DETAILED WORK PLAN FOR SITE RESTORATION ACTIVITIES

Blanchard River Station

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Prepared for:
Waste Management Program, Yukon
Indian Affairs and Northern Development
Whitehorse

By:

Royal Roads University Applied Research Division and
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1. INTRODUCTION

Royal Roads University Applied Research and UMA Engineering Ltd. conducted a detailed site investigation of Blanchard River Station, Yukon, during June 14 – 20, 1999. *The purpose of this document is to describe in detail the recommended tasks to be undertaken during fiscal year1999-2000 as well as in subsequent years in order to remediate the site.* The framework used for site investigation and remediation is based on the Yukon Renewable Resources Contaminated Sites Regulation (Yukon CSR). A thorough description of the detailed site investigation will be provided under separate cover. The results and recommendations for action previously have been communicated to representatives from the Department of Indian and Northern Affairs Waste Management and Lands, Yukon Territorial Government (YTG) Renewable Resources and YTG Transport, Heritage Canada, Environment Canada, and Champagne and Aishihik First Nations at a meeting held in Whitehorse on August 5th, 1999.

2. BACKGROUND

During the period 1950-1952, the United States government commissioned the Fluor Corporation, Los Angeles, California to construct an eight inch multi-fuel line to supply fuels from the deep water port at Haines to military sites in Alaska. The Haines-Fairbanks pipeline was subsequently constructed in 1954-1955. Six pump stations, including Blanchard River and associated facilities were constructed along the Canadian section of the line. The Blanchard River Station is located at Mile 87 of the pipeline and is just on the Yukon side of the border with British Columbia. The Yukon Territorial Government (YTG) Highways Department presently uses the site as a Highway Maintenance Camp.

The original Blanchard Pump Station consisted of one main building and six trailers. The main building housed the engine room, pumps, generators, maintenance shop and water supply while the six trailers provided accommodation. The trailers were removed in 1986 and the main building was extended on the north end and converted to the Highways Maintenance Garage. An accommodation building was constructed on the original site of the trailers to house the highway workers. Demolition debris was buried to the north of the site. Other old disposal areas that were associated with the original pump station are present at the site.

2.1 Preliminary Site Investigation

A preliminary environmental investigation was conducted at Blanchard Station in 1995 by UMA Engineering Ltd. and Ambio Research Associates as part of investigations along the Haines Fairbanks Pipeline (UMA 1995). This investigation identified a rust coloured leachate plume on the north side of the site and sub-surface soils at the southwest side of the maintenance building as the main areas of contamination. Extractable hydrocarbons, mono-aromatic hydrocarbons and metals were the main contaminants of concern. Elevated levels of PCBs, halogenated volatile hydrocarbons, phenoxy herbicides, pesticides and polycyclic aromatic hydrocarbons were not found.

High levels of inorganic elements (arsenic, barium, cobalt, selenium and zinc) and extractable hydrocarbons were found in soil/sediment samples collected from the leachate plume. It appeared this leachate plume originated from the maintenance complex. The results of an EM survey indicated that a buried pipe which originated between the shop and residence terminated at the leachate plume and this pipe may be the conduit for the contaminants found in the samples collected in the leachate. The origin of this pipe was not ascertained during the preliminary investigation. Hydrocarbon contamination was also found in groundwater and sub-surface soils obtained from the southwest side of the site. In addition, a small amount of free product was observed on the surface of water in the Blanchard River, near the sampling locations.

The origin and extent of the two contaminant plumes summarized above could not be determined from the limited investigation. There was however, limited evidence that these plumes were introducing hydrocarbons and inorganic elements into the Blanchard River. The report recommended a detailed site investigation to characterize the source, composition and extent of contamination at the site.

The recommendations provided above form the basis for a detailed site investigation which was undertaken during the summer of 1999. The main objectives included –

- the completion of a detailed site investigation to determine the source, composition and spatial extent of soil and groundwater contamination at Blanchard River Station;
- an evaluation of the current operation of the site and its contribution, if any to contaminant loading;
- an environmental assessment of the data obtained; and
- derivation of cleanup/remedial options if required.

2.2 Detailed Site Investigation

A work plan was provided for the detailed site investigation on April 26th, 1999. The work included the following tasks:

- Task 1: Project Management and Implementation
- Task 2: Historical Review
- Task 3: Field Investigations
- Task 4: Site Assessment
- Task 5: Derivation of Clean-up/Remedial Options
- Task 6: Engineering Design
- Task 7: Stakeholder Consultation and Permitting
- Task 8: Preparation of Detailed Report
- Task 9: Schedule, Level of Effort and Budget

The specific sub-tasks for the field program (Task 3) included –

- borehole drilling and piezometer installation;
- surveying of boreholes, monitoring wells and relevant features ;
- collection of surface and sub-surface soil samples, surface water, and groundwater samples;
- acquisition of field data for calculation of hydraulic conductivity, groundwater flow direction and gradient, and contaminant migration rates;
- use of field test methods for the screening analysis of contaminants in soil and water;
- re-sampling of existing wells, especially for petroleum hydrocarbon groundwater contamination;
- a field quality assurance/quality control program;
- information exchange with local stakeholders, including YTG and the Champagne and Aishihik First Nations;
- qualitative re-evaluation of contaminant migration pathways and site-specific receptors and limited sampling of biota as merited in order to measure contaminant bioaccumulation (e.g., where elevated arsenic levels were observed); and
- complete documentation of site conditions and sampling program.

A major portion of the field investigation involved the delineation of the extent of subsurface hydrocarbon contamination detected in separate areas to the north and south of the site.

Tables 2.1 and 2.2 provide a summary of the sampling and analytical program for the detailed site investigation.

Table 2.1: Summary of Sampling Program for Blanchard River Detailed Site Investigation

