Golder Associates Ltd.

500 - 4260 Still Creek Drive
Burnaby, British Columbia, Canada V5C 6C6
Telephone (604) 298-6623
Fax (604) 298-5253

PLAN OF RESTORATION

SOIL AND WATER MANAGEMENT PROCEDURES FOR CONTAMINATED SOIL YUKON PIPELINES LIMITED PIPELINE RIGHT-OF-WAY YUKON

Submitted to:

Yukon Pipelines Limited
206 Lowe Street
Whitehorse, Yukon
Y1A 3T1

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May 1998 962-1818B

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1.0 INTRODUCTION

1.1 Background

Yukon Pipelines Limited (YPL) is in the process of decommissioning its pipeline and associated facilities located in British Columbia and the Yukon Territory. In accordance National Energy Board (NEB) hearing MH–3–96 and NEB Order MO-7-96 and as part of the decommissioning planning process, Golder Associates Ltd. (Golder) conducted an Environmental Site Assessment (ESA) and prepare a Plan of Restoration for the YPL pipeline right-of-way (the Sites, see Figure 1). Results of the ESA and Plan of Restoration for the Site are contained in Golder's report "*Environmental Site Assessment and Plan of Restoration, The Yukon Pipelines Limited Pipeline Right-of-way, Yukon*", February 1998.

Four areas of potential environmental concern (APEC) were identified during the Phase I ESA:

APEC 17-2 Alaska Highway, marker 1,469 Km
APEC 17-3 Mile marker 104.5
APEC 17-4 Alaska Highway crossing (MacRae)
APEC 17-5 Mile marker 90.1 (Klondike Highway)

Two APEC (17-4 and 17-5) were identified as requiring restoration and continued monitoring. APEC 17-2 and 17-3 do not require restoration as no significant soil and/or groundwater contamination were identified at these two locations.

1.1.1 Mile Marker 90.1

Soils beneath and near the site generally consist of unconsolidated fine sands over silt and clay at 3.0 m depth. BTEX, LH, and PAH concentrations reported for all of the soil samples analysed from the site met the Yukon CSR industrial land use criteria. Approximately 1,100 m^3 of soil located within the upper 3.0 m of the soil profile contains LEPH and VPH concentrations in excess of the Yukon CSR industrial land use criteria.

The depth to groundwater beneath the site ranged from 2.0 to 2.7 m in October 1997. BTEX and PAH concentrations in the groundwater were below the Yukon CSR-AL standard in the immediate area of the site.

1.1.2 Alaska Highway Crossing (MacRae)

Soils beneath and near the Alaska Highway Crossing (MacRae) site generally consist of unconsolidated sands and silts with gravel at 3.0 m depth. Benzene, toluene, ethylbenzene and xylene (BTEX), light hydrocarbons (LH), volatile petroleum hydrocarbons (VPH), and polycyclic aromatic hydrocarbons (PAH) concentrations reported for all of the soil samples analysed from the site met the Yukon Contaminated Sites Regulations (CSR) industrial land use criteria. Approximately 1,500 m^3 of soil located within the upper 3.0 m of the soil profile contains light extractable petroleum hydrocarbons (LEPH) concentrations in excess of the Yukon CSR industrial land use criteria.

The depth to groundwater beneath the site ranged from 1 to 2 m in October 1997. BTEX and PAH concentrations in the groundwater were below the Yukon CSR-aquatic life (AL) standard in the immediate area of the site.

1.2 Regulatory Requirements

The approach to the remediation and assessment of soils and water at the Sites is consistent with the Yukon CSR and CCME guidelines. The CSR and CCME standards for industrial land use were established as the criteria for all soils and water at the Sites.

1.3 Approach

In order to meet the Yukon CSR and CCME standards for the Sites the petroleum hydrocarbon contaminated soils will need to be remediated. Excavation followed by land farming was the option chosen to address the shallow soil contamination located at the Mile marker 90.1 site. The remediation of the Mile 90.1 site involves excavating the zone of contaminated soil, transporting the soil to the former Carcross Pump Station and actively tilling the soil with the addition of water and nutrients, as required.

In situ bioremediation was selected for the Alaska Highway crossing site. The remediation of the Alaska Highway crossing site will involve the addition of nutrients and water to the contaminated soil area and mixing or filling the nutrients into the ground.

