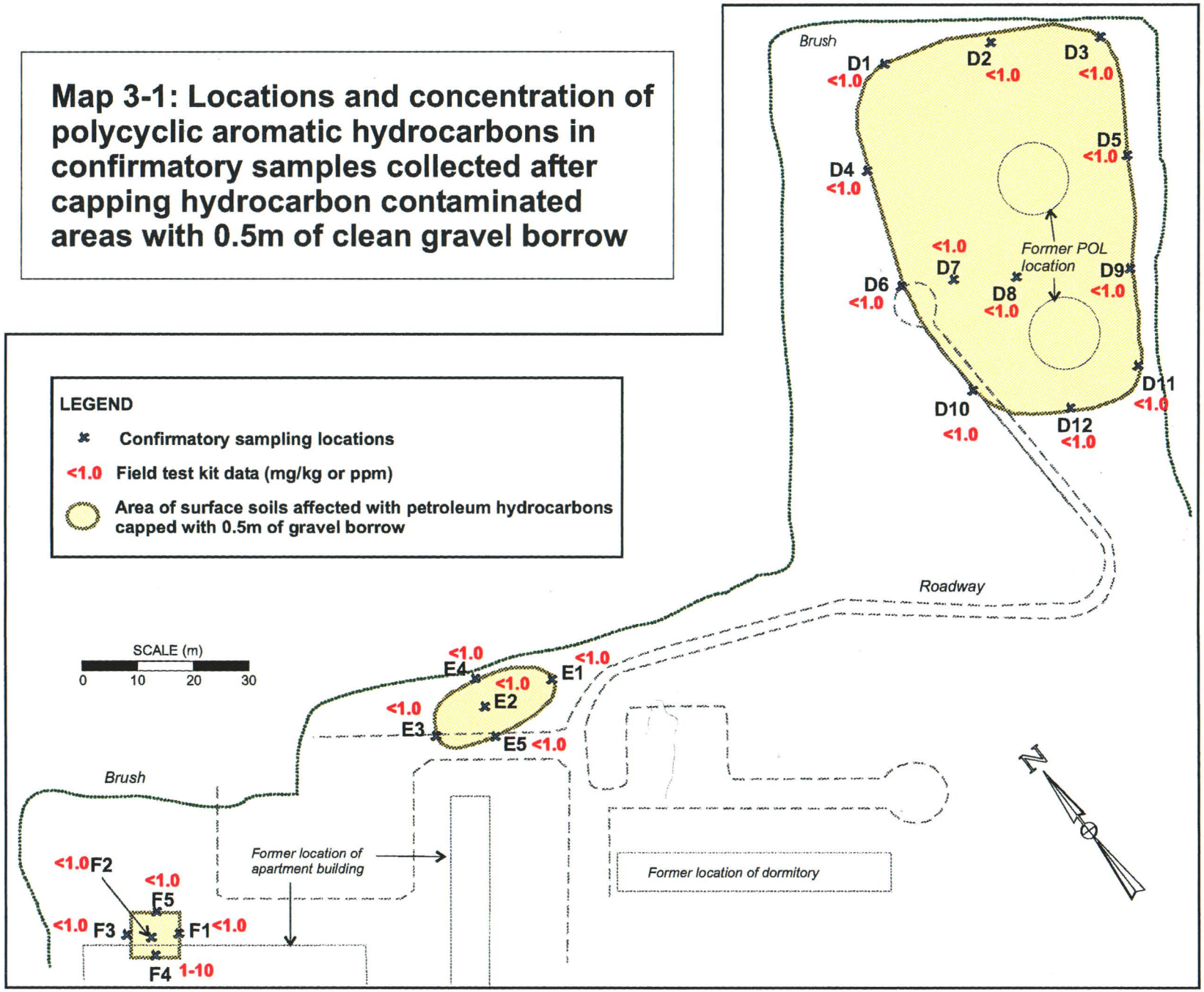
3.5 TP96-03 and TP96-14

Soil at TP96-14, originally designated in the Construction Specification for excavation and hauling to TP96-03 for capping, was left and capped in place. TP96-03 was capped as planned. The location of these areas are shown on Drawing 04 and Photograph 8. The total volume of soil placed in these two caps was 126 m^3. Confirmatory samples were collected and analyzed with the test kits. The data obtained and sampling locations are given on Map 3-1.

Table 3-4: Concentration of total PAHs (mg/kg or ppm) in samples collected after capping at the TP96-03 and TP96-14

Sample Number	Concentration	Sample Number	Concentration
E1	<1.0	F1	<1.0
E2	<1.0	F2	<1.0
E3	<1.0	F3	<1.0
E4	<1.0	F4	>1.0
E5	<1.0	F5	1 - 10

Map 3-1: Locations and concentration of polycyclic aromatic hydrocarbons in confirmatory samples collected after capping hydrocarbon contaminated areas with 0.5m of clean gravel borrow



4. SEALING AND RESETTING OF WELLS

Eleven monitoring wells were sealed and abandoned. These included:

WP-1; WP-2; WP-3; WP-4; WP-5; WP-6;
WP-8; WP-9; WP-10; WP-11; and WP-12

Eighteen monitoring wells were reset to below ground surface. The purpose of this task was to reduce the visibility of the monitoring wells at the site and minimize the potential for tampering. These included:

WP-7; WP-13; MW-8; MW-10; MW-11a; MW-11b;
MW-12; MW-13; MW-14; MW-15; MW-16; MW-17;
MW-18; MW-19; WM-20; MW-21; MW-22; and MW-23.

The locations of these wells are shown in Drawings 02, 03, and 04.

Sealing and resetting of the wells was completed on August 21 and 22, 1997. Those wells designated for sealing had the casing removed and the lower portion of the hole backfilled with clean sand. The upper one to two metres of the hole was filled with bentonite pieces. The wells that were lowered to below grade (Photograph 9) were refit with protective casings and sealed with bentonite pieces. The wells were then buried under approximately 0.3 - 0.5 m of soil.

5. REFERENCES

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UMA Engineering Ltd. 1997. Construction Specifications for the Site Remediation of the border Pump Station and Rainy Hollow Sites, British Columbia, Canada. Prepared for Indian and Northern Affairs Canada, Waste Management, Yukon. July 1997.

6. APPENDICES

Appendix A: Photographs

Appendix B: Drawings and Cap Cross-Sections

Appendix C: Sampling and Analytical Methods, and Laboratory Report

Appendix D: Correspondence Regarding Work Plan and Removal of Contaminated Soils

APPENDIX A: PHOTOGRAPHS

Photograph 1: Border Station showing the partially placed cap at the former location of the Temporary Storage Facility, the stock pile of clean fill required to complete the cap, and tarp covering the temporary stock pile of contaminated soil excavated from DDT contaminated areas.

Photograph 2: Excavated area near the Trench at Rainy Hollow looking east

Photograph 2a: Excavated area near the Trench at Rainy Hollow looking north

Photograph 3: Depression near the entrance of the road leading to the Temporary Storage Facility (M14) after the excavation of DDT contaminated soil and capping with gravel

Photograph 4: Gravel borrow area after removal of material and prior to final landscaping

Photograph 5: View from the southern end of capped and graded area at Rainy Hollow

Photograph 5A:View from the northwestern end of Rainy Hollow after capping and grading

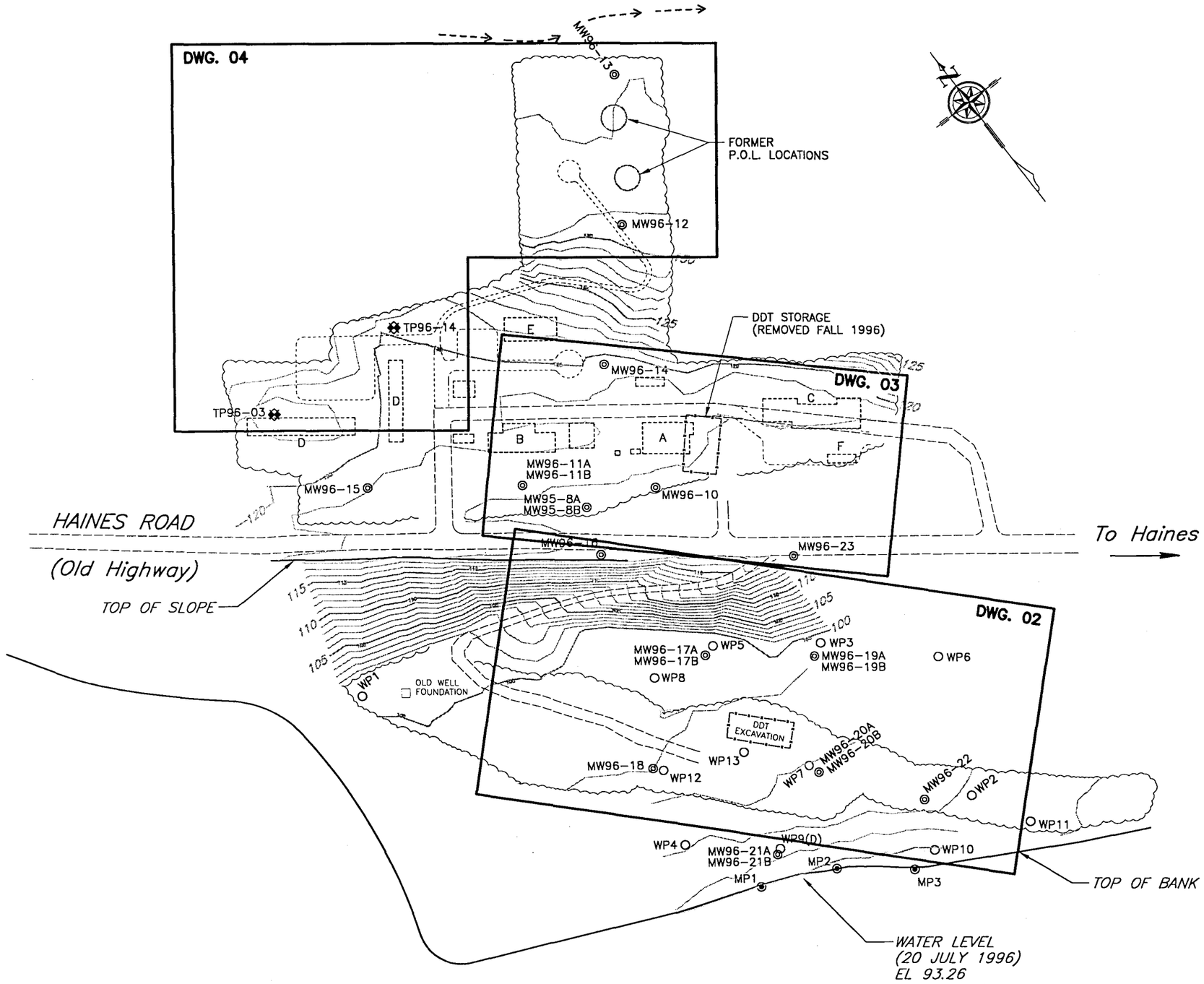
Photograph 6: View of two localized capped and graded areas at Rainy Hollow

Photograph 7: Former POL storage area at Border Station after capping and grading

Photograph 8: TP96-14 and TP96-03 (background) after capping and grading

Photograph 9: Monitoring wells after modification for burial

APPENDIX B: DRAWINGS AND CAP CROSS-SECTIONS



LEGEND

- ◎ MONITORING WELL (UMA 1995, 1996)
- ◉ MINI PIEZOMETER (UMA 1996)
- ○ WELL POINT (Golder Associates 1994)
- ✱ TEST PIT (UMA 1996)
- ——— EDGE OF ROAD
- ····· FORMER EDGE OF ROAD
- ~~~~ TREE LINE
- ~~~~ ELEVATION CONTOUR
- ----→ CREEK

A — APPROX. LOCATION OF FORMER BUILDINGS

A – MAIN LINE PUMP BUILDING
B – UTILITY BUILDING
C – WAREHOUSE/SHOP/GARAGE
D – APARTMENT COMPLEX
E – DORMITORY
F – PUMP ISLAND

Scale 1:2000

UMA Engineering Ltd.
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Indian and Northern Affairs Canada
Waste Management Yukon
SITE REMEDIATION – BORDER PUMP STATION / RAINY HOLLOW