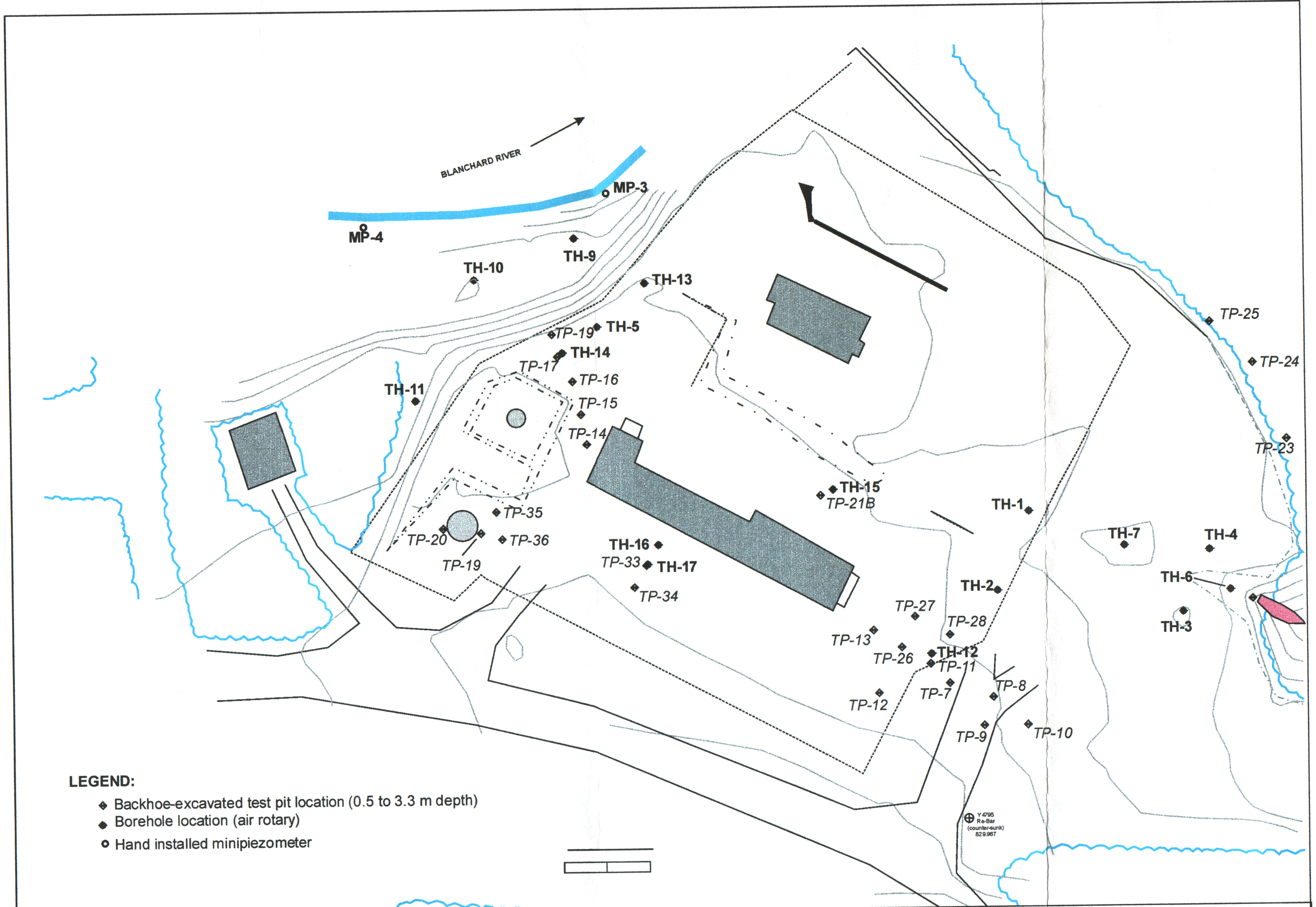
Sample Type	Number Completed/ Collected
• Bore holes/subsurface soils – track mounted air rotary drill	12
• Monitoring wells /groundwater samples	10
• Test pits/subsurface soils– backhoe completed	30
• Mini-piezometers/groundwater	2
• Surface soils and sediments– hand collected	7
• Surface water – Blanchard River and recipient areas	5
• Drinking water	2

Table 2.2: Summary of Laboratory Analytical Program for Blanchard River Detailed Site Investigation: Number of Samples Analyzed

Sample type	Substance							
	VOC/ VPH[1]	BTEX/ VPH[2]	EPH[3]	LEPH/ HEPH[4]	Metals	PCBs	OCP[5]	
Soil/ Sediment	12	13	30	23	27	10	10	
Water	5	12	6	18	21	-	-	

1: Volatile Organic Contaminants/Volatile Petroleum Hydrocarbons.
2: Benzene, Toluene, Ethylbenzene, Xylenes/ Volatile Petroleum Hydrocarbons.
3: Extractable Petroleum Hydrocarbons (including PAHs).
4: Light- and Heavy Extractable Petroleum Hydrocarbons (excluding PAHs).
5: Organochlorine Pesticides.

The sampling locations are also shown on Map 2.1.



MAP 2.1:BLANCHARD RIVER STATION - SITE LAYOUT
Including sampling locations, 1995 preliminary site investigation and 1999 detailed site investigation

3. OVERVIEW OF FINDINGS FROM CONTAMINATED SITE INVESTIGATIONS AT BLANCHARD RIVER SITE

The major conclusions as well as areas of concern identified based on the detailed site investigation are briefly described below:

- It was verified that polychlorinated biphenyls, volatile organic contaminants and chlorinated pesticides such as DDT were not contaminants of concern at Blanchard River.

- In drinking water samples from Blanchard River, metals/metalloids and the monoaromatic hydrocarbons benzene, ethylbenzene, toluene, and xylenes did not occur at levels exceeding the Yukon CSR drinking water standards.

- In surface or subsurface soil samples, the concentrations of most metals/metalloids were not of concern (i.e., did not exceed the relevant Yukon CSR standard). There are naturally elevated levels of chromium in the Blanchard River site soils, and eight soil samples contained chromium in excess of the Yukon CSR standard. Arsenic and zinc were measured at concentrations in excess of Yukon CSR residential/parkland standards in sediments of the rust-coloured leachate plume previously identified at the north end of the site.

- In surface water samples, either along the leachate pathway or from the Blanchard River itself, only aluminum, iron, and manganese exceeded the Yukon CSR water quality standards for the protection of aquatic life (in some but not all samples). This is interpreted to result from a combination of natural conditions and redox-related dissolution into groundwater where hydrocarbon contamination occurs. It was not deemed to pose any environmental risks *per se.*

- Nine of 51 subsurface soil samples, from boreholes and test pits, exhibited hydrocarbon contamination at concentrations in excess of the Yukon CSR standards for residential/parkland land use (1,000 μg/g for each of light- and heavy extractable petroleum hydrocarbons). A few samples also exceeded the commercial industrial standard of 2,000 μg/g LEPHs and 5,000 μg/g HEPHs. The samples with hydrocarbon contamination in excess of the Yukon CSR standards are shown in Table 3.1.

- Six of sixteen groundwater samples (excluding field duplicates) exhibited contamination by one or more hydrocarbon components at concentrations excess of the Yukon CSR water standards for aquatic life or drinking water (Table 3.2).

Table 3.1: Summary of Yukon CSR Soil Standard Exceedances for Subsurface Soil Samples (exceedances highlighted with grey shading)

Sample #	EPH (C10-18)	EPH (C19-31)	LEPH	HEPH
CSR residential /parkland			1000	1000
CSR industrial			2000	5000
TH9-7	11000	29000	11000	29000
TH12-5	910	<200	910	<200
TH12-10	1300	<200	1300	<200
TH12-16	960	<200	960	<200
TP11-1	2500	19000	2500	19000
TP13-1	1300*	<200	-	-
TP13-2	1500	<200	-	-
TP15-1	1400	264	-	-
TP28-2	1700	<200	-	-
BLS-16	750	3800	700	3800

*(Note: in all cases, the concentration of EPH (C10-18) was virtually identical to LEPHs, the values of which have been adjusted through the subtraction of the PAH component. The LEPH standard was used therefore to interpret the EPH (C10-18) data. A similar rationale was applied for the EPH (C19-31) and HEPH data.)

Table 3.2: Summary of Yukon CSR Water Standard Exceedances for Groundwater Samples (exceedances highlighted with grey shading).