At the Mile 90.1 site and the Alaska Highway crossing site monitoring wells (one and three, respectively) were installed during the ESA (Figures 2 and 3, respectively). We propose four additional groundwater monitoring events over the next two years to ensure that the groundwater quality continues to meet the applicable Yukon CSR-AL standards.

2.0 EXCAVATION OF CONTAMINATED SHALLOW SOILS (90.1 MILE)

2.1 General

This section describes briefly the procedures that will be used in managing soil and water that is or potentially will be handled during excavation of the shallow soils (up to 3.0 m deep) at the Mile 90.1 site. The approach adopted with respect to the excavation, stockpiling and sampling of contaminated soils at the site is consistent with the guidelines and criteria developed by the Contaminated Sites Unit of B.C. Environment. These guidelines are presented in their document entitle *"Guidance on Contaminated Sites: Characterization and Confirmation Testing"*. The guidelines present a generic approach to perform detailed characterisation of soils either prior to or following excavation, to ensure that the soils are adequately characterised to define disposal and/or remediation requirements.

The results of the field investigation and sampling programs ("*Environmental Site Assessment and Plan of Restoration, The Yukon Pipelines Limited Pipeline Right-of-way, Yukon*", Golder report, February 1998) indicated that there are elevated concentrations of LEPH and VPH at the site to a depth of approximately 3 m (Figure 2).

The results of the soil vapour survey at the Mile 90.1 site indicated that an organic vapour plume with a soil vapour concentration of 100 ppm, inferred to be approximately 20 m long by 10 m wide, was located immediately to the south of the valve at 90.1 mile. The soil vapour plume corresponds to field observation of petroleum hydrocarbon-like odours present in soil samples collected from the area

2.2 Remediation Plan

The planned remediation program at the site is to remove the shallow soil contamination from the area associated with the valve at Mile 90.1. The limits of the proposed excavation are summarised in the attached Figure 2. The soils excavated from the site will be stockpiled and transported to YPL's Carcross Pump Station for land farming (Figure 4).

Water will only be collected from the excavation if the water impedes or interferes with the excavation of the contaminated or potentially contaminated soils, or the placement of backfill. At Mile marker 90.1 the water table varies between 1.7 m to greater than 3.0 m below grade, therefore some water is expected to enter the excavation, however it should be minimal. If rainwater or other surface water enters the excavation it will also be removed. All water collected will be placed in the lined holding ponds located at YPL's Carcross Pump Station (Figure 4). The collected water will be sampled for the constituent(s) required to permit its discharge to the ground via an infiltration system.

Backfilling of the excavated area will be done with soils that generally consist of clean, granular soils obtained from a local borrow area.

2.3 Soil and Water Management Procedures

It is anticipated that the soil and water (if required) handling procedures required for this site will include:

- monitoring the excavation of soil, prior to and during land farming;
- confirmatory sampling of the exposed soils in the excavation to verify chemical concentrations in the soils remaining in-place;
- confirmatory sampling of water collected from the excavations; and
- monitoring backfilling of the excavation.

2.3.1 Proposed Management Procedures for Soil

The excavation program will be conducted in the area identified on Figure 2. If feasible, the excavation will commence in the most heavily contaminated areas, that is, in the

centre of the inferred contaminant zone. Once the zones of the higher contamination have been removed, the excavation will then proceed to areas with lower levels of contamination. This sequence of excavation will allow a visual (and olfactory) recognition of heavily contaminated materials, such that other materials possessing similar characteristics and can be recognised accordingly during subsequent excavation.

Exposed soil sidewall surfaces will be sampled following the removal of all suspected contaminated soils, to determine if the remediation objective has been met. The excavation will extend to approximately 3.0 m depth, where base samples will be collected. The results of the confirmatory sampling program will determine whether additional excavation is required to meet the CSR and CCME criteria.

The locations of the samples collected, together with observations and contents of land farmed soil and any other relevant information, will be recorded in field notebooks and/or on appropriate forms. Samples will be distinctly numbered and/or identified, and will be located on a site plan showing the locations of the samples, such that further excavation of the soils at either pipeline location can be conducted, if necessary.