TITLE:	GENERAL SITE PLAN		
JOB No.	C799-001-03-02	DATE:	DECEMBER, 1997
DRAWN:	MAG/RN	DWG. No.	01
CHECKED:	JP/TW		

CST-DWG4
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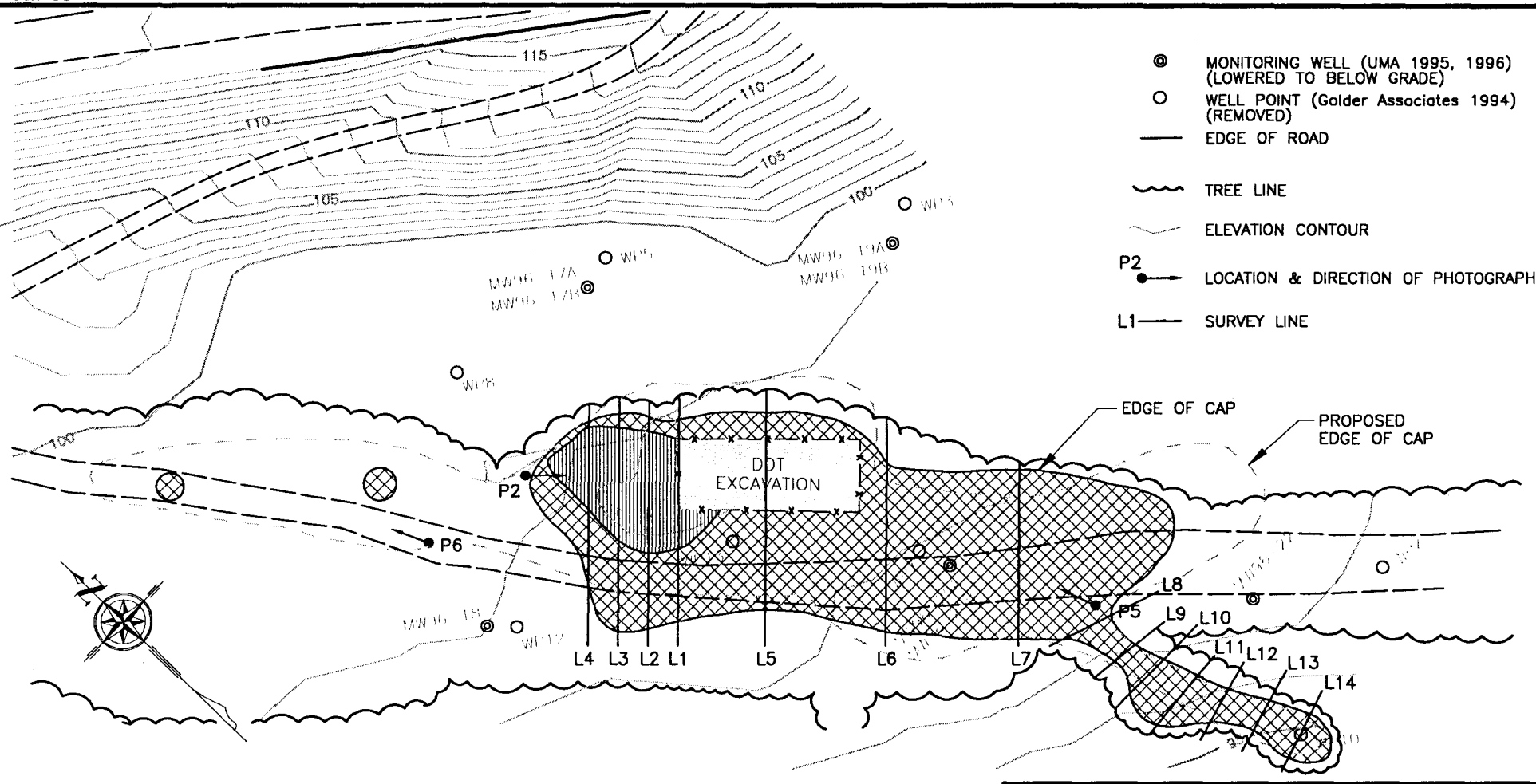
19 Jan 98



LEGEND

- AREA OF SURFACE SOIL AFFECTED WITH DDT CONCENTRATIONS >10ppm REMOVED AND DISPOSED OFF SITE

- AREA OF SURFACE SOIL AFFECTED WITH DDT CONCENTRATIONS 1–10ppm CAPPED WITH 0.5m OF CLEAN BORROW MATERIAL AND BLENDED INTO THE NATURAL TOPOGRAPHY

Scale 1:1000

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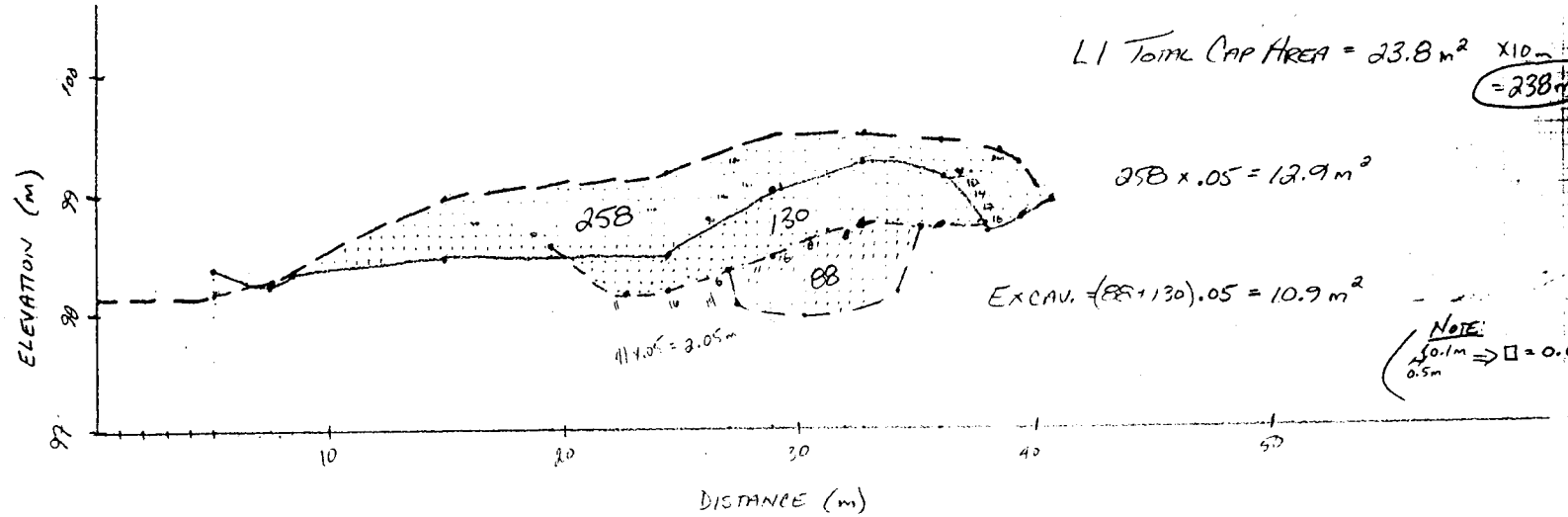
Indian and Northern Affairs Canada
Waste Management Yukon
SITE REMEDIATION – BORDER PUMP STATION / RAINY HOLLOW

TITLE:	CAPPING LOCATIONS FOR SURFACE SOIL AFFECTED WITH DDT – LOWER LEVEL		
JOB No.	C799-001-03-02	DATE:	DECEMBER, 1997
DRAWN:	MAG/RN	DWG. No.	02
CHECKED:	JP/TW		

RAINY HOLLOW - L1



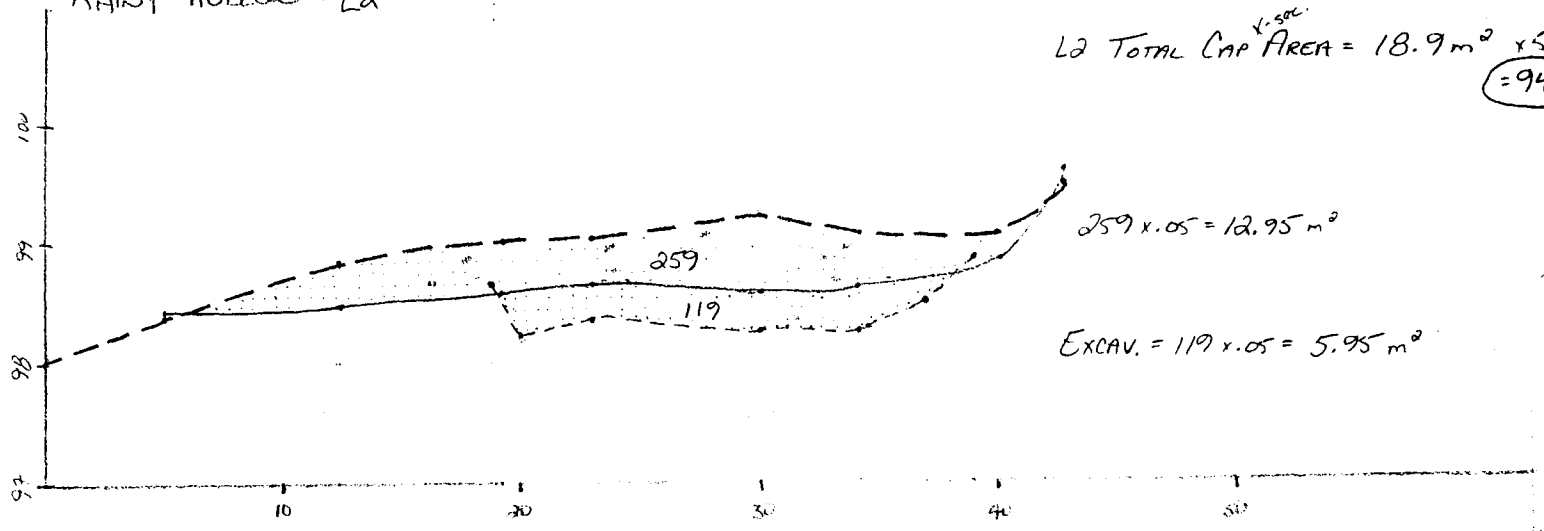
L1 TOTAL CAP AREA = 23.8 m² x10m = 238 m³