Sample No.	Yukon CSR Generic Numerical Water Standars		MW-1	MW-2	MW-5	MW-D1 (MW-5Dup)	MW-12	MW-D2 (MW-2Dup)	MW-13	MW-14	BLW-2
	AW[1]	DW[2]	All results in mg/L (ppm)								
Non-halogenated Volatiles											
Benzene	3	*0.005*	*0.0198*	*0.0427*				*0.0344*			
Ethylbenzene	7	*0.0024*	*0.0769*	*0.16*	*0.026*	*0.028*		*0.0622*			*0.0065*
Styrene											
Toluene	3	*0.024*		0.0115				*0.457*			
meta- & para-Xylene		*0.3[3]*		*0.319*				*0.376*			
ortho-Xylene			0.0022	0.195	0.0452	0.043 2		0.137	0.0103	0.0394	<0.0005
VPH C6-10			0.8	1.4	0.9	0.8		3.3	0.1	0.4	0.2
PAHs											
Benzo(a)pyrene	**0.0001**	*1E-05*						*0.00002*			
Naphthalene	**0.01**		0.0165	0.0347	0.197	0.175	0.063	0.0658	0.0094	0.0355	
Phenanthrene	**0.003**					0.005		0.0511			
Pyrene	**0.0002**							0.0036	0.00017	0.00019	
Extractables											
LEPH			1.1	5.8	13.4	13.1	3.4	38.3	2.1	12.3	0.4
HEPH			<1	<1	2	2	<1	12	<1	2	<1

1: Aquatic life standard.
2: Drinking water standard.
3: As total xylenes.

Based on the pattern of distribution of various hydrocarbon constituents in subsurface soils and groundwater, the sources of subsurface contamination were identified and appropriate mitigative strategies developed. The detailed site investigation identified five or more source areas of hydrocarbons to the subsurface environment. Two or three of these sources, however, have not resulted in hydrocarbon contamination above levels which would merit remediation.

We identified through historical photographs the past presence of a small above ground storage tank (AST) located to the east of the shop building and across from the well house (Map 2.1: location of TH-17). In addition, a rock pit installed in 1985 to the west of the main shop bay was investigated. This rock pit receives runoff from the main shop floor drains. The rock pit itself and surrounding soils are obviously stained with petroleum hydrocarbons; however, soil and groundwater immediately down gradient from the rock pit do not presently exhibit petroleum hydrocarbon contamination in excess of the Yukon CSR standards. A similar situation exists for subsurface soil adjacent to the largest, now disused AST to the south of the shop, along the north and west sides of the tank. There was strong visual and olfactory evidence of petroleum hydrocarbon contamination; however, the concentrations did not exceed the Yukon CSR standards.

These three areas of hydrocarbon redistribution are deemed to have arisen from release of less free product than would be required to migrate in large quantities through the two or more meters of unsaturated soils and substantially impact the underlying groundwater. Given that the soil groundwater samples did not contain petroleum hydrocarbon constituents at concentrations in excess of the relevant Yukon CSR standards, there is no regulatory impetus to remediate these soils. In addition, the hydrocarbons do not presently pose any risk to humans or other organisms since they are contained in the subsurface environment, are not associated with any peripheral groundwater or drinking water contamination, and the concentrations will continue to attenuate naturally over time.

Two areas of the site exhibited subsurface petroleum hydrocarbon contamination which requires mitigative action. The first problem area is located at and down gradient from the site where a burn pit was located during the operation of Blanchard River as a pump station, prior to 1985. The discharge of hydrocarbon waste products to the burn pit from the pump house resulted in petroleum hydrocarbon contamination in the vicinity of test hole TH/MW-12 (Map 2.1) as well as the down-gradient contamination of groundwater and subsurface soils in test hole/monitoring wells TH/MW-1 and –2. The rust coloured stain found in a water course to the north of the site arises from contaminated water emanating from a culvert. It is strongly suspected that the culvert serves as a conduit for contaminated water plume originating from the test pit as well. The culvert, based on an EM survey conducted in 1995, passes through the contaminated area, with its source at the former location of the burn pit.

The second area of petroleum hydrocarbon contamination at the south end of the maintenance building. The subsurface contamination at the south end of the site has on occasion been observed to result in the presence of a hydrocarbon sheen along a limited portion of the Blanchard River shoreline. The area of subsurface contamination includes boreholes TH-5, TH-9, TH-13 and TH-17 as well as mini-piezometer MP-3. The depth of contamination was greatest just above, and limited vertically by a silt-clay layer (at a depth of 6 m at TH-17). The contamination of soils just above a clay layer in test hole TH-9, established on the bench below the site an along the flood plain of the river was dominated by a heavier hydrocarbon component than observed in other borehole or test pit soil samples from the site. The HEPH concentration in sample TH9-7, at a depth below the surface of 4 m, was 29,000 μg/g, possibly indicating the presence of a dense non-aqueous phase liquid (DNAPL) plume migrating toward the river, in addition to the lighter hydrocarbon fraction noted in other boreholes/monitoring wells which is probably moving laterally in concert with, but slower than, groundwater flows.

A possible source of petroleum hydrocarbon contamination to the south side of the site was a soak away pit which receives discharge from the oily water separator from the floor drains in the shop's welding bay. This soak away pit was installed during the construction of the pump station in 1955. The soak away pit and drain lines were tested in 1985, when the building was converted for use by YTG transport, and are still in use today.

Given the site layout, other sources of petroleum hydrocarbons to ground at the south end of the shop cannot presently be discounted as major contributors. These include historical spills and/or leakage from the larger, now disused AST; largely historical leaks from the smaller of the two ASTS (still in use); as well as possible inputs from either cracks in the shop cement floor/foundation or the oily water separator prior to the point at which waste would be channeled to the soak away pit. The source area and extent of soil contamination require detailed delineation, since naphthalene, phenanthrene, and pyrene occur in groundwater samples at concentrations exceeding Yukon CSR water standards for aquatic life. In addition, the observed introduction of free product, albeit in very limited quantities, to the Blanchard River merits further examination.

4. RECOMMENDED WORK PLAN FOR SITE REMEDIATION

In light of conclusions derived from the preliminary and detailed site investigations, the consulting team identified several major issues. These are summarized in the following Table, in order of priority.