2.3.2 Proposed Management Procedures for Water

Where water ponds and/or pools at and around the excavations is encountered and must be removed to facilitate further excavation, the Excavation Contractor shall collect this water. The Contractor will collect the water in an appropriate manner and the water will be sampled and analysed to determine whether the water can be discharged without further treatment or requires treatment prior to discharge. The collected water will be placed into one of the retention ponds located at YPL's Carcross Pump Station prior to discharge (Figure 4).

The water in the pond will be sampled and analysed for the appropriate chemical constituents to allow its permitted disposal or treatment. The results of the chemical analyses of the water samples obtained from the ponds will determine the appropriate means of treatment, if necessary, or disposal of the water.

2.4 Land Farming of Excavated Soils

Shallow soils excavated in and around the pipeline site will be spread over the area indicated on Figure 4, at YPL's Carcross Pump Station. The soils will be placed in lifts a maximum of 0.3 m thick, which is optimum for tilling. An above ground sprinkler system will be used to apply water and nutrients to the tilled soil in order to enhance biodegradation of the petroleum hydrocarbons. The water/nutrient application will also aid in preventing wind dispersal of contaminated dust. The rate of water/nutrient application will be such that it maximises the biodegradation rate (maintains a moisture content of approximately 40 to 80 percent of the water holding capacity of the soil), but does not permit surface runoff. Small ditches will surround the land farming area to intercept any runoff, which will then be collected and placed in one of the retention ponds on site.

Soil samples will be collected from the tilled area to confirm compliance with the Yukon CSR and CCME criteria for industrial land use. Soil samples will be collected on a 20-m by 20 m grid pattern over the entire land farming area. The locations of the samples and any relevant information will be recorded in field notebooks and/or on appropriate forms. Samples will be distinctly labelled and will be located on a site plan showing the locations of the samples, such that further tilling and irrigating of soils can be conducted, if necessary.

Soil samples will be collected in glass sample jars and visually examined for the presence of hydrocarbon or other signs of contamination. To further assess the presence of product, field shake tests and screening using the dry headspace method may be performed.

3.0 IN SITU BIOREMEDIATION ALASKA HIGHWAY CROSSING (MACRAE)

3.1 General

This section describes briefly the procedures that will be used in remediating the contaminated soil at the Alaska Highway Crossing (MacRae) site. Two organic vapour plumes were identified on the north side of the Alaska Highway crossing (Figure 3); no significant soil vapours concentrations were encountered on the south side of the

crossing. The two plumes were interpreted to be elongated in a north-south direction in an ellipsoidal shape parallel to the pipeline. The dimensions of the smaller plume is inferred to be approximately 25 m long by 15 m wide and the larger plume is inferred to be approximately 70 m long by 30 m wide. Both of the soil vapour plumes correspond to field observation of petroleum hydrocarbon-like odours present in soil samples collected from the area.

The necessary tasks to implement the *in situ* bioremediation of the Alaska Highway crossing site are described in this section. A site monitoring system will be installed, then fertiliser will be applied to the contaminated soil to provide nutrients to the indigenous soil bacteria. Periodic sampling and analysis of the site soil gas and groundwater will be conducted to monitor and maintain the optimum bioremediation conditions until the soils are below regulatory cleanup levels. Verification soil sampling will be used to confirm site cleanup.

3.2 Site Monitoring

3.2.1 Groundwater

There are three monitoring wells are located at the site (BH97-22, -23 and -24). Each well will be developed using a pump or other means to remove fine sediment from the well. Water purged from the wells will be discharged to the ground surface within the area previously impacted by the spill

3.2.2 Soil Gas

The soil gas will be monitored in the existing groundwater monitoring wells at the site. Because the wells will be screened across the groundwater contact, they will permit monitoring of the oxygen, carbon dioxide and organic vapour concentrations within the native soils using field instruments (O_2/CO_2 meter and photoionization detector [PID]).

3.2.3 Monitoring Frequency

Monitoring of the soil gas and groundwater at the site will include one round of baseline samples prior to the start of the fertilising program, and then monthly sampling following fertiliser application. No sampling will be done during the winter due to cold weather.

Sampling will continue until the results indicate that petroleum concentrations are below the Yukon CSR cleanup levels. Cleanup verification sampling is discussed in Section 3.5.