258 x .05 = 12.9 m²

EXCAV. = (88+130).05 = 10.9 m²

NOTE: 0.1m ⇒ □ = 0.05 m²
0.5m

RAINY HOLLOW - L2

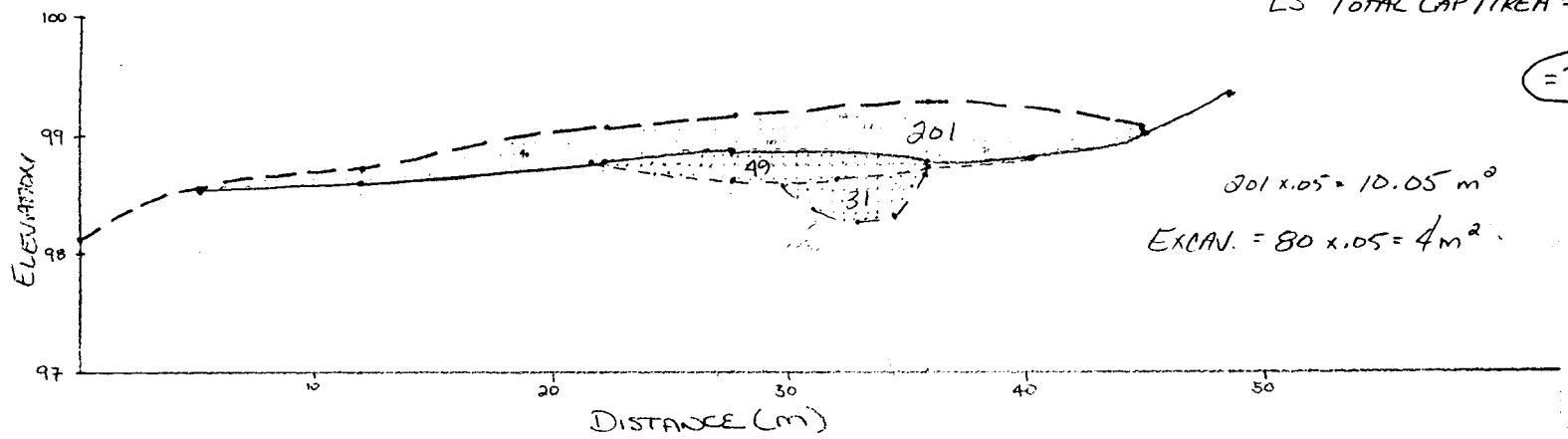


L2 TOTAL CAP AREA = 18.9 m² x5m = 94.5 m³

259 x .05 = 12.95 m²

EXCAV. = 119 x .05 = 5.95 m²

RAINY HOLLOW - L3

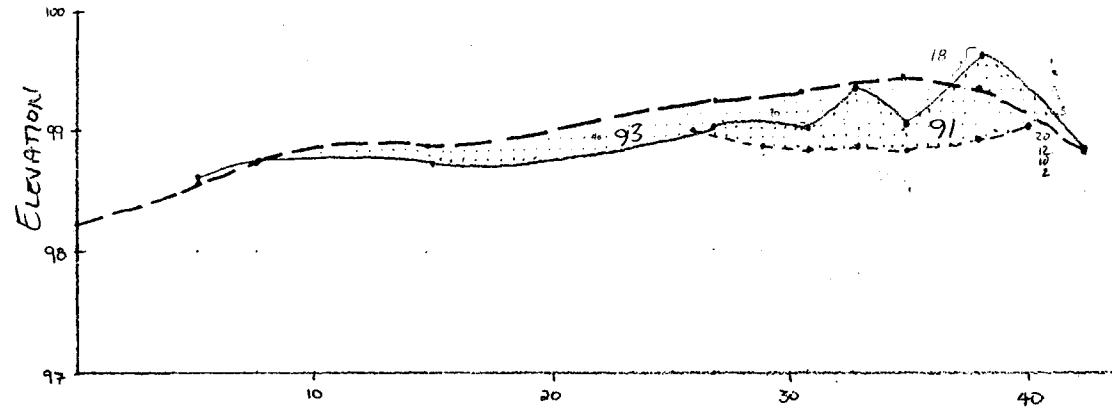


L3 TOTAL CAP AREA = 14.05 m² (5 m)
= 70.25 m³

201 x.05 = 10.05 m²

EXCAV. = 80 x.05 = 4 m²

RAINY HOLLOW - L4



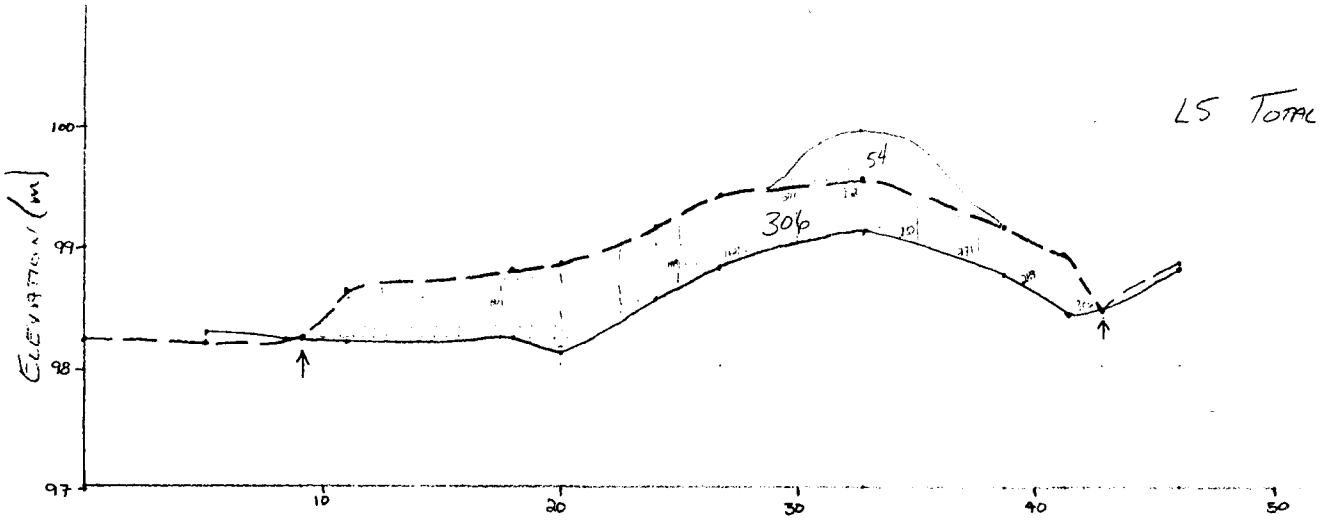
L4 TOTAL CAP AREA = 8.3 m² x 8m
= 66.4 m³

18 x.05 = 0.9

93 x.05 = 4.65 m²

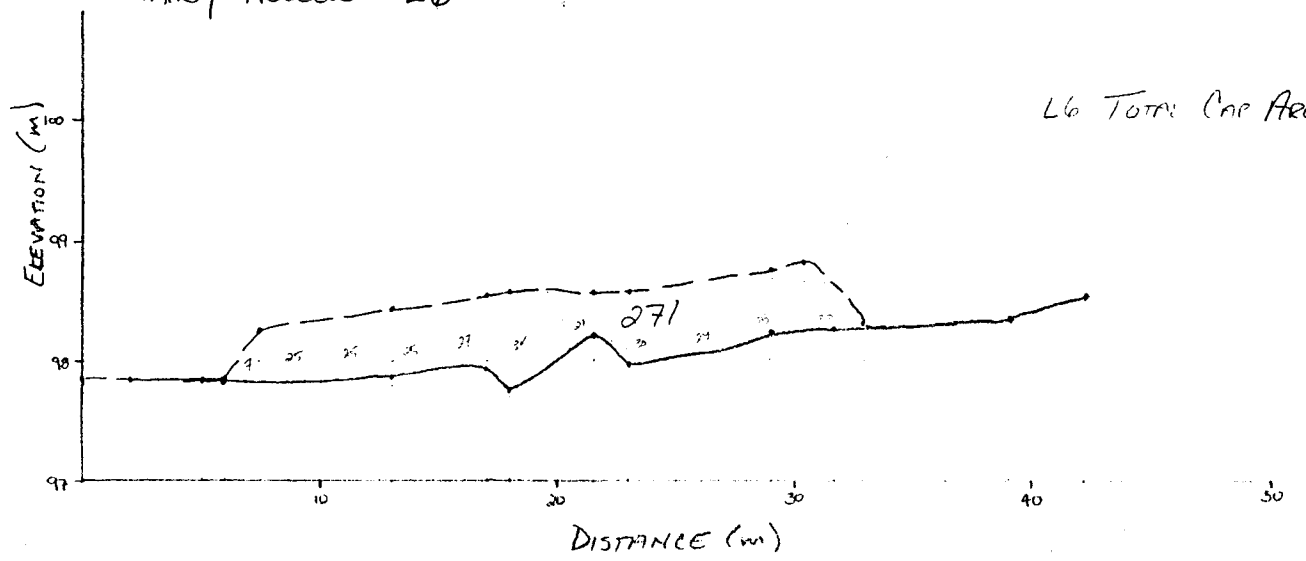
EXCAV. = 91 x.05 = 4.55 m²

RAINY HOLLOW - L5



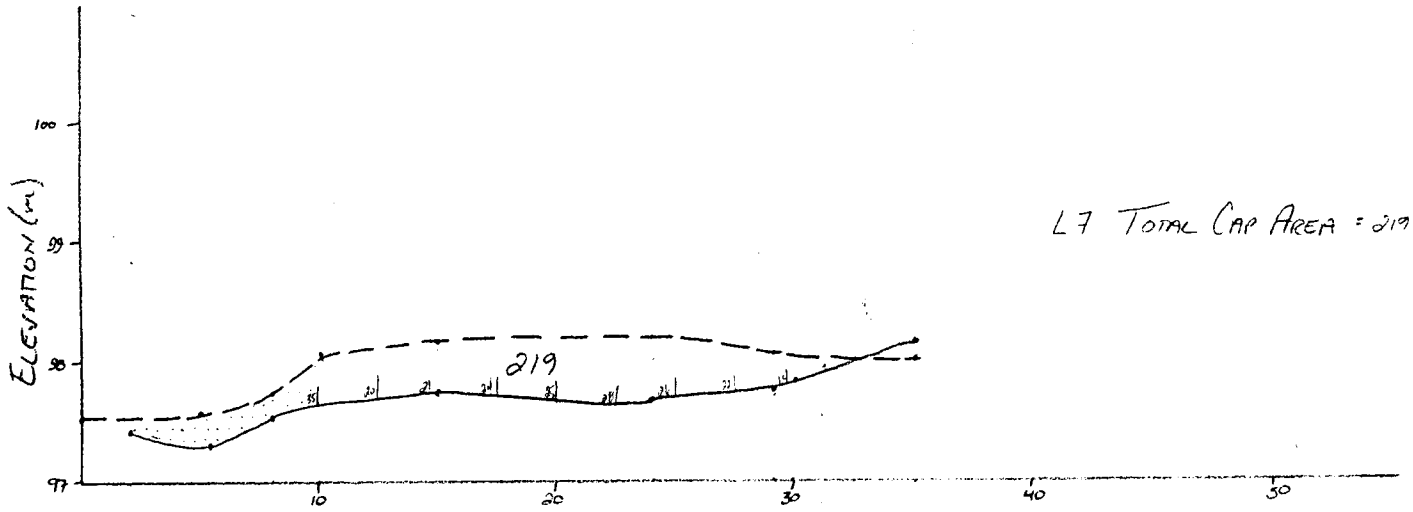
L5 TOTAL CAP AREA = 306 x .05 = 18 m²
+2.
x 17.5
=36

RAINY HOLLOW - L6



L6 TOTAL CAP AREA = 271 x .05 = 13.55 m²
x 21m
=284.55m³

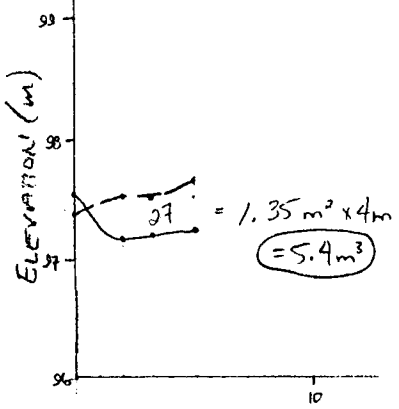
RAINY HOLLOW - L7



L7 TOTAL CAP AREA = 219 x .05 = 10.95m² X 31m
= 339.45m³

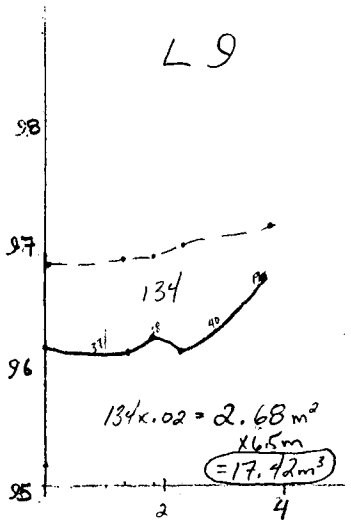
RAINY HOLLOW -

L8



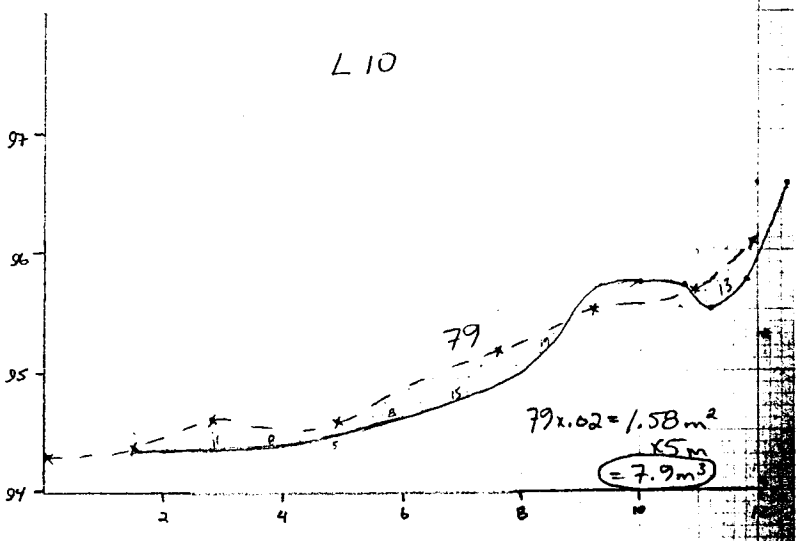
27 = 1.35m² x 4m
= 5.4m³

L9



134 x .02 = 2.68m²
X 6.5m
= 17.42m³

L10

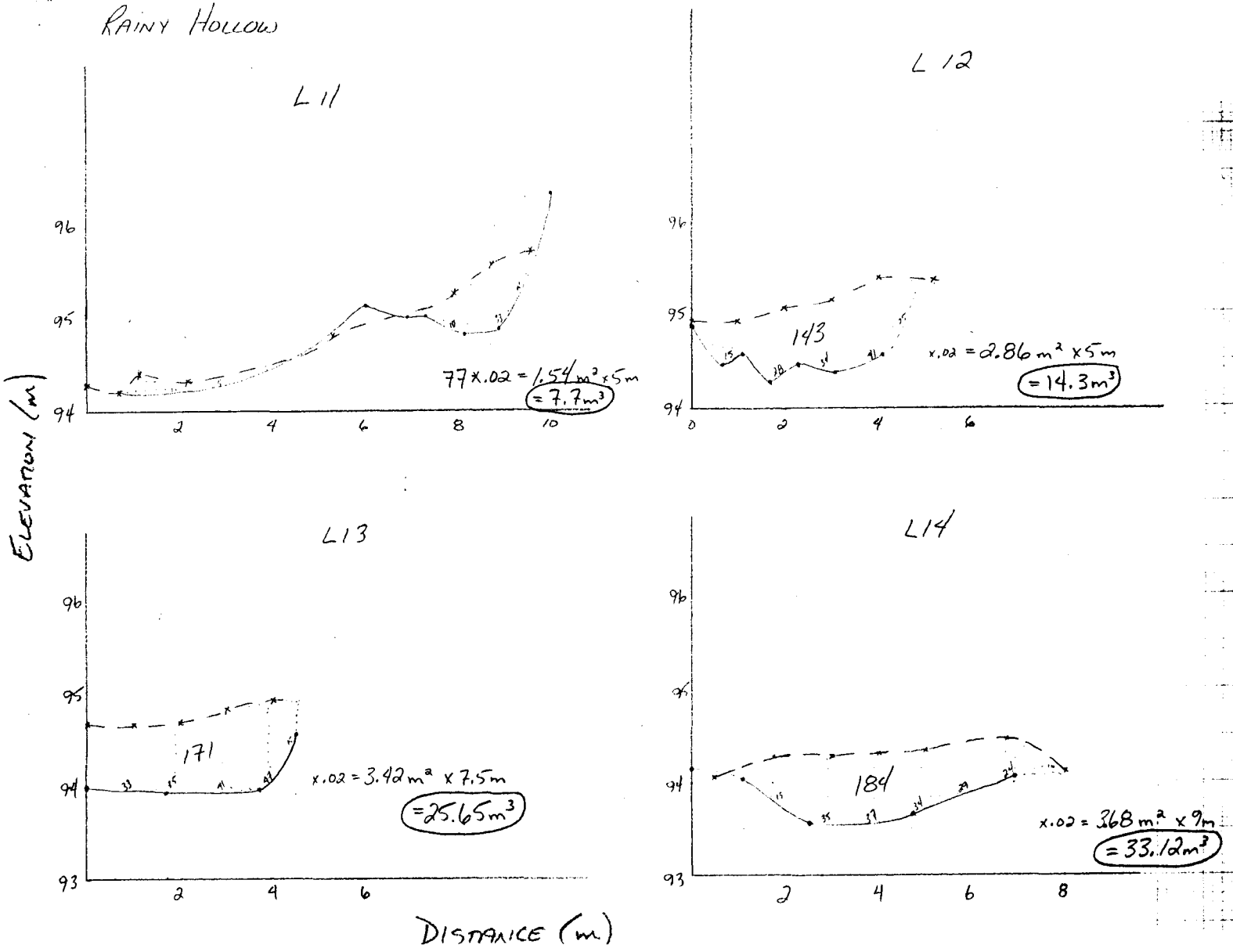


79 x .02 = 1.58m²
X 5m
= 7.9m³

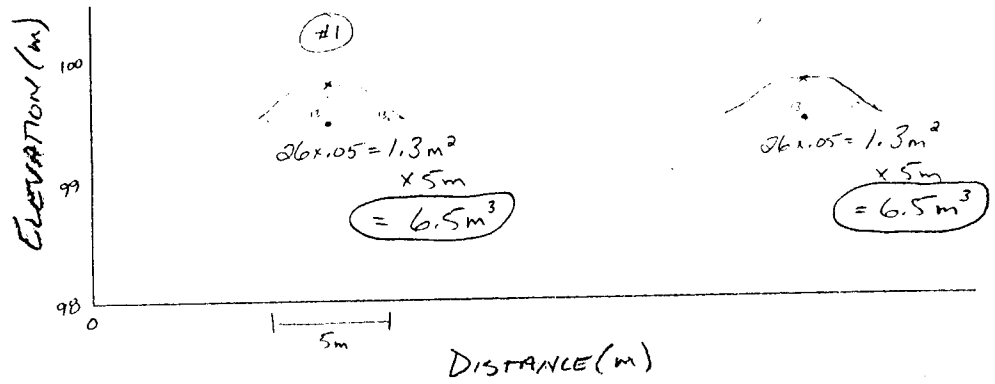
DISTANCE (m)