Table 4.1: Major Contaminant Issues at Blanchard River Station

Issue	Comments	Action
1. Petroleum hydrocarbon contamination (PHC) in vicinity of burn pit	Past inputs have resulted in PHC contamination of groundwater and adjacent down gradient soils. Probably accounts for contaminated discharge from culvert at N. end of site.	Removal of contaminated soil mass at former burn pit location to eliminate major component of in place contaminant source.
2. PHC contamination at south end of Blanchard River site	The soil mass affected, possible presence of a dense non-aqueous phase liquid (DNAPL) migrating toward the river, and original source areas cannot be confidently identified yet.	Augment detailed site investigation through the installation of four to five new boreholes/monitoring wells. Investigate DNAPL. Additional backhoe test pitting in vicinity of welding bay and ASTs.
3. Contaminated flow from culvert, causing rust coloured stain at N. of site/	The source of water to the culvert is not known. The culvert may have been installed to channel a spring discharge away from the site working area. Suspected source of hydrocarbon contamination is entrainment where culvert passes through contaminated soil mass.	Excavate culvert, with adequate precautions to capture and treat contaminated flow; verify source of water and whether contaminated or not. If clean, re-route through uncontaminated area.
4. Rock pit from floor drains in the main shop area.	Installed in 1985. No evidence that the rock pit is causing	Decommission rock pit and replace with more up-to-date

Issue	Comments	Action
	substantial subsurface contamination. Rock pit is partially plugged, however, and ongoing use could cause future site contamination from oily waste.	oily waste – water separation technology, with offsite disposal of recovered oily waste for recycling.
5. Existing oily-water separator (1985 vintage) and soak away pit (1955 vintage) from welding bay floor drains.	The historical, and possibly ongoing use of the soak away pit may contribute to Issue 2.	Decommission. Capture floor drain discharge and re-route to new treatment facility as per issue 4.
6. Abandoned AST at S. end of shop/maintenance building.	Related to Issue 2, above. Additional investigation and possibly soil removal required if deemed to be a major source to plume migrating toward Blanchard River.	Additional test pitting and field investigation required. No requirement to disassemble the AST over the short term.

Since the date of the field program for the detailed site investigation, the Blanchard River Site Supervisor further discovered a buried six inch line to the east of the maintenance shop. This line is believed to contain some free product, and is not associated with any utility or supply in current use. The site remediation plan will also include the investigation and removal if appropriate of this potential source of petroleum hydrocarbons to the subsurface environment.

From a perspective of environmental risks, the hydrocarbon contaminant plume at the north end of the site presently offers no viable exposure pathway for humans or other organisms except in the case where the contaminated groundwater emerges from the culvert at the top of the rust-coloured stain. Elsewhere, the contamination is limited to the subsurface environment (generally greater than 2 m in depth), where no possibility of exposure by humans, soil invertebrates, plants, birds, mammals, or other ecological receptors occurs.

The petroleum hydrocarbon plume at the south end of the site exhibited groundwater with concentrations of BTEX components in excess of Yukon CSR drinking water standards. The actual samples of drinking water from the station, however, did not contain detectable BTEX concentrations. Elevated human health risks, therefore, would not be plausible at the present time, unless recreational or other users derived drinking water from some point along the southern hydrocarbon plume where these substances were elevated. Groundwater samples from wells installed in this southern hydrocarbon plume also exhibited a limited number of PAHs (naphthalene, phenanthrene, pyrene) at concentrations in excess of the Yukon CSR water standards for aquatic life. This, and the previous observations of a sheen on the Blanchard River along the bank adjacent to the site, suggest the possibility of risks to aquatic receptors in the Blanchard River, at least within the immediate area where the contaminated groundwater enters the river.

Additional sampling for testing of contaminants in potable water from the rafters spring will be undertaken during the site remediation visit.

There is sufficient information on contaminant sources and distribution arising from the detailed site investigation to estimate volumes and derive credible remediation plans for the majority of the site. We recommend, therefore, that the petroleum hydrocarbon contaminated area at the north end of the site be remediated over the short term, primarily through source removal. Remediation and/or the management of risks from the he contaminant plume at the south end of the site, however, will be feasible with less uncertainty and in a more-cost effective manner only after limited additional study is carried out to further delineate the underlying contaminant source(s). This may lead to additional remediation activities in future years, depending on predicted fate of the contaminant plume, as well as the immediate and possible future risks to biota within the Blanchard River from the petroleum hydrocarbon contamination.

The following sections provide a detailed description of recommendations for site remediation and further investigation, possibly to be undertaken during 1999 prior to major snow accumulation or frost accumulation in the ground.

Task 1: Excavate petroleum hydrocarbon contaminated soils in the vicinity of the former burn pit.

Relevant Remediation Standards and Land Use Categorizatiuon

The maximum observed concentration of petroleum hydrocarbons in shallow subsurface soils beneath the former burn pit area was 19,000 μg/g HEPHs and 2,500 μg/g LEPHs. This occurred in a test pit sample collected from near the centre of the former location of the burn pit, at a depth from the present-day surface of 0.6 m. These concentrations exceed both the Yukon industrial and residential/parkland standards for extractable petroleum hydrocarbons. The maximum LEPH concentration observed in borehole TH-12 was 1,300 μg/g in sample TH12-5, at a depth of 2.5 to 3 meters. Soil samples collected below the presumed bottom of the burn pit prior to burial did not exhibit concentrations of LEPHs, HEPHs or other petroleum hydrocarbon constituents at concentrations in excess of industrial standards. Soils that were contained within the former burn bit during the time when it was used undoubtedly represent a special case: The hydrocarbon signature in these soils is influenced by both fuel oil release and combustion, resulting in a dominance of heavy hydrocarbon fractions.

Based on discussions with major stakeholders during and subsequent to the August 5th, 1999 meeting in Whitehorse, it was deemed appropriate to apply industrial soil remediation standards to the portion of the site used almost exclusively for non-residential activities associated with the highways maintenance camp. A residential or parkland soil standard is more appropriate in areas within the vicinity of the residence, near areas used recreationally, and on or adjacent to wildlands such as the riparian zone of the Blanchard River. The area of the Blanchard River Station between the north entrance gate, along a divide created by the small drop off which parallels and runs between the maintenance garage and residence, and extending to the outer existing fence on the southern perimeter could reasonably be considered as being of industrial land use under the present conditions. Wildlife use of this area is expected to be rare and transient. In addition, exposure of human beings would occur over shorter duration on a daily basis (generally less than eight hours per day) and there is little potential for more sensitive subpopulations such as young children to be exposed.

The limited access to the industrial portion of the station could be further reinforced by the addition of a chain-link fence separating into roughly equal portions the eastern maintenance and western residential areas. As an added level of assurance, surface soils - those most likely to come in direct contact with humans or wildlife - could be remediated down to a residential/parkland soil standard on the industrial portion of the site. The very small possibility of future risks to humans based on excavating contaminated soils would be further limited if soils within the top 2 m from the surface are remediated using a residential//parkland standard. This would further serve to eliminate a major portion of the total mass of petroleum hydrocarbons in the larger source and plume area, thus reducing future mobilization into groundwater, and lateral migration.

Delineation of area and volume of soil to be excavated

An rough-order of magnitude estimate was initially made of soil volumes for the subsurface area contaminated with petroleum hydrocarbons, based on excavation to a residential-parkland standard. This estimated volume of soil to be excavated was 5,000 m^3, with an estimated cost of removal and ex-situ treatment estimated at around $500,000.

A revised estimate of soil volumes and associated costs, based on clean-up to a residential/parkland standard within the top two meters of soil and an industrial standard below 2 m is 2,000 m^3.