3.3 Fertiliser Application and Biodegradation Rate

Once the baseline soil gas and groundwater samples have been collected, fertiliser will be applied to the area containing LEPH greater than 2000 mg/kg (Figure 3). A slow release fertiliser (32% N : 4% P : 8% K) sulphur-coated urea, or a close substitute, will be used for fertilisation because of its ability to provide nutrients over a long time frame, which will minimise impacts to surface water due to runoff. An initial fertiliser application rate of 1 kg/m^3 will be used on the surface to account for the rapid dilution as the fertiliser is washed into the native soils during heavy rains. At this rate and using a maximum volume of 1,500 m^3 of soil having LEPH greater than 2000 mg/kg, a total of 1,000 kg of fertiliser will be applied, in one application, at the surface then mixed into the soil using a tiller.

Because of the low moisture content of the contaminated material it may also be necessary to add water periodically. Ideally moisture content should be between 40 and 85 percent of the water holding capacity of the soil.

The rate of biodegradation will be monitored via the site monitoring system and, if satisfactory progress is not achieved then additional fertiliser applications or a revision to this Plan of Restoration may be necessary.

3.4 Air Emissions

The biodegradation of petroleum hydrocarbons by aerobic bacteria consumes oxygen from the air and produces organic degradation intermediates, including carbon dioxide, water, and microbial cells.

Bioremediation of the site is expected to result in a temporary increase in carbon dioxide emissions from the soil and a permanent decrease in organic vapour emissions as the LEPH is remediated. Air emissions from the soil will be monitored by measuring the oxygen, carbon dioxide and organic vapour concentrations in soil gas within the monitoring wells.

3.5 Evaluation And Cleanup Verification

The sample results from the site monitoring system will be reviewed and evaluated to determine the progress of the *in situ* bioremediation of the site and whether additional fertiliser applications or any revisions to this Plan of Restoration are needed. When the sample results indicate that LEPH concentrations are below cleanup levels, three test pits will be excavated into the previously impacted area and two verification soil samples will be selected from samples collected in each pit and submitted for laboratory analysis of LEPH, HEPH and BTEX.

Following receipt of verification sample results, a report will be prepared and submitted to the YTG and NEB, which will document the site monitoring results, verification sampling and cleanup of the site.

4.0 FIELD PROCEDURES

4.1 Health and Safety

The Health and Safety Plan prepared, as part of the site investigation work plan will be implemented during the monitoring program. This plan is a modification of Golder's existing health and safety plan used on other active petroleum hydrocarbon sites in British Columbia and the Yukon. YPL's safety instructions were incorporated in to the Health and Safety Plan. Additional direction on health and safety issues related to YPL's requirements will be given on-site before the start of field investigation.

4.2 Groundwater Sampling

Groundwater sampling will proceed in accordance with protocols that are standard for the environmental industry. Each well will be purged of at least three well volumes and monitored for temperature, pH, electrical conductivity, and dissolved oxygen until stable, prior to obtaining representative samples. Samples will be appropriately preserved in laboratory-supplied bottles, labelled and placed in a cooler on ice.

4.3 Water Level Monitoring

Golder will conduct a water level survey at each well located at the Sites. An electric water-level meter will be used to monitor water levels and an interface probe will be used to measure free-product thickness, if present.

4.4 Soil Sampling

Discrete samples from the excavation sidewalls at the Mile 90.1 site will be collected by digging into the exposed soil surface approximately 0.15 m. A series of five discrete samples will be collected for every 20 m of sidewall. The five discrete samples from each sidewall segment will be composited in a clean, stainless steel bowl to form a wall composite sample. The wall composite will be submitted for selected chemical analyses.

The location of the sidewall samples with respect to prominent site features and/or field measurements, together with observations of soil condition, staining odour and/or other relevant information will be recorded in field notebooks and/or on appropriate sampling forms.

Soil samples will also be collected at the base of the excavation.

4.5 Groundwater Chemistry

Groundwater samples collected from the monitoring wells (BH97-22 through BH97-24, Alaska Highway crossing (MacRae) and BH97-2, 90.1-mile marker) will be submitted to a qualified laboratory for chemical analyses. Based on previous studies at the Site, BTEX, LH and VPH which are considered the primary contaminants of concern (COC), therefore all groundwater samples will be analysed for these constituents.