□ = .02

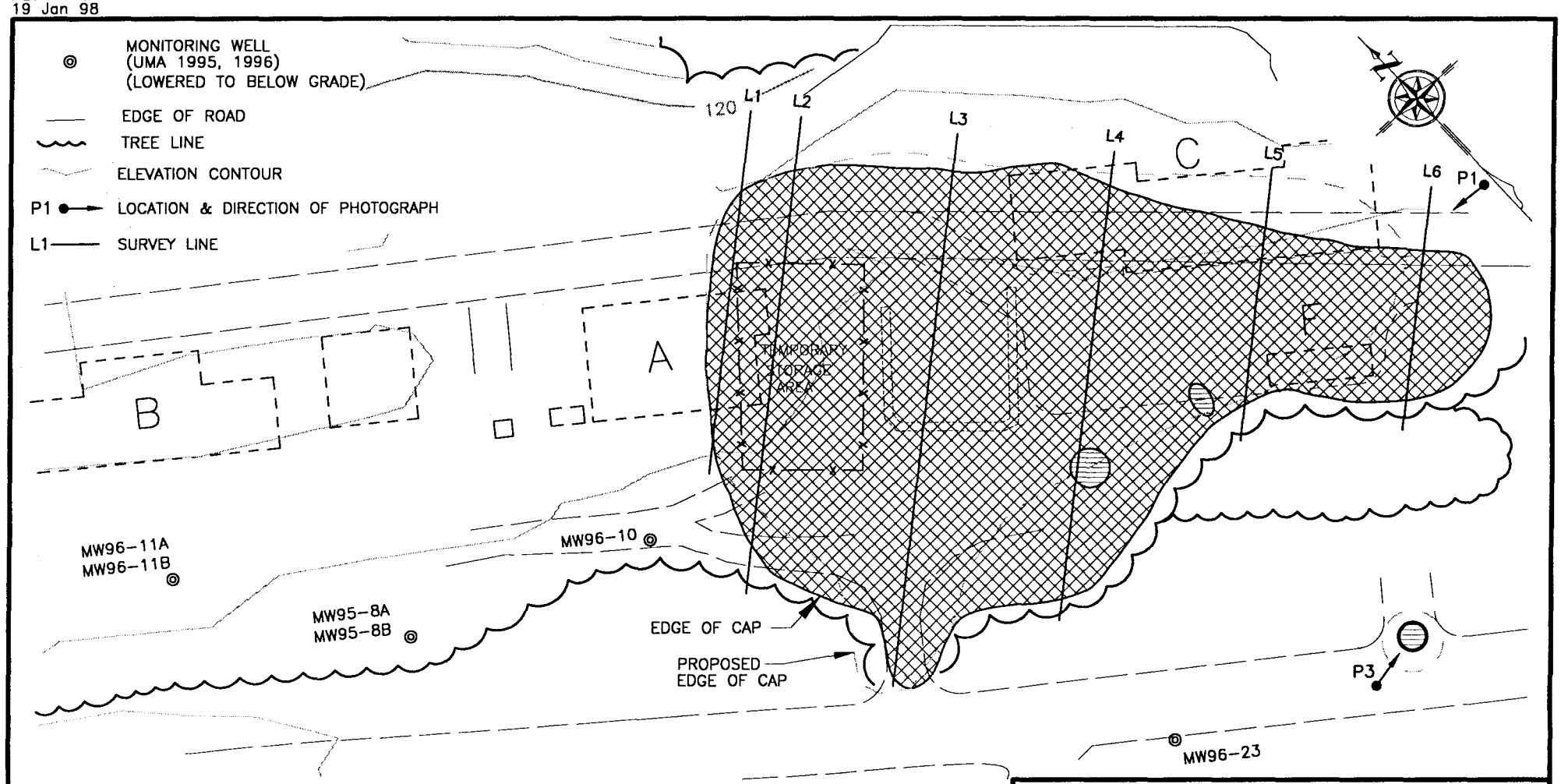
RAINY HOLLOW



Rainy Hollow - Local Caps #1 & #2



CST-DWG3
PLOT 1=.75
19 Jan 98



LEGEND

- AREA OF SURFACE SOIL AFFECTED WITH DDT CONCENTRATIONS >10ppm REMOVED AND DISPOSED OFF SITE
- AREA OF SURFACE SOIL AFFECTED WITH DDT CONCENTRATIONS 1–10ppm CAPPED WITH 0.5m OF CLEAN BORROW MATERIAL AND BLENDED INTO THE NATURAL TOPOGRAPHY

Scale 1:750

ROYAL ROADS UNIVERSITY

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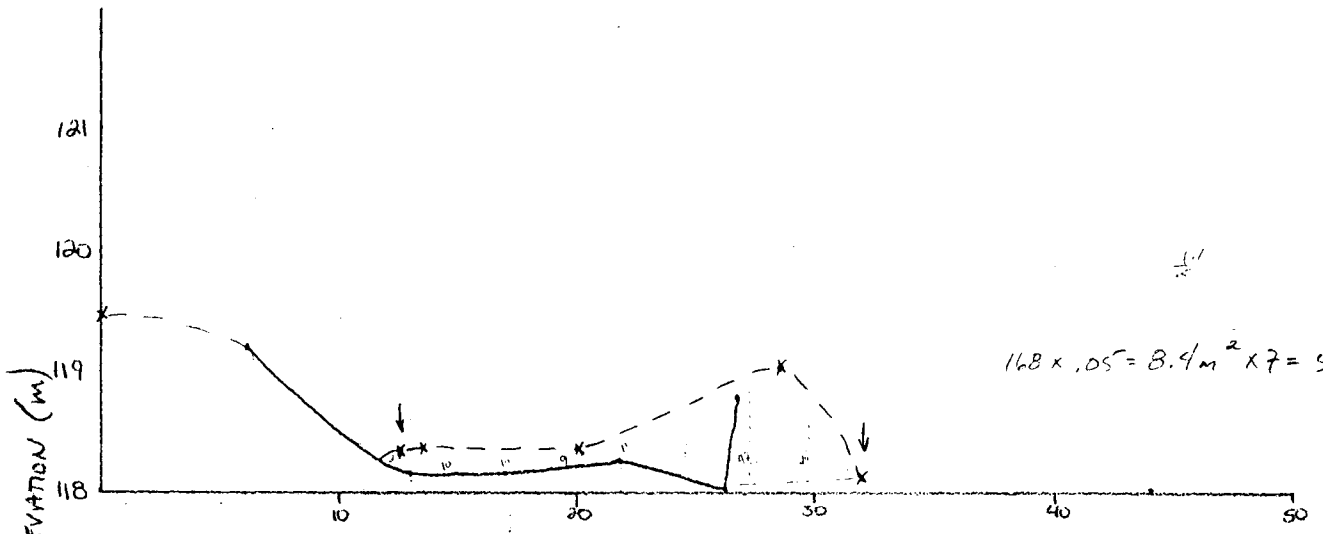
Indian and Northern Affairs Canada
Waste Management Yukon
SITE REMEDIATION – BORDER PUMP STATION / RAINY HOLLOW

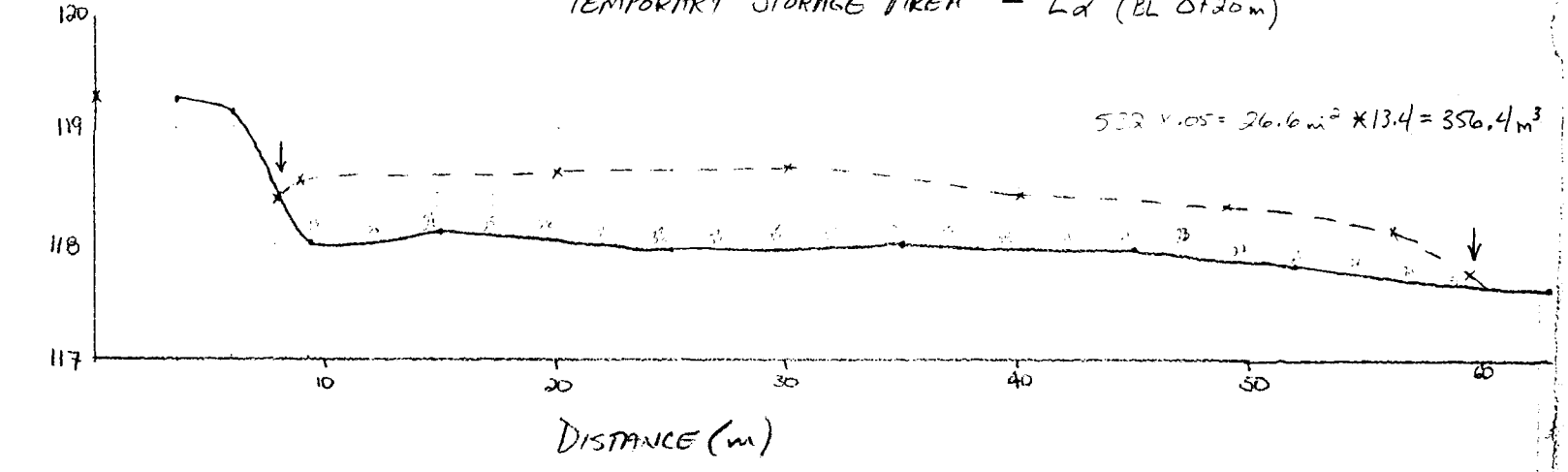
TITLE:	CAPPING LOCATIONS FOR SURFACE SOIL AFFECTED WITH DDT – UPPER LEVEL		
JOB No.	C799-001-03-02	DATE:	DECEMBER, 1997
DRAWN:	MAG/RN	DWG. No.	03
CHECKED:	JP/TW		

TEMPORARY STORAGE AREA - L1 (BL 0+13.2m)



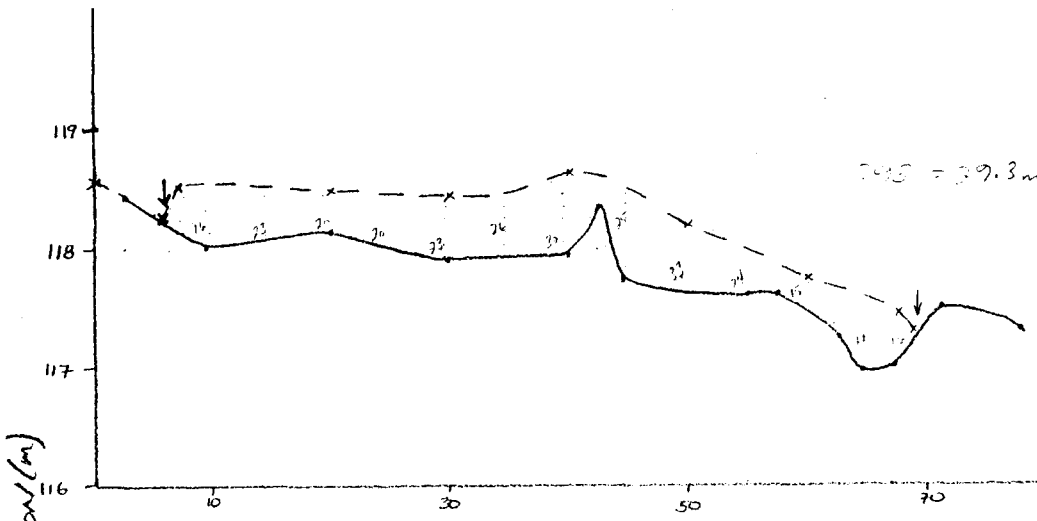
$16.8 \times .05 = 8.4 m^2 \times 7 = 58.8 m^3$