- soils within top 2 m exceeding residential/parkland standards: circle with max. diameter of 12 m by 2 m deep = 491 $m^3 \approx 500\ m^3$;
- soils at depths greater than 2 m from surface, exceeding industrial standards: up to 300 m^3.
- Total estimated = 800 m^3

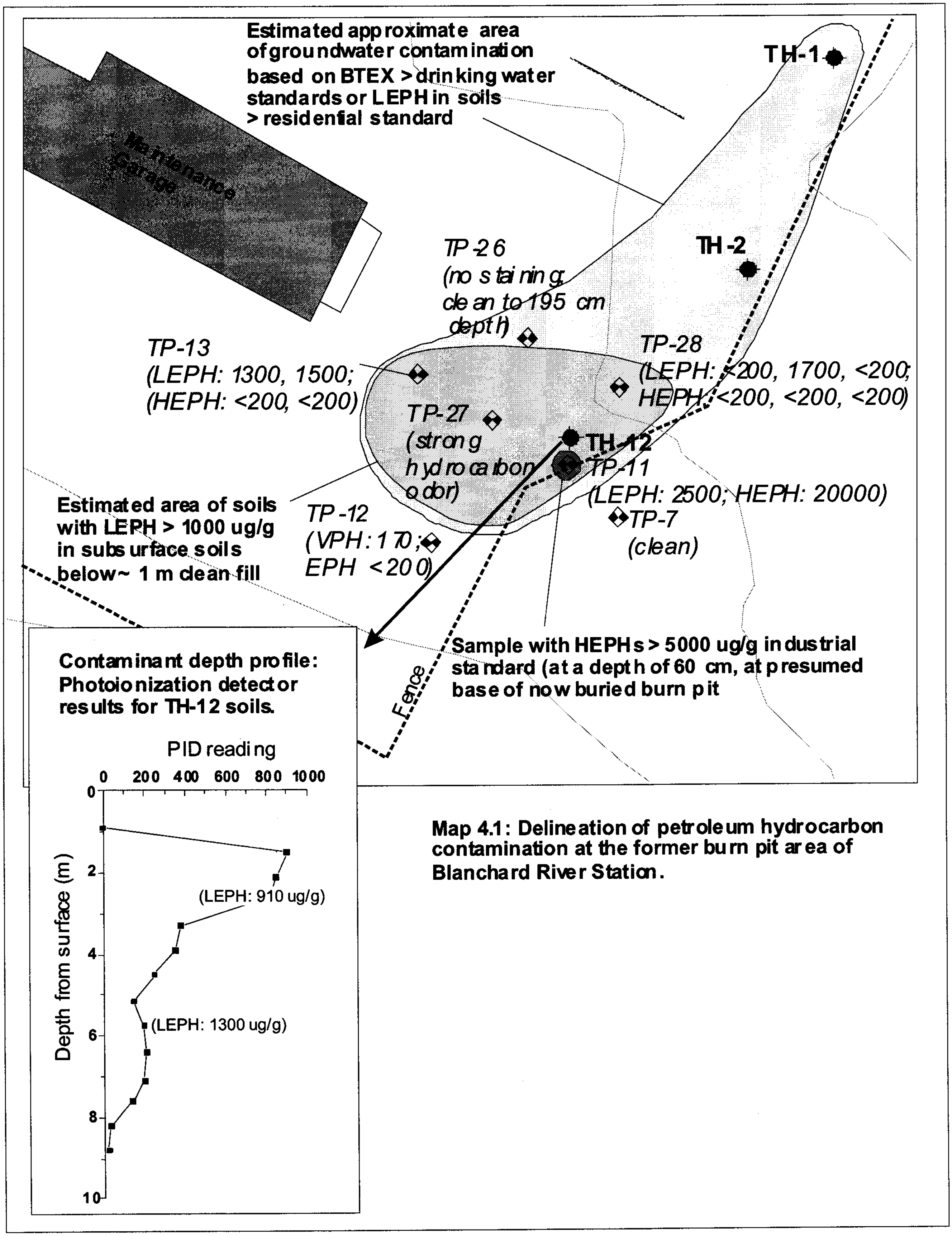
Soil removal and confirmatory testing.

Details of the confirmatory testing protocol to be used for petroleum hydrocarbon contaminated soils are provided below. However, removal of soils in the vicinity of the burn pit area will be carried out using the following procedure:

- the contractor, with assistance from the YTG Transport site supervisor and other parties as deemed necessary will locate and clearly mark all buried utilities, including power cable services to yard lights. All necessary precautions will be taken to ensure human safety and the integrity of utilities during soil excavation and associated activities.
- The general procedure to be followed will be to excavate from the burn pit area 0.5 m of clean fill, lying above the hydrocarbon contaminated soils. Following this, the scientific authority on site will define the outer boundary of soils within the next 0.5 meter contaminated with petroleum hydrocarbons in excess of residential/parkland standards. These soils will be excavated and removed to the treatment facility. The next stratum will then be tested, down to a depth of 2 m from the present day surface, and soils within a boundary defined by residential/parkland standards will be excavated.
- Lateral excavation will be considered to be sufficient when, within the top two meters, field analytical techniques fail to detect soils with concentrations exceeding residential/parkland soil standards. The vertical extent of excavation will be deemed to be sufficient for soils greater than 2 m if field analytical techniques fail to detect soils with concentrations exceeding industrial soil standards.
- After the lateral and vertical extent of soils to be excavated have been defined, additional soil samples will be taken for field testing along the wall and floor of the excavation. These will be collected directly into sample jars, rather than from stock piles. An average of one confirmatory sample will be collected for each 10 m^2 of exposed excavation perimeter (including floor). An average of 50% of the samples collected from the wall of the excavation and 25% of the samples collected from the floor of the excavation will be selected for laboratory analysis.
- Pursuant to confirmation of having achieved the remediation goals based on the confirmatory testing, the excavation will be back-filled with clean fill, to be provided by YTG Transport. The original contours will be restored and the surface left in a condition suitable for use as a parking and road access area.