4.6 Soil Chemistry

Samples collected from the sidewalls and base of the excavation will be submitted, with appropriately completed chain-of-custody forms, for chemical analyses of selected constituents (COC) and/or for archiving. COC at the Sites include, LEPH and VPH, in addition samples will be analysed for BTEX compounds.

4.7 Notification of Chemical Analysis

The laboratory will be instructed to notify YPL immediately, by phone, if any analyses indicate the presence of contaminant levels above Yukon CSR standards. Upon notification, YPL will immediately inform the Contaminated Sites Coordinator, Mr. Kevin McDonnell (867-667-5851) of the results.

4.8 QA/QC Chemistry

In addition to the above, for Quality Assurance purposes blind duplicates will be submitted for laboratory analysis. All sampling will be performed in accordance with Golder protocols. Analytical laboratories routinely conduct 10 percent laboratory replication and 10 percent to 20 percent reference standard samples with each sample batch.

5.0 SAMPLING PROCEDURES

5.1 Sample Collection

Groundwater samples will be collected once the monitoring wells have been appropriately developed and allowed to recover. The water level will be measured in each well and the probe will be triple rinsed prior to monitoring each well.

Removing approximately three times the calculated well water volume before sampling will purge each well. After allowing the well to recover, groundwater samples will be collected with a bailer or a pump. Sampling equipment used to obtain samples from more than one well will be cleaned prior to each use. A clean glass container will be filled with groundwater collected from each well for field measurements of pH, temperature, dissolved oxygen and electrical conductivity. Samples will be labelled and placed in an insulated cooler so that they can be kept at 4°C ± 2°C. In order to assure sample integrity, strict chain of custody procedures will be followed.

5.2 Decontamination of Sampling Equipment

Non-disposable groundwater and soil sampling equipment will be decontaminated between sampling points. The wash and rinse fluids will be discharged to the ground on site at the completion of each sampling point. If any solvent is used it will be collected,

stored, and disposed of in accordance with applicable hazardous waste disposal guidelines.

5.3 Waste Management

All disposable personnel protective equipment and disposable sampling tools will be rinsed with potable water prior to disposal. This equipment will be collected in plastic bags, sealed, and disposed of as solid waste.

5.4 Sample Containers

The sample containers utilised will be pre-cleaned by the manufacturer and will be certified to be clean prior to use. Sample containers will be delivered to Golder sampling personnel by the analytical laboratory. Container types and volumes will be appropriate for the intended analyses.

All sample containers will be inspected prior to transit to the Site to verify that they are undamaged and are tightly sealed. Any damaged or unsealed containers will not be used for sampling. All containers will be retained under chain of custody during this sampling program.

5.5 Sample Holding Times

All samples collected under this plan will be stored and transported in insulated coolers. Sufficient cold packs will be placed in the coolers with the samples to maintain the interior temperature 4°C ± 2°C until the samples are delivered to the laboratory. Care will be taken to prevent the filled sample containers from freezing. Upon receipt, the laboratory will process the samples and complete analysis within the maximum allowable holding time.

6.0 DECOMMISIONING, SCHEDULING AND REPORT PREPARATION

After the YTG and NEB concur that any remaining petroleum concentrations at either the Mile 90.1 and/or the Alaska Highway crossing sites are acceptable and no further remediation is required, the monitoring systems at the Sites will be decommissioned. The above ground protective casings of the monitoring wells will be removed and any

pipe or casing that cannot be removed from below ground will be filled with bentonite chips or grout.

Groundwater sampling will be carried out after the "spring thaw" (May) and prior to the "winter freeze" (October). Excavation of soils and *in situ* bioremediation at the Sites along the pipeline will begin in May or June and continue for approximately one week. Land farming of the excavated soils will occur in conjunction with the excavation activities. Tilling of the land farm area will commence once the lifts have been place and irrigation system is in place. Tilling of the soil will occur twice during the remainder of the summer. Confirmatory sampling of the land farmed soil will occur after the soil has been tilled twice. Whether or not two tilling events have occurred, soil samples will be collected from the land farmed soil prior to the "winter freeze" in order to determine the following season's sampling program.