TEMPORARY STORAGE AREA - L2 (BL 0+20m)



$532 \times .05 = 26.6 m^2 \times 13.4 = 356.4 m^3$

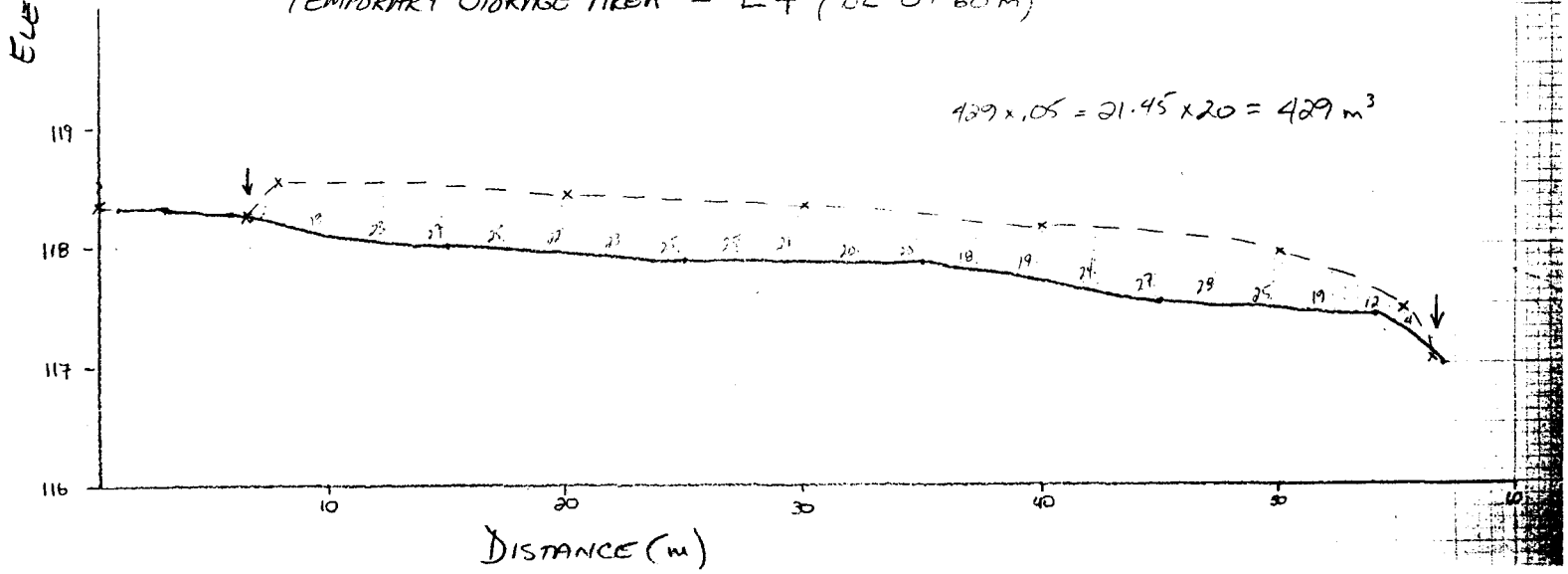
TEMPORARY STORAGE AREA - L3 (CL 0+40m)



$29.3 m^2 \times 20 = 586 m^3$

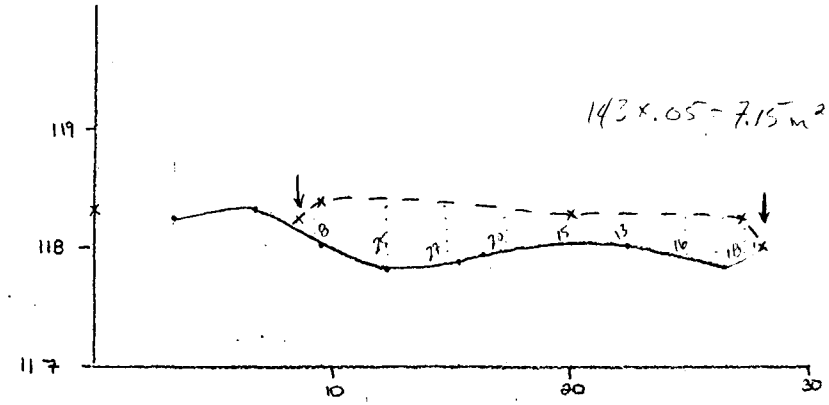
1:1
1.0

TEMPORARY STORAGE AREA - L4 (CL 0+60m)



$429 \times .05 = 21.45 \times 20 = 429 m^3$

Temporary Storage Area – L5 (BL 0+80m)

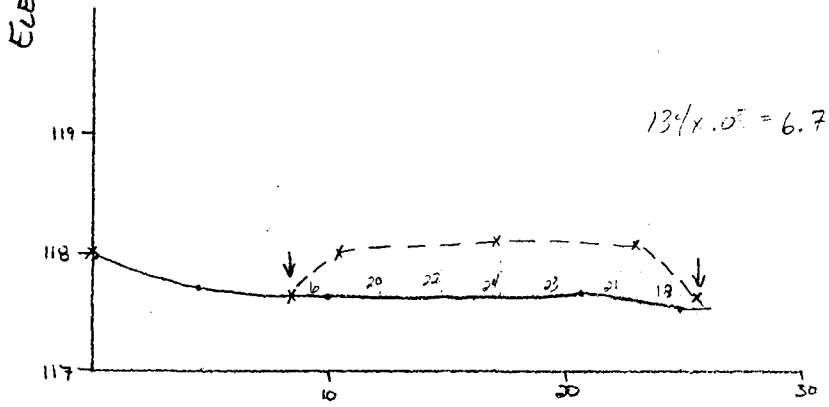


$143 \times .05 = 7.15\ m^2 = 143\ m^3$

1 in 40

1 in 50

Temporary Storage Area - L6 (BL 1+00m)



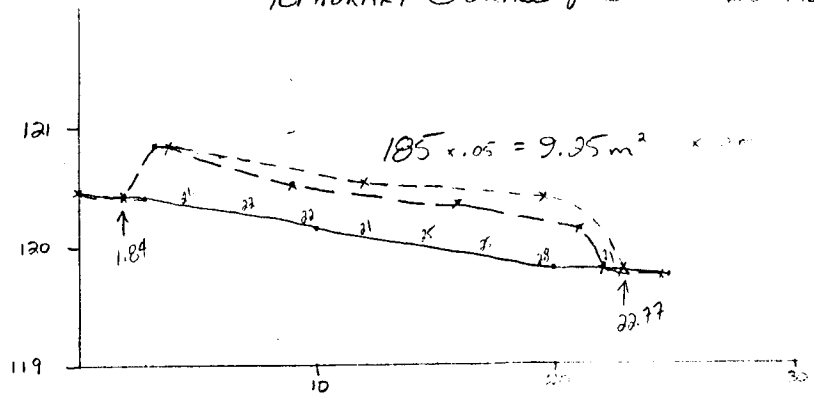
$134 \times .05 = 6.7\ m^2 \times 12.5 = 83.75\ m^3$

1 in 40

1 in 50

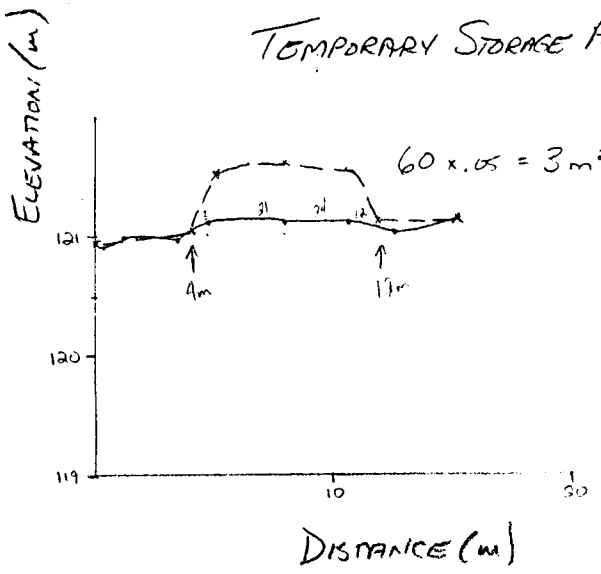
TEMPORARY STORAGE AREA – LOCAL CAP #1 (TP96-03)

CAP VOLUME = 92.5 m³



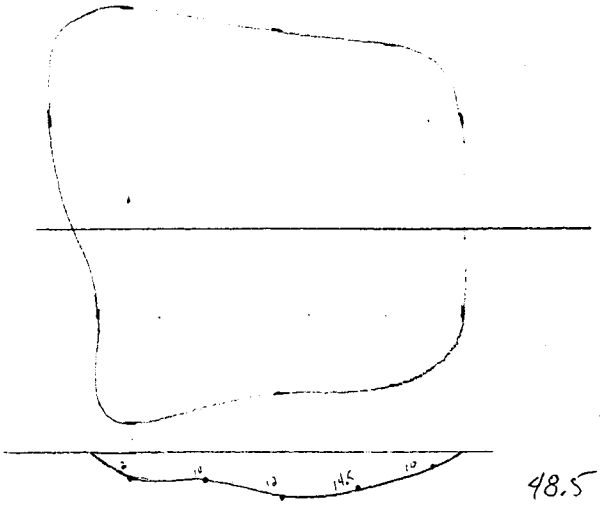
TEMPORARY STORAGE AREA LOCAL CAP #2 (TP96-14)

CAP VOLUME = 24 m³

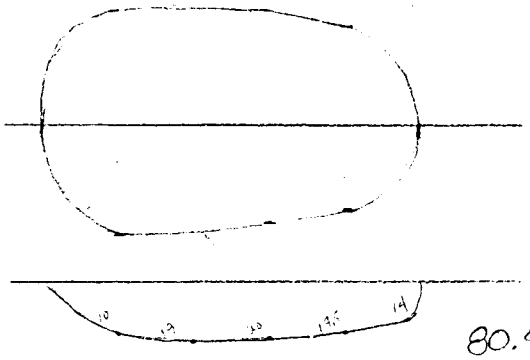


TEMPORARY STORAGE AREA - LOCAL EXCAVATIONS

Total Vol. Excavated = 14.077 m³
(from Border Str. Pump)

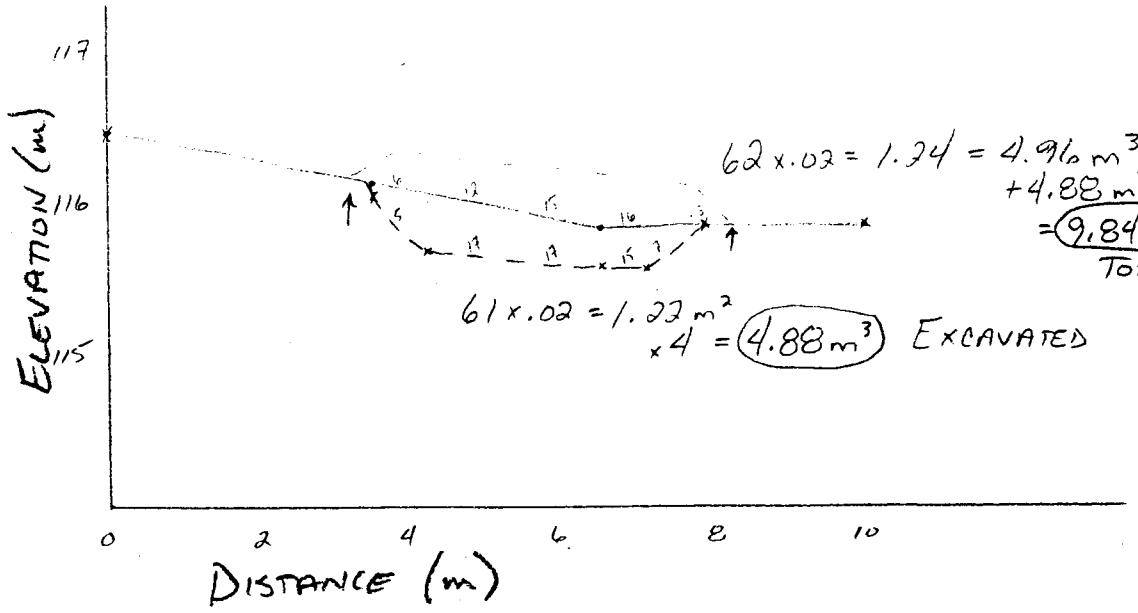


48.5 x .02 = .97 m²
x 5 = (4.85 m³)



80.5 x .02 = 1.61 m²
x 2.7 = (4.347 m³)