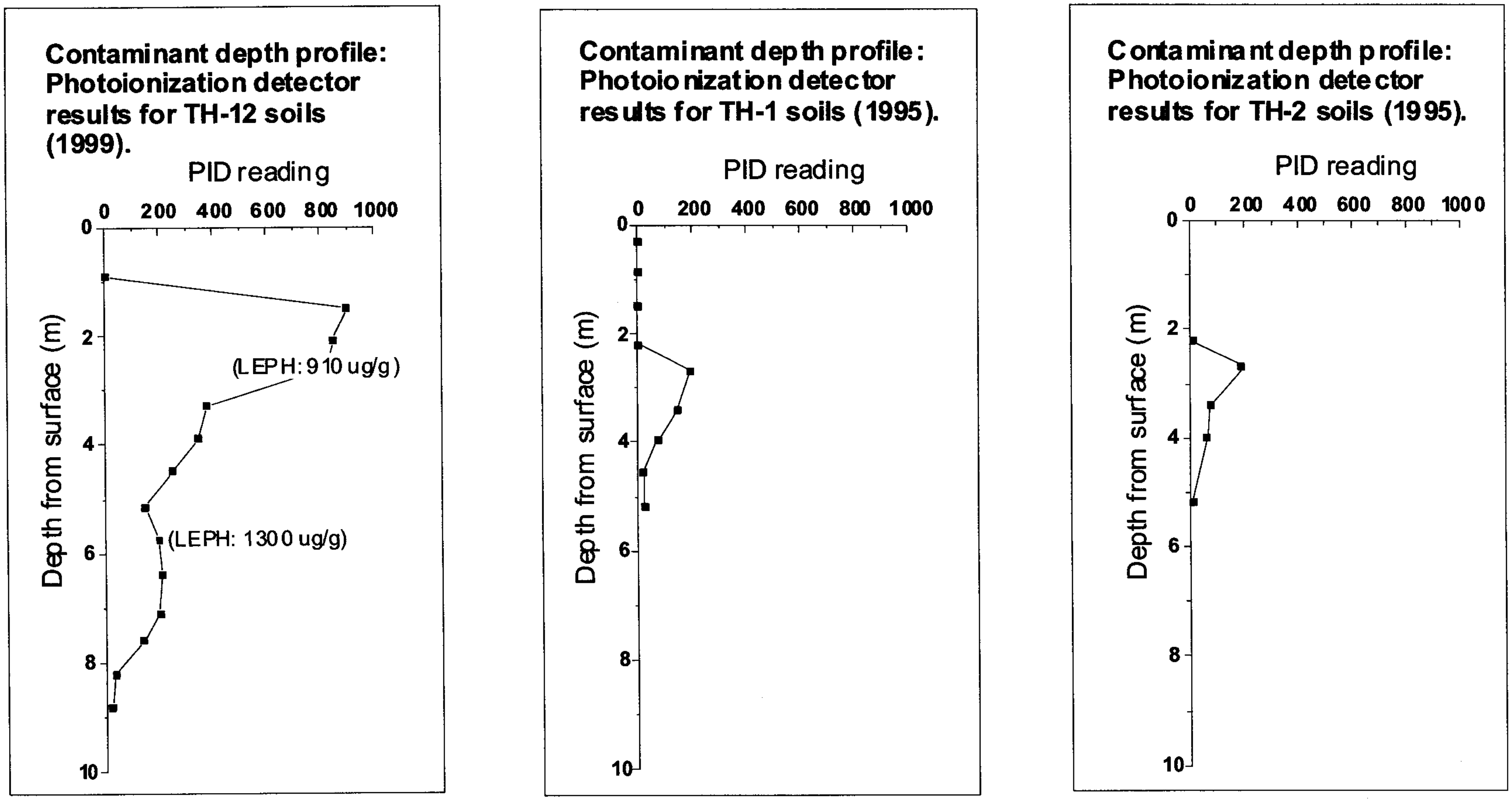
Related Issues

- The spatial extent of the excavation may or may not require the disassembly and relocation of either the perimeter chain link fence or the large light standard immediately outside of the gate to the compound. Should relocation be required, the contractor and site remediation supervisor will consult with the YTG site supervisor to devise an appropriate plan. The light standard and fence, including gate, will be returned to the same working and aesthetic condition that it was in prior to the commencement of work.



Map 4.1: Delineation of petroleum hydrocarbon contamination at the former burn pit area of Blanchard River Station.

Figure 4.1: Vertical distribution of hydrocarbon contamination down gradient from bun pit area.



Task 2: Establish ex-situ soil remediation site or temporary holding facility along stretch of abandoned Haines-Fairbanks highway, north of British Columbia-Yukon Border

A site for construction of an ex-situ remediation facility for the hydrocarbon-contaminated soils has tentatively been identified along the old, now abandoned Haines-Fairbanks Highway. The following assumes a flat site the width of the old highway. It is further assumed that access can be restored. Finally, the site could be constructed in anticipation of receiving up to 2,000 m^3 of soil should removal eventually be deemed to be required from the south end of the site. It should not be difficult, however, to add cells in the future as required, given the linear nature of the site.

Initial sampling and characterization of soils as baseline for evaluation of remediation effectiveness.

Task 3: Curtail contaminated groundwater discharge from culvert at top of rust-coloured stain at N. end of site.

The aim of Task 3 is to curtail the presumed entrainment of hydrocarbon contaminated groundwater and discharge from the existing culvert onto the slope at the northern edge of the Blanchard River Station. This requires an investigation of the source of flows (and purpose of the culvert), as well as the source of contamination prior to the discharge point. Also required are provisions for the capture and treatment of active, contaminated flow, such that uncontaminated areas are not contaminated during the course of remediation. Finally, it is anticipated that the source of discharge into the culvert will need to be re-routed around the area of subsurface contamination.

Removal and re-routing of the culvert discharging at the north end of the Station will be carried out using the following procedure:

- Construct lined catch basin along path of culvert and within area of currently defined contaminant plume. Location of the culvert at this and other points may require additional delineation using an EM31, ground penetrating radar, or similar techniques. Depending of flows, pump from catch basin into on site Hazco oily wastewater treatment plant (leased).
- Construct secondary lined catch basin near end of culvert.
- Excavate using backhoe portion of culvert between primary catch basin and end of culvert.
- Locate and mark path of culvert to south of primary catch basin. Locate and mark all active and abandoned utilities along culvert path.
- Using backhoe, excavate culvert back to point or origin. Should it become evident that flow upgradient from the burn pit contaminant plume is also contaminated with petroleum hydrocarbons, based on visual or olfactory

evidence and well as through the use of a photoionization detector, construct catch basins at intervals to capture and treat flows.

- Assuming initial flow source is benign, evaluate need to re-channel around contaminated subsurface area, using new culvert (200 ϕ or suitable alternate). Estimated length of new culvert required: 120 m.
- Restore trench and surface contours using clean fill as necessary and by back-blading. Restore temprary catchment basins. Dispose of liner.

Task 4: Remove offsite major portion of metal contaminated sediments in rust-coloured stain.

Map 4.2 shows and estimate of the spatial extent of sediments affected by metal/metalloid dissolution followed by adsorption under oxidized conditions, below the end of the culvert. Portions of these soils at the top of the discharge are also contaminated with light and heavy extractable hydrocarbons The contaminated sediments are easily identified visually by the strong rust colouration of precipitated iron oxides, which further serves adsorb other metals from the newly surfaced groundwater.

The stained sediments have a maximum depth of up to 3 cm. An estimate of the volume of metal-contamined rust-coloured sediment, as shown in Map 4.2, is ???.

This material should be removed by hand excavation, placed in hazmat barrels, and removed offsite. The remediation effort should aim to achieve an 80% capture of in place stained sediments within the upper 12 m of the stained water course. Spot removal only of areas of sediment accumulation should be carried out beyond this, since the water course and stained area narrow considerably beyond this point, and since the iron oxides have lower levels of associated adsorbed co-contaminants beyond this point.

Final offsite disposal of these soils would be managed under subcontract to Hazco.

Task 5: Excavate six inch fuel line at east side of maintenance shop.

A backhoe will be used to investigate the six inch fuel line uncovered in August, 1999, during the installation of new above-ground storage tanks. This may involve the removal to the constructed landfarm of petroleum hydrocarbon contaminated soils, should they contain concentrations in excess of the appropriate remediation standard.

Task 6: Decommission 1985-vintage rock pit to west of maintenance building, and replace with more up to date technology.

The extent of remediation planning in this area for the present fiscal year will include the investigation of options for replacement of the current floor drain disposal system with a modern separator/treatment unit. This will include an evaluation of different vendors, costs, and performance. Based on discussions with DIAND and YTG, it may be deemed appropriate to initiate the purchase and installation of a new disposal system.