The same groundwater sampling events will be carried out in 1999. A report will be prepared after the final sampling event and will include the results of each sampling event.

GOLDER ASSOCIATES LTD.

G.J. Hamilton, P.Geo.
Associate – Project Manager

D. Grady, Ph.D.
Project Hydrogeologist

GJH/DG/vee/vw
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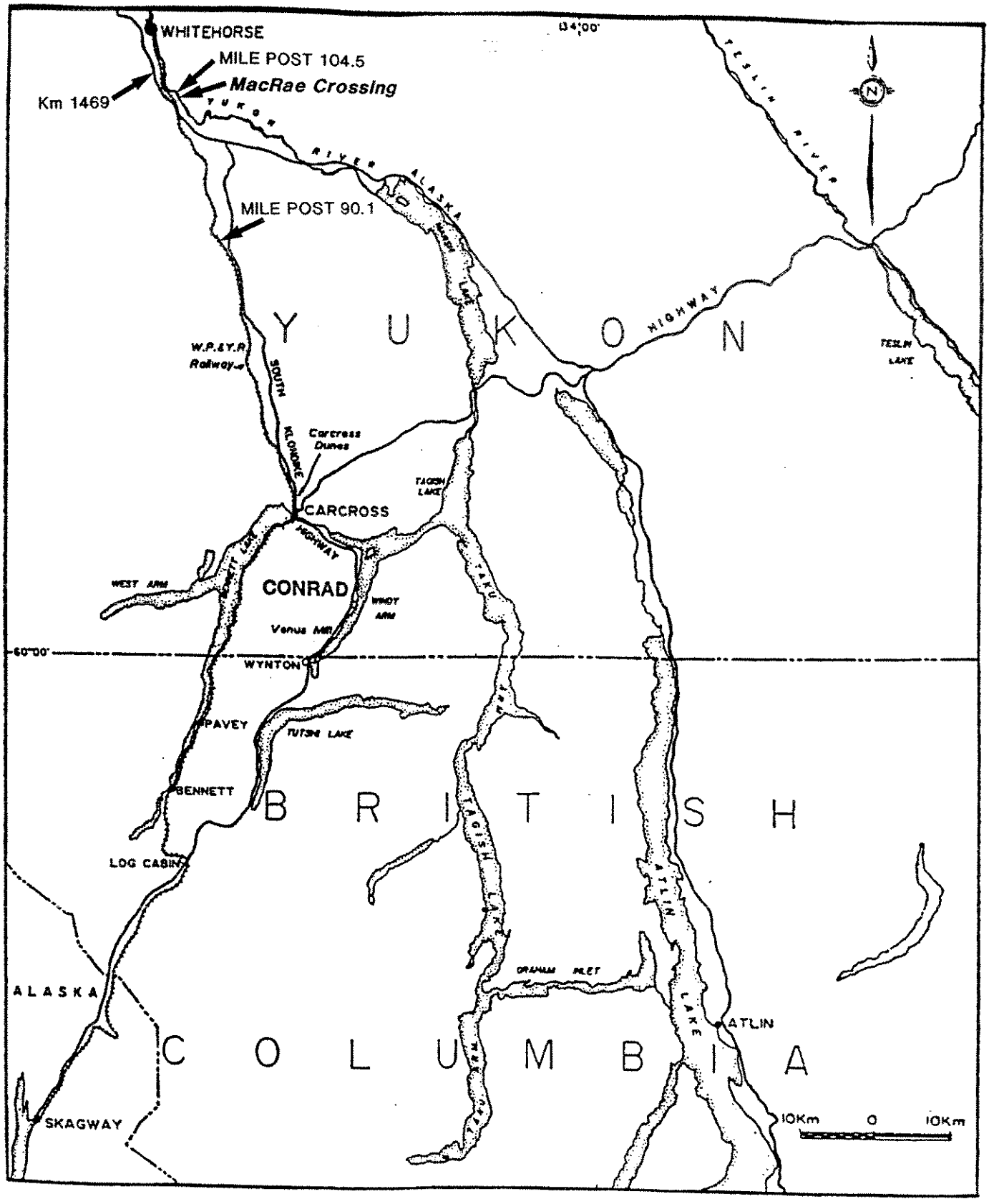