DOT EXCAV. IN ROAD EMBANKMENT - TEMP. STORAGE AREA



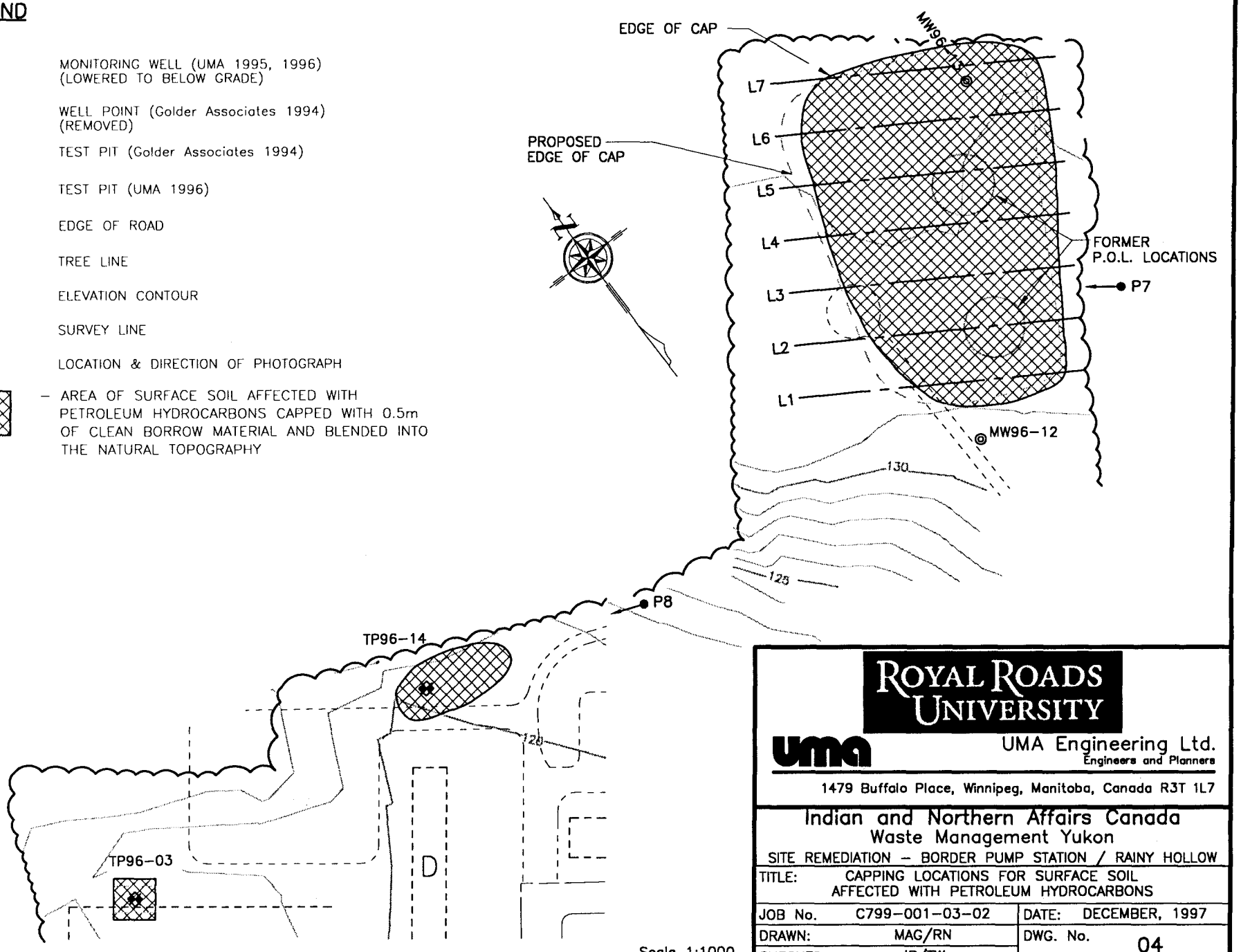
62 x .02 = 1.24 = 4.96 m³ Cap/
+4.88 m³ Backfill
= (9.84 m³) Total

61 x .02 = 1.22 m²
x 4 = (4.88 m³) EXCAVATED

CST-DWG2
PLOT 1=1
19 Jan 98

LEGEND

- MONITORING WELL (UMA 1995, 1996) (LOWERED TO BELOW GRADE)
- WELL POINT (Golder Associates 1994) (REMOVED)
- TEST PIT (Golder Associates 1994)
- TEST PIT (UMA 1996)
- EDGE OF ROAD
- TREE LINE
- ELEVATION CONTOUR
- L1 — SURVEY LINE
- P8 — LOCATION & DIRECTION OF PHOTOGRAPH
- AREA OF SURFACE SOIL AFFECTED WITH PETROLEUM HYDROCARBONS CAPPED WITH 0.5m OF CLEAN BORROW MATERIAL AND BLENDED INTO THE NATURAL TOPOGRAPHY



ROYAL ROADS UNIVERSITY

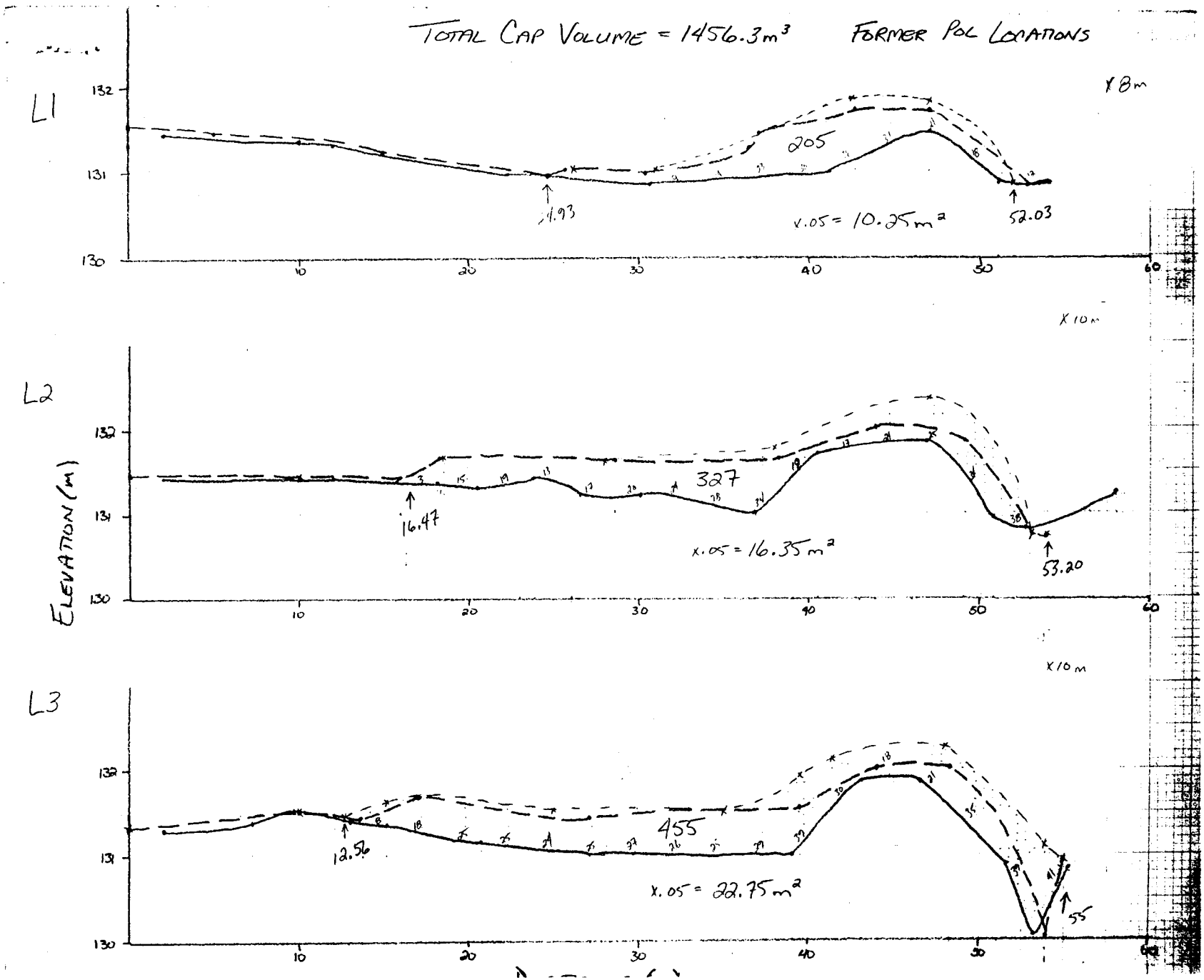
UMA Engineering Ltd.
Engineers and Planners

1479 Buffalo Place, Winnipeg, Manitoba, Canada R3T 1L7

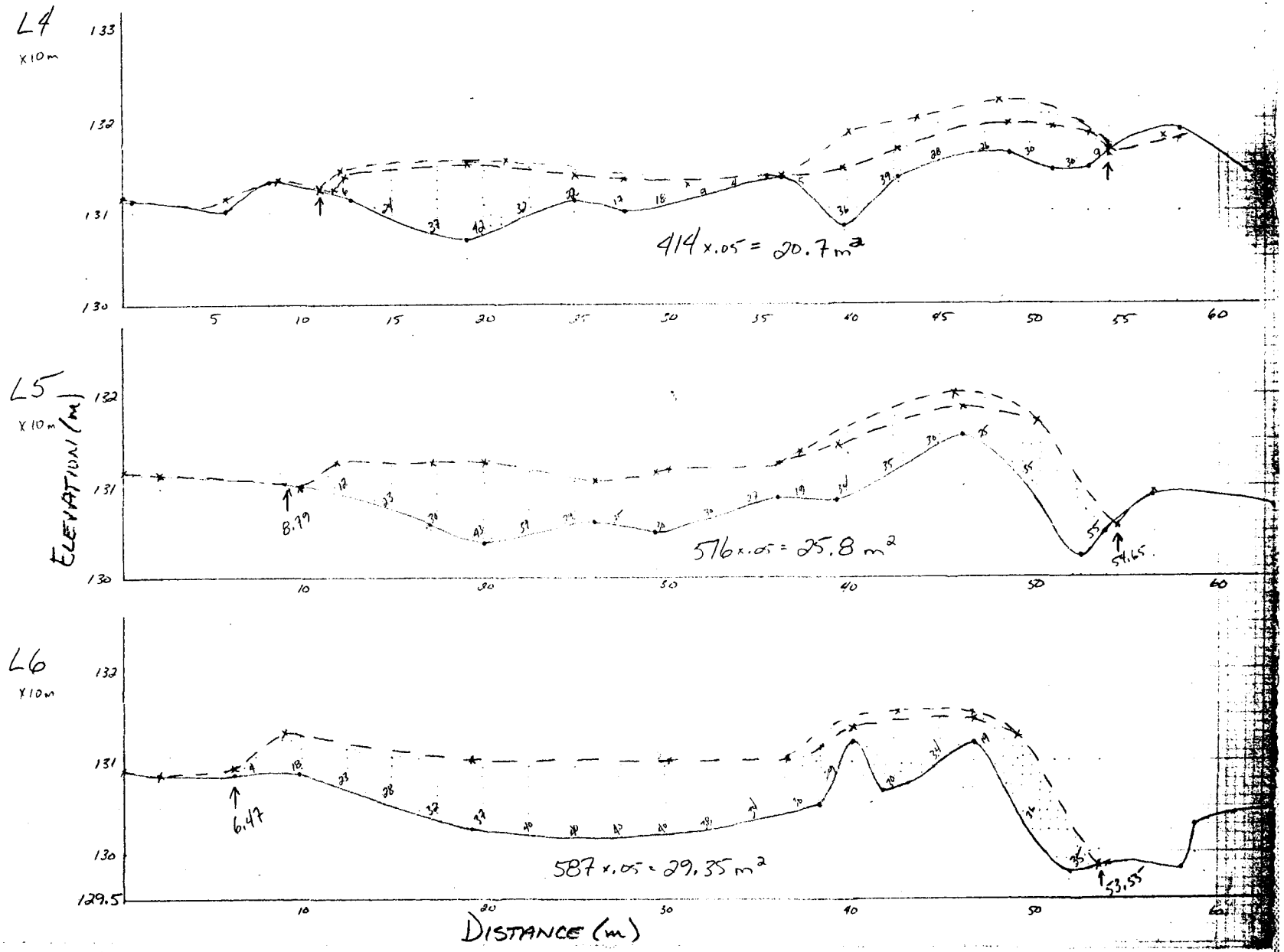
Indian and Northern Affairs Canada
Waste Management Yukon
SITE REMEDIATION – BORDER PUMP STATION / RAINY HOLLOW