Task 7: Decommission oily-water separator and soak away pit which drain floor drains of welding bay.

Task 8: Complete detailed site investigation of petroleum hydrocarbon plume on south end of site.

Additional tasks to be undertaken for the completion of detailed site characterization will include –

- Completion of four new boreholes at the south end of the site and installation of monitoring wells;
- Test pitting around large abandoned AST;
- Investigation as part of the drilling program of possible DNAPL, based on prior evidence from TH-9;
- Laboratory analysis of test pit and borehole soil samples for VPHs, LEPHs, and HEPHs (including BTEX and PAHs);
- Development and sampling of the four new monitoring wells; re-sampling of wells TH-5, 9-11, 13, 14;
- Completion of response tests for new wells;
- Survey in new wells, test pits and other relevant features.

Task 9: Conduct confirmatory testing of excavated areas, for petroleum hydrocarbon contamination. Analyze additional samples from the site.

An iterative approach will be used to maximize the analytical data relative to analytical costs. Field test methods, including a volatile organics detector (Photoionization Detector, PID, or OVS), immunoassay-based test kits (Millipore) and/or "Petroflag" Hydrocarbon analyzer test kits will be used on a large number of surface and subsurface samples as a tool for the confirmatory testing of hydrocarbons in soil and water samples.

The photoionization detector provides an initial indication of elevated volatile hydrocarbon concentrations in soils and have been used in US EPA protocols (Driscoll, 1993). On the basis of the PID results and/or other unusual physical characteristics such as odour and staining, selected samples will be tested in the field for one or more of PAHs, TEH, or other petroleum hydrocarbon constituents using Millipore EnviroGard Test Kits. Field test results will be used to guide the selection of samples for laboratory analysis. The kits utilize the enzyme linked immunosorbent assay which is based on antibodies that are specifically designed to bind to target analyte molecules and have been accepted for US EPA SW-846 Methods (PCB, PCP, TPH, BTEX, DDT, Toxaphene, Chlordane). Several EPA regional studies have used immunoassays as screening tools (Emon and Grelach, 1995). We have routinely used immunoassay based field test kits to successfully guide environmental site investigations elsewhere in the Yukon.

Laboratory Analysis

Samples collected during the field programs will be submitted to ASL, Vancouver, for the analysis of BTEX, VPH, LEPHs, HEPHs, and PAHs. Prior to and throughout the field program, RRU will liaise with the laboratories to ensure that all QA/QC objectives, such as detection limits, proper sample containers, sample delivery, etc., are being met. Samples will be submitted to the laboratories using a blind sample numbering system via a rigorous chain-of-custody. Blind submission of the samples will disguise the identity of the sample as to its location and concentration, and thereby avoid possible biases. Selected samples based on field screening tests will be targeted for immediate analysis on the chain-of-custody forms submitted to the lab; additional samples will be archived and frozen for later analysis as warranted, based on the initial round of analyses.

Quality Assurance and Quality Control

The project team will utilize a field QA/QC program which will incorporate measures to ensure the integrity of the soil and groundwater samples collected and meets sampling program data quality objectives. As a minimum, the QA/QC program will include –

- documentation (date, time, site identification, site conditions, sampling equipment, sample type, preservatives, etc.) of sampling;
- collection of field duplicates for at least 10% of all samples;
- equipment rinsate, background, and traveling spiked blank samples; and
- copies of the chain-of-custody forms.

Prior to sampling, the sampling program and required analytical suites will be reviewed with the analytical laboratory. The laboratories will supply sufficient clean and appropriately sized sample containers, and associated preservatives and coolers for storage and transport. Additional containers will be purchased for archiving samples. Containers will be marked in the field with unique identifiers specifying the site, location and sample depth. The time and date of sampling will be indicated on the container and the documents destined for the lab to ensure that time sensitive analytes such as volatile hydrocarbons are analyzed within the recommended holding times.

Groundwater samples from wells will be sampled after up to three well volumes have been purged from the well bore. Disposable gloves will be used during sampling. Samples will be field measured for pH, temperature, and conductivity until three consecutive measurements within 10% are attained. Samples for analyses will then be collected in designated containers (with applicable preservatives) and capped and placed in the cooler.

Soil samples will be collected with pre-cleaned tools (scoops, hand auger, power auger or coring device depending on the nature of the subsurface materials and depth of investigation). Disposable gloves will be used during the sampling procedure. Samples will be placed in the appropriate containers and capped and placed in a cooler. Drill casings will be pressure washed between boreholes when contaminated materials are encountered to help minimize the potential for cross contamination.

Task 10: Implement plan for the transportation of contaminated soil, as well as health and safety program.

As part of the site remediation program, a Health and Safety Program will be designed to meet the requirements of applicable Canadian Occupational Health and Safety Regulations, the Workers Compensation Board (WCB), Workplace Hazardous Materials Information System (WHMIS) and territorial statutes. On site will be properly equipped with necessary personal protective equipment—using National Institute for Occupational Health and Safety (NIOSH) guidelines--, first aid kit, and have the proper safety training.

All members will familiarize themselves with the Safety Program and Emergency Response Plan and be given specific instructions on actions to be taken in case of safety violations, accidents, personal injury and emergencies. An effective reporting system will also be incorporated into the program. The Health and Safety Program and the Emergency response Plan will be submitted to the DIAND Project Manager for review and approval prior to implementation.

The site remediation supervisor will ensure that contaminated soils and all materials are transported according to requirements of the Transport of Dangerous Goods Act (TDGA) and all applicable Federal, Territorial and Provincial statutes regulations.

Task 11: Equipment Decontamination and Demobilization

All light and heavy equipment will be decontaminated using a steam cleaner before moving between contaminated and non-contaminated areas of the site, after completion of site remediation, and as necessary to avoid any tracking of contaminated soils on or beyond the Blanchard River site.

Blanchard River Remediation Work Plan –

APPENDIX A: DETAILED COST ESTIMATES

Estimated costs for the previously described tasks for investigative and remedial work to be conducted at Blanchard River during September/October 1999 are documented below. These are divided into costs to be covered under the RRU-DIAND standing offer, and costs covered through other financial mechanisms. Note that for the costs under RRU-DIAND standing offer, these are firm estimates based on the present scope of activities as previously described. A change in scope may necessitate re-visiting these estimates through further discussions between the project manager and the DIAND project authority.

Costs for some materials, heavy equipment operation and others, outside of the RRU standing offer have been tentatively estimated by us as an aid to planning, but are not considered to be hard estimates, nor more than rough order-or-magnitude estimates. It is our understanding that DIAND representatives will enter into various financial agreements with other parties based on a prior understanding of financial details.