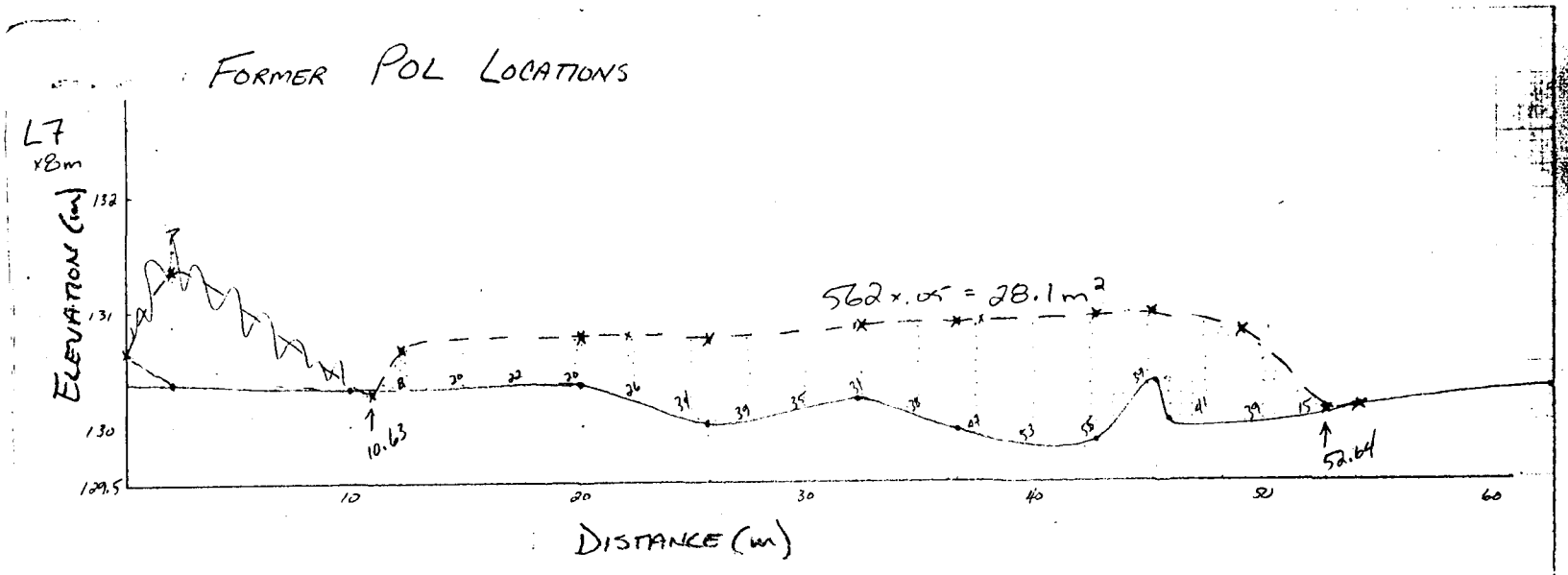
TITLE: CAPPING LOCATIONS FOR SURFACE SOIL AFFECTED WITH PETROLEUM HYDROCARBONS

JOB No.	C799-001-03-02	DATE:	DECEMBER, 1997
DRAWN:	MAG/RN	DWG. No.	04
CHECKED:	JP/TW		


TOTAL CAP VOLUME = 1456.3m³
FORMER POL LOCATIONS
L1
X 8m
205
14.93
X.05 = 10.25m²
52.03
L2
X 10m
ELEVATION (m)
327
16.47
X.05 = 16.35m²
53.20
L3
X 10m
455
12.56
X.05 = 22.75m²
55

Former POL Locations




FORMER POL LOCATIONS
L7
x8m
ELEVATION (m)
132
131
130
129.5
562 x .05 = 28.1 m²
10.63
52.64
10
20
30
40
50
60
DISTANCE (m)

APPENDIX C:
SAMPLING AND ANALYTICAL METHODS, AND LABORATORY REPORT

SAMPLING AND ANALYTICAL METHODS AND LABORATORY REPORT

Sampling

The objectives of the sampling program were two fold:

- to refine the extent of contamination indicated in the Construction Specification drawings; and
- confirm that cleanup was successful.

In order to achieve the first objective, samples from contaminated areas were obtained from locations where data was limited. Sampling locations for confirmatory purposes were chosen at random along survey lines initially used to define the volume of the cap.

Soil samples were collected with stainless steel scoops (which had been pre-washed, baked and stored in baked aluminum foil to preclude organic contamination) and deposited into 100 mL amber jars fitted with Teflon lined lids. These jars were pre-cleaned and free of organic materials. Soil samples were generally restricted to the upper 0.1 m, except for some of the confirmatory samples which were obtained at a depth of up to 0.25 m. Maps showing all the sampling locations are given in Chapters 2 and 3 of the main report.

Samples designated for laboratory analyses were shipped by guaranteed air freight to Axys Analytical Services. Sample shipment was accompanied by a chain-of-custody form.

Field Analysis

Field analyses for DDTs and PAHs were performed using EnviroGard™ immunoassay test kits. These were obtained from Diagnostix Inc., Mississauga, Ontario. The kits utilize the enzyme-linked immunoabsorbent assay technique which is based on antibodies that are designed to bind to specific analytes. These antibodies are bonded onto polystyrene coated test tubes and operate on the principles of competitive immunoassay where the absorbance signal is inversely proportional to the concentration of the analyte (i.e., the greater the concentration of analyte, the lighter the colour). When solutions containing an analyte of interest (e.g., DDTs) are incubated in the tube along with an enzyme conjugate, the analyte bind to the antibodies while the conjugate binds to the unoccupied antibody binding sites. After incubation the unbound conjugate is decanted and the tube washed thoroughly. A solution containing a chromogene peroxidase substrate is then added to the tubes. This interacts with the bound enzyme conjugate to form a coloured product. Quantitation is achieved by comparing the colourimetric signal generated by a unknown sample with a set of standards using a portable spectrophotometer.

The immunoassay was carried out on-site according to the manufacturer's instruction. A 5 g portion of soil sample was weighed and extracted with 5 mL methanol. The soil-methanol mixture was filtered and an aliquot of the extract used for subsequent analysis.

Laboratory Analysis

Laboratory analyses for DDTs were conducted by Axys Analytical Services Ltd. of Sidney, B.C. The analytical method and laboratory results are presented in the following pages.

DETERMINATION OF CHLORINATED PESTICIDES IN SOIL/SEDIMENT SAMPLES

9718

SUMMARY

Samples were spiked by ^{13}C-labelled internal standards and extracted with dichloromethane:acetone. Target analytes were isolated by column chromatography on Florisil and analyzed by HRGC/LRMS.

1. Extraction

A subsample of wet soil or sediment (approximately 3 g) was weighed into a screw-top jar and mixed with surrogate internal standard solution ($^{13}C_6$-Hexachlorobenzene, $^{13}C_{12}$-p,p'-DDT). Ten grams of anhydrous sodium sulphate and 40 mL of 1:1 dichloromethane:acetone were added. The sample was extracted by shaking for 20 min, the liquid decanted and the extraction repeated two additional times with dichloromethane. Combined extracts were filtered through a sodium sulphate column, concentrated by rotary evaporation and solvent-exchanged to hexane.

2. Column Chromatography

The concentrated extract was applied to a Florisil column for which cutpoints had been previously determined. The column was eluted by 15% dichloromethane:hexane. The fraction containing the target analytes was concentrated by rotary evaporation to 1 mL, treated with activated copper to remove sulphur and further concentrated to near dryness. The extract was redissolved in recovery standard solution ($^{13}C_{12}$-PCB 153) prior to instrumental analysis.

3. Instrumental Analysis

Analysis was conducted on a Varian Saturn 1 ion trap mass spectrometer equipped with a Varian 3400 GC. Chromatographic separation was achieved using 30 m DB-5 capillary column (id 0.25 mm, 0.2 μm film thickness). Data were collected in full scan mode. Identification of the target chromatographic peaks was confirmed by mass spectral fit.

Reported concentrations were corrected for recovery of the surrogate standards added prior to workup.

Reference: SOP 013 AV.

BATCH SUMMARY

Batch ID: AV-1	***Date:*** September 5, 1997
Analysis Type: PCB/Pesticide	***Matrix Type:*** Soil

BATCH MAKEUP

Samples: 9718 -28 -29 -30 -31 -32 -33 A -34 -35	***Blank:*** BLK-197
	Reference or Spike:
	Duplicate: 9718-33B
Comments	

PCB/PESTICIDE ANALYSIS REPORT

CLIENT SAMPLE I.D: Procedural Blank

AXYS ID: BLK-197

CLIENT: Royal Roads University

DATE: 05/Sept/97

SAMPLE TYPE: Soil

METHOD NO.: SOP 113 (AV)

SAMPLE SIZE: 1.0 g dry

INSTRUMENT: GC-MS

% MOISTURE: 3.6

CONCENTRATION IN: ng/g

Compounds	Concentration	(SDL)
o,p'-DDE	0.1	0.1
p,p'-DDE	0.2	0.2
o,p'-DDD	0.3	0.3
p,p'-DDD	0.4	0.4
o,p'-DDT	0.5	0.5
p,p'-DDT	1.4	1.4
Aroclor 1242	ND	5.0
Aroclor 1254	ND	3.0
Aroclor 1260	ND	3.0

Surrogate Standards	% Recovery
13C-Hexachlorobenzene	64
13C-p,p'-DDT	87

1. SDL = Sample Detection Limit
2. ND = Not Detected
3. NDR = Peak detected but did not meet quantification criteria
4. Data have not been blank corrected
5. Concentrations are recovery corrected

Approved

PCB/PESTICIDE ANALYSIS REPORT

CLIENT SAMPLE I.D: RH-A9

AXYS ID: 9718-28

CLIENT: Royal Roads University

DATE: 05/Sept/97

SAMPLE TYPE: Soil

METHOD NO.: SOP 113 (AV)

SAMPLE SIZE: 2.78 g dry

INSTRUMENT: GC-MS

% MOISTURE: 1.4

CONCENTRATION IN: ng/g

Compounds	Concentration	(SDL)
o,p'-DDE	ND	2.0
p,p'-DDE	ND	2.0
o,p'-DDD	14	1.0
p,p'-DDD	24	1.0
o,p'-DDT	23	1.0
p,p'-DDT	110	1.0
Aroclor 1242	ND	5.0
Aroclor 1254	ND	7.0
Aroclor 1260	ND	5.0

Surrogate Standards	% Recovery
13C-Hexachlorobenzene	86
13C-p,p'-DDT	86

1. SDL = Sample Detection Limit
2. ND = Not Detected
3. NDR = Peak detected but did not meet quantification criteria
4. Data have not been blank corrected
5. Concentrations are recovery corrected

Approved

PCB/PESTICIDE ANALYSIS REPORT

CLIENT SAMPLE I.D: RH-A12

AXYS ID: 9718-29

CLIENT: Royal Roads University

DATE: 05/Sept/97

SAMPLE TYPE: Soil

METHOD NO.: SOP 113(AV)

SAMPLE SIZE: 2.85 g dry

INSTRUMENT: GC-MS

% MOISTURE: 9.3

CONCENTRATION IN: ng/g

Compounds	Concentration	(SDL)
o,p'-DDE	ND	0.4
p,p'-DDE	9.1	0.4
o,p'-DDD	18	0.4
p,p'-DDD	73	0.4
o,p'-DDT	32	0.4
p,p'-DDT	200	0.4
Aroclor 1242	ND	5.0
Aroclor 1254	ND	7.0
Aroclor 1260	ND	5.0

Surrogate Standards	% Recovery
13C-Hexachlorobenzene	97
13C-p,p'-DDT	79

1. SDL = Sample Detection Limit
2. ND = Not Detected
3. NDR = Peak detected but did not meet quantification criteria
4. Data have not been blank corrected
5. Concentrations are recovery corrected

Approved

PCB/PESTICIDE ANALYSIS REPORT

CLIENT SAMPLE I.D: RH-A15

AXYS ID: 9718-30

CLIENT: Royal Roads University

DATE: 05/Sept/97

SAMPLE TYPE: Soil

METHOD NO.: SOP 113(AV)

SAMPLE SIZE: 2.93 g dry

INSTRUMENT: GC-MS

% MOISTURE: 8.8

CONCENTRATION IN: ng/g

Compounds	Concentration	(SDL)
o,p'-DDE	4.0	0.2
p,p'-DDE	29	0.2
o,p'-DDD	74	0.2
p,p'-DDD	140	0.2
o,p'-DDT	330	0.2
p,p'-DDT	1100	0.2
Aroclor 1242	ND	5.0
Aroclor 1254	ND	7.0
Aroclor 1260	ND	5.0

Surrogate Standards	% Recovery
13C-Hexachlorobenzene	102
13C-p,p'-DDT	80

1. SDL = Sample Detection Limit
2. ND = Not Detected
3. NDR = Peak detected but did not meet quantification criteria
4. Data have not been blank corrected
5. Concentrations are recovery corrected

Approved

PCB/PESTICIDE ANALYSIS REPORT

CLIENT SAMPLE I.D: RH-B2

AXYS ID: 9718-34

CLIENT: Royal Roads University

DATE: 05/Sept/97

SAMPLE TYPE: Soil

METHOD NO.: SOP 113(AV)

SAMPLE SIZE: 2.69 g dry

INSTRUMENT: GC-MS

% MOISTURE: 6.2

CONCENTRATION IN: ng/g

Compounds	Concentration	(SDL)
o,p'-DDE	61	2.0
p,p'-DDE	1900	2.0
o,p'-DDD	380	1.0
p,p'-DDD	285	1.0
o,p'-DDT	847	1.0
p,p'-DDT	13000	1.0
Aroclor 1242	ND	20
Aroclor 1254	ND	50
Aroclor 1260	ND	30

Surrogate Standards	% Recovery
13C-Hexachlorobenzene	100
13C-p,p'-DDT	95

1. SDL = Sample Detection Limit
2. ND = Not Detected
3. NDR = Peak detected but did not meet quantification criteria
4. Data have not been blank corrected
5. Concentrations are recovery corrected

Dale Hoover

Approved

PCB/PESTICIDE ANALYSIS REPORT

CLIENT SAMPLE I.D: RH-C3

AXYS ID: 9718-35

CLIENT: Royal Roads University

DATE: 05/Sept/97

SAMPLE TYPE: Soil

METHOD NO.: SOP 113(AV)

SAMPLE SIZE: 2.70 g dry

INSTRUMENT: GC-MS

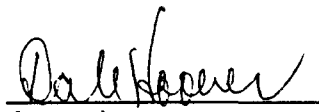
% MOISTURE: 3.1

CONCENTRATION IN: ng/g

Compounds	Concentration	(SDL)
o,p'-DDE	14	0.6
p,p'-DDE	660	0.6
o,p'-DDD	47	0.4
p,p'-DDD	213	0.4
o,p'-DDT	675	0.4
p,p'-DDT	4400	0.4
Aroclor 1242	ND	5.0
Aroclor 1254	ND	7.0
Aroclor 1260	ND	20

Surrogate Standards	% Recovery
13C-Hexachlorobenzene	105
13C-p,p'-DDT	92

1. SDL = Sample Detection Limit
2. ND = Not Detected
3. NDR = Peak detected but did not meet quantification criteria
4. Data have not been blank corrected
5. Concentrations are recovery corrected



Approved

PCB/PESTICIDE ANALYSIS REPORT

CLIENT SAMPLE I.D: RH-C8

AXYS ID: 9718-33 A

CLIENT: Royal Roads University

DATE: 05/Sept/97

SAMPLE TYPE: Soil

METHOD NO.: SOP 113(AV)

SAMPLE SIZE: 2.82 g dry

INSTRUMENT: GC-MS

% MOISTURE: 12

CONCENTRATION IN: ng/g

Compounds	Concentration	(SDL)
o,p'-DDE	18	0.4
p,p'-DDE	1100	0.4
o,p'-DDD	156	0.4
p,p'-DDD	456	0.4
o,p'-DDT	1100	0.4
p,p'-DDT	6700	0.4
Aroclor 1242	ND	5.0
Aroclor 1254	ND	8.0
Aroclor 1260	ND	6.0

Surrogate Standards	% Recovery
13C-Hexachlorobenzene	99
13C-p,p'-DDT	91

1. SDL = Sample Detection Limit
2. ND = Not Detected
3. NDR = Peak detected but did not meet quantification criteria
4. Data have not been blank corrected
5. Concentrations are recovery corrected

Approved

PCB/PESTICIDE ANALYSIS REPORT

CLIENT SAMPLE I.D: RH-C8

AXYS ID: 9718-33 B
DUPLICATE

CLIENT: Royal Roads University

DATE: 05/Sept/97

SAMPLE TYPE: Soil

METHOD NO.: SOP 113(AV)

SAMPLE SIZE: 2.86 g dry

INSTRUMENT: GC-MS

% MOISTURE: 10

CONCENTRATION IN: ng/g

Compounds	Concentration	(SDL)
o,p'-DDE	24	0.4
p,p'-DDE	1500	0.4
o,p'-DDD	182	0.4
p,p'-DDD	548	0.4
o,p'-DDT	1200	0.4
p,p'-DDT	8900	0.4
Aroclor 1242	ND	5.0
Aroclor 1254	ND	8.0
Aroclor 1260	ND	6.0

Surrogate Standards	% Recovery
13C-Hexachlorobenzene	105
13C-p,p'-DDT	80

1. SDL = Sample Detection Limit
2. ND = Not Detected
3. NDR = Peak detected but did not meet quantification criteria
4. Data have not been blank corrected
5. Concentrations are recovery corrected

Dale Hopper
Approved

PCB/PESTICIDE ANALYSIS REPORT

CLIENT SAMPLE I.D: RH-AA6

AXYS ID: 9718-32

CLIENT: Royal Roads University

DATE: 05/Sept/97

SAMPLE TYPE: Soil

METHOD NO.: SOP 113(AV)

SAMPLE SIZE: 2.77 g dry

INSTRUMENT: GC-MS

% MOISTURE: 8.0

CONCENTRATION IN: ng/g

Compounds	Concentration	(SDL)
o,p'-DDE	1.1	0.2
p,p'-DDE	26	0.2
o,p'-DDD	5.8	0.2
p,p'-DDD	9.0	0.2
o,p'-DDT	28	0.2
p,p'-DDT	120	0.2
Aroclor 1242	ND	5.0
Aroclor 1254	ND	8.0
Aroclor 1260	ND	6.0

Surrogate Standards	% Recovery
13C-Hexachlorobenzene	69
13C-p,p'-DDT	71

1. SDL = Sample Detection Limit
2. ND = Not Detected
3. NDR = Peak detected but did not meet quantification criteria
4. Data have not been blank corrected
5. Concentrations are recovery corrected

Approved

PCB/PESTICIDE ANALYSIS REPORT

CLIENT SAMPLE I.D: RH-AA10

AXYS ID: 9718-31

CLIENT: Royal Roads University

DATE: 05/Sept/97

SAMPLE TYPE: Soil

METHOD NO.: SOP 113(AV)

SAMPLE SIZE: 2.79 g dry

INSTRUMENT: GC-MS

% MOISTURE: 8.0

CONCENTRATION IN: ng/g

Compounds	Concentration	(SDL)
o,p'-DDE	0.1	0.2
p,p'-DDE	1.8	0.2
o,p'-DDD	0.8	0.2
p,p'-DDD	1.6	0.2
o,p'-DDT	6.7	0.2
p,p'-DDT	22	0.2
Aroclor 1242	ND	5.0
Aroclor 1254	ND	7.0
Aroclor 1260	ND	5.0

Surrogate Standards	% Recovery
13C-Hexachlorobenzene	81
13C-p,p'-DDT	95

1. SDL = Sample Detection Limit
2. ND = Not Detected
3. NDR = Peak detected but did not meet quantification criteria
4. Data have not been blank corrected
5. Concentrations are recovery corrected

Dale Hoover

Approved

APPENDIX D:
CORRESPONDENCE REGARDING WORK PLAN AND REMOVAL OF CONTAMINATED SOILS

Yukon
ARCTIC
ENVIRONMENTAL
STRATEGY

ACTION ON WASTE

#345, 300 Main Street
Whitehorse, Yukon
Y1A 2B5

Phone: (403) 667-3270
Fax: (403) 667-3199

Mr. Lanny T. Hubbard
Director - Industrial Waste and
Hazardous Contaminants Branch
Province of British Columbia
Ministry of Environment, Lands and Parks
4th Floor
777 Broughton Street
Victoria, B.C.
V8V 1X4

October 28, 1996

VIA FAX: 250-356-9836

Dear Mr. Hubbard:

Re: Rainy Hollow - Contaminated Soil Removal

Please be advised that the DDT contaminated soil stored at Rainy Hollow has been removed as of October 15, 1996.

This work was completed by Champagne and Aishihik First Nations and their subcontractor Hazco Environmental Services Ltd. The material was transported to an industrial landfill in Edmonton, Alberta, operated by Waste Management of Canada, Ltd.

Indian and Northern Affairs - Canada has conducted on-site inspections and confirms removal of soil, tarps, ground sheets and fencing.

If I can offer any further information, please contact me at 403-67-3270 fax 403-667-3206.

Sincerely,

Brett Hartshorne
Manager - Action on Waste
Arctic Environmental Strategy
Indian and Northern Affairs - Canada

Gord Allison	Champagne-Aishihik First Nations	Haines Junction	403-634-2108
Doug Bright	Royal Roads University	Victoria	250-391-2522
Sarah Browne	DIAND - Communications	Whitehorse	403-667-4319
Doug Crow	BCMELP - Parks	Haines Junction	403-634-7043
Vic Enns	Environment Canada	Whitehorse	403-667-7962
Peggy Evans	BCMELP - Cont. Sites	Victoria	250-387-9935
Alex Grant	BCMELP - Env. Protection	Smithers	250-847-7591
Jennifer Gusoott	DIAND - Lands	Whitehorse	403-667-3214
Doug Johnson	Dept of US Army	Fairbanks	907-428-1186
Hugh Markides	BCMELP - Parks	Smithers	250-847-7659
Valerie Noftle	DFAIT	Ottawa	613-995-1405
Ian Sneddon	DIAND - Lands	Ottawa	819-953-2950
Mark Zrum	DIAND - Land Use	Whitehorse	403-667-3214

Indian and Northern Affairs Canada / Affaires indiennes et du Nord Canada

Canada

Indian and Northern Affairs Canada / Affaires indiennes et du Nord Canada

Waste Management Program
345-300 Main Street
Whitehorse, Yukon
Y1A 2B5
ph: 403-667-3270
fax: 403-667-3199

Your file / Votre référence

Our file / Notre référence

August 13, 1997

VIA FAX: **PAGE ONE OF TWO**

Gord Allison	Champagne & Aishihik First Nations	Haines Junction	403-634-2108
Laurie Baron	BCMELP - Parks - Tatshenshini	Haines Junction	403-634-7043
Matt Dodd	Royal Roads University - ARD	Victoria	250-391-2522
Bill Dushenko	Royal Roads University - ARD	Victoria	250-391-2522
Vic Enns	Environment Canada - Env. Prot.	Whitehorse	403-667-7962
Peggy Evans	BCMELP - Contaminated Sites	Victoria	250-387-9935
Alex Grant	BCMELP - Environmental Protection	Smithers	250-847-7591
Rob McLenehan	BCMELP - Contaminated Sites	Victoria	250-387-9935
Hugh Markides	BCMELP - Parks	Smithers	250-847-7659
Mark Palmer	DIAND - Contaminants	Whitehorse	403-667-3199
Tom Wingrove	UMA Engineering Ltd.	Winnipeg	204-475-3646

Re: UPDATE: RAINY HOLLOW/BORDER PUMP STATION REMEDIATION

We have scheduled the 1997 work program to commence at Rainy Hollow August 20, 1997. The program remedial recommendations are described in *Border Station/Rainy Hollow Detailed Site Investigation and Risk Assessment* produced for the Rainy Hollow Working Group and DIAND - Yukon Region by Royal Roads University - Applied Research Division/UMA Engineering Ltd./Golder Associates. The methodology is contained in *Site Remediation of the Border Pump Station and Rainy Hollow Sites - British Columbia, Canada* produced for DIAND - Yukon Region by UMA Engineering Ltd.

To very briefly summarize:

The objective is the isolation or removal and off-site disposal of 1). DDT-contaminated surface soils greater than 1 mg/kg and 2). high-level (above 1000 mg/kg) hydrocarbon-contaminated surface soils.

Soils above 10mg/kg DDT will be removed and disposed of off-site at an approved facility.

Soils ranging from 1 - 10 mg/kg DDT will be capped by a minimum of 0.5 metres of clean fill acquired from an off-site quarry source.

All excavations will be backfilled and graded to blend with the natural topography and assist in drainage.

A long-term monitoring plan is under development and will be distributed for comment as soon as possible.

Existing monitoring wells will be modified to below grade, or sealed and abandoned.

../2

Canada

The project team consist of:

ORGANIZATION	ROLE	CONTACT	PHONE/FAX NO.
Champagne-Aishihik First Nations	Constuction Contractor	Mr. Harold Kane/ Mr. Gord Allison	(Haines Junction, Y.T.) 403-634-2288 403-634-2108
Royal Roads University - Applied Research Division	Scientific/Technical Consultant	Dr. Matt Dodd/ Dr. Bill Dushenko	(Victoria, B.C.) 250-391-2583 250-391-2522
UMA Engineering Ltd.	Engineering Consultant	Mr. Tom Wingrove	(Winnipeg, Man.) 204-284-0580 204-475-3646
DIAND	Project Authority	Mr. Brett Hartshorne/ Mr. Mark Palmer	(Whitehorse, Yukon) 403-667-3270 403-667-3199

As mentioned, work is scheduled to commence August 20, 1997. We anticipate completion by the end of August.

If you have any questions or comments, please call me at 403-667-3270, fax 403-667-3199, or e-mail: hartshorneb @ inac.gc.ca.

I will keep you advised of any further developments.

Sincerely,

Brett Hartshorne, Manager
DIAND - Waste Program - Yukon Region

Indian and Northern Affairs Canada
Affaires indiennes et du Nord Canada

Waste Management Program - Yukon
345 - 300 Main Street
Whitehorse, Yukon Y1A 2B5
Phone: 867-667-3268
Fax: 867-667-3199

Your file Votre référence

Our file Notre référence

November 25, 1997

FAXED 97/11/26

Royal Roads University
Applied Research Division
2005 Sooke Road
Victoria, B.C. V9B 5Y2
Attn: Dr. Matthew Dodd
VIA FAX: 250-391-2610

Dear Dr. Dodd:

Re: Rainy Hollow/Border Pumpstation - Contaminated Soil Removal and Disposal

Please accept this letter as confirmation of the removal and disposal of the contaminated soil from the Rainy Hollow/Border Pumpstation site as described in *Construction Specifications for the Site Remediation of the Border Pump Station and Rainy Hollow Sites, British Columbia, Canada* - UMA Engineering Ltd., Winnipeg, Manitoba prepared for Indian and Northern Affairs - Canada, Yukon Region.

The removal operation was conducted on September 14, 1997 by Champagne and Aishihik First Nations of Haines Junction, Yukon, and Hazco Environmental Services Ltd. of Calgary, Alberta. The contaminated soil was loaded onto eight special waste transporter units. DIAND - Waste Management representative, Brett Hartshorne, supervised this operation.

A total of 226,850 kg. of contaminated soil was removed. This weight was confirmed through the use of Yukon Territorial Government (YTG)-supplied portable scales at the site, and at the YTG Weigh Station, Haines Junction, Yukon.

This material was transported to, received and disposed of at the East Peace Industrial Waste Treatment and Disposal Site, Peace River, Alberta, under waste approval code EP11134980903. The material arrived at the disposal site September 16 and 17, 1997. Completed Waste Manifests are on file with the DIAND - Waste Management office, Whitehorse, Yukon.

../2

Canada

Also on September 14, 1997, following the removal of the soil from the Rainy Hollow/Border Pumpstation site, Champagne and Aishihik First Nation completed the capping operation (as described in the Construction Specifications). DIAND - Waste Management conducted a final confirmatory cap survey on October 10, 1997. Survey results have been forwarded to UMA Engineering Ltd. of Winnipeg.

I trust this adequately meets your requirements. If I can offer anything further, please contact me or Mr. Mark Palmer.

Sincerely,

Brett Hartshorne, Manager
Waste Management Program - Yukon