<u>Estimate of additional investigative and remediation costs</u>

A. As covered under the RRU-DIAND standing offer (excluding GST):

• *Professional Fees (Table 1): UMA*	*$47,130*
• *Professional Fees (Table 1): ARD*	*$21,280*
• *Laboratory Analytical Costs through ASL*	*$32,070*
• *Purchase of Petrogard Field Test Kits (Diagnostix)*	*$6,480*
• *Drilling and piezometer installation (Midnight Sun)*	*$20,000*
• *Travel, accommodation, vehicle rental*	*$12,000*
Subtotal	*$138,960*
GST	*$9,727*

B. As covered through other agreements (ROM estimates only):

• *Liner for landfarm*	*$83,000*
• *Heavy Equipment and Contracting Costs (Table 2)*	*$80,000*
• *Other contracting costs*	*$10,000*
• *HAZCO wastewater treatment plant*	*?*
• *Other materials (culverts and other)*	*$10,000*
• *Disposal costs – metals contaminated soils in Hazmat barrels (est. 30 m^2 surface area x 0.2 m depth x 2 uncertainty factor) = 12 m^2 @ $200 m^2*	*$2,400*
• *Replacement for and decommissioning of old soak away and rock pits*	*$150,000*
Subtotal	*$335,400*

A major portion of the estimated costs is associated with decommissioning the rock pit and soak away pit and replacing them with a non-contaminating oily-water separator. The feasibility, options, and associated costs will be examined in detail as part of the project. The $150,000 estimate, therefore, is assumed to be very rough and probably high.

Finally, in addition to work undertaken in the 1998-99 fiscal year, the consulting team has previously identified the possible need for the following commitments in the future:

- Annual sampling of up to ten soil samples in the landfarm until LEPH/HEPH concentrations are reduced to below the Yukon CSR residential/parkland standards;
- Decommissioning of the land farm when remediation objectives have been achieved;
- Risk management and/or remediation activities as required for the elimination of risks from petroleum hydrocarbon movement into the Blanchard River from the south end of the station from a subsurface source area;
- Limited future confirmatory sampling of groundwater in wells downgradient from the burn pit area; and
- Ongoing monitoring of groundwater hydrocarbon concentrations in established wells to the south of the station until there is confidence that there are negligible risks.

Table 1: Estimate of Professional Fees, Blanchard River Station Remediation

Activity	T.Wingrove	L. Bielus	R. Nichol	A. Passalis	T. Starodub	Drafting	Clerical	D. Bright	M. Dodd	UMA Expenses	Total ($)
Hourly rate ($)	120	110	70	60	110	50	53	85	85		
Task 1 - Remediation of Petroleum Hydrocarbon Contaminated											
Soils in the Vicinity of the Former Burn Pit											
Preparation, layout excavation grid	2	4		10				8			1,960
Field Supervision, soil segregation & stockpiling				24						1000	2,440
Data analysis, field classification				4				16	16		1,600
Backfilling				10							600
Project management, reporting	2	2		8		4	2	2	16	100	1,622
Sub Total											8,222
Task 2 - Establish Ex-situ Soil Remediation Facility											
Preparatio n	2	4	8	24							2,680
Site Surveys/Design			8	12							1,280
Field Supervsion of Construction			46	30						1800	6,820
Project management, reporting	2	4	16	8		4	2		4	200	2,892
Sub Total											13,672
Task 3 - Curtail Contaminated Groundwater Discharge											
from Culvert at Rust Colored Stain.											
Preparatio n	1	2		2							460
Field Supervision, construct temporary containment				30				8		1000	3,480
Data Analysis / Water Treatment				6				4			700
Project management, reporting	2	3		4		2	2		4	100	1,222
Sub Total											5,862

Activity	T.Wingrove	L. Bielus	R. Nichol	A. Passalis	T. Starodub	Drafting	Clerical	D. Bright	M. Dodd	UMA Expenses	Total ($)
Task 4 - Remove Offsite Metal Contaminated Sediments											
at Rust Colored Stain											
Preparation, liase with hazardous waste contractor		2		2							340
Field Supervision of hand excavation				8							480
Confirmatory sample collection and data analysis				1					4	800	860
Project management, reporting	1	2		1		2	2		4	150	862
Sub Total											2,542
Task 5 - Excavate 150 mm pipe at east side of											
maintenance shop											
Preparation		2		2							340
Supervision and delineation of pipe				6						700	1,060
Soil sampling and data evaluation (if req'd)				2				4			460
Project management, reporting		4		2		1	2	2		100	1,092
Sub Total											2,952
Task 6 - Decommission 1985 Vintage Rock Pit to West											
of Maintenance Building and Replace with up to Date											
Technology											
Preparation		2			6						880
Site Inspection					8					1100	1,980
Review of Alternatives	2	1	8		12						2,230
Preliminary Design	1	2	12		14	8	2			100	3,432

Activity	T.Wingrove	L. Bielus	R. Nichol	A. Passalis	T. Starodub	Drafting	Clerical	D. Bright	M. Dodd	UMA Expenses	Total ($)
Sub Total											8,522
Task 7 - Decommision Oily-Water Separator and Soak											
Away Pit which Drain Floor Drains of Welding Bay											
Preparation		2			6						880
Site Inspection					8					1100	1,980
Review of Alternatives	2	1	8		12						2,230
Preliminary Design	1	2	12		14	8	2			100	3,432
Sub Total											8,522
Task 8 - Complete Detailed Site Investigation of											
Petroleum Hydrocarbon Plume on South End of Site											
Preparation	2	4		4							920
Field Supervision, drilling & test pits				32				32		1200	5,840
Sample collection and data analysis	2	2		6				4			1,160
Project management, reporting		4		8		8	2	16	4		2,892
Sub Total											10,812
Task 9 - Conduct confirmatory testing of excavated areas											
for petroleum hydrocarbon contamination. Analyze additional											
samples from the site.											
Preparation	2			1					4		300
Confirmatory sample collection				2					8	600	720
Field screening and data analysis	1	2		4					16		580

Activity	T.Wingrove	L. Bielus	R. Nichol	A. Passalis	T. Starodub	Drafting	Clerical	D. Bright	M. Dodd	UMA Expenses	Total ($)
Reporting	2	2		2		1	2		16		842
Sub Total											2,442
Task 10 - Implement Plan for the Transportation of											
Contaminated Soil and Health and Safety Program											
Preparation		2		2							340
Reporting, Site Meetings	2			4			1	8	8		1,266
Sub Total											1,606
Task 11 - Equipment Decontamination and Demobilization	1	1	2	8						1000	850
Task 12 - Decommission and remove former USTs and											
pump island.											
Preparation		2		1							280
Supervise decommissioning and removal				6						1000	1,360
Sample collection and data analysis				2					12		120
Project management, reporting		2		2		2	1		4	100	646
Sub Total											2,406
TOTAL	**30**	**60**	**120**	**280**	**80**	**40**	**20**	**104**	**205**		**68,410**

Table 2: Estimate of Heavy Equipment Time Required

	235 Track-hoe	Loader	Tandem Truck	Wide Track D3 with Blade	D6 with Blade	Grader
Landfarm Construction [1]	80	75	350	90	85	10
South Investigation	30					
Culvert Investigation	30	5	10			
150 mm Pipe Investigation	10					
Burn Pit Remediation [2]	40	40	150	30		
Est. Equipment Rate $/hour	125	80	50	85	100	125
Total Estimate Cost $	23,750	9,600	25,500	10,200	8,500	1,250

[1] *Assuming landfarm construction 100 m x 100 m*

[2] *Assuming 1000 m^3 excavated and backfilled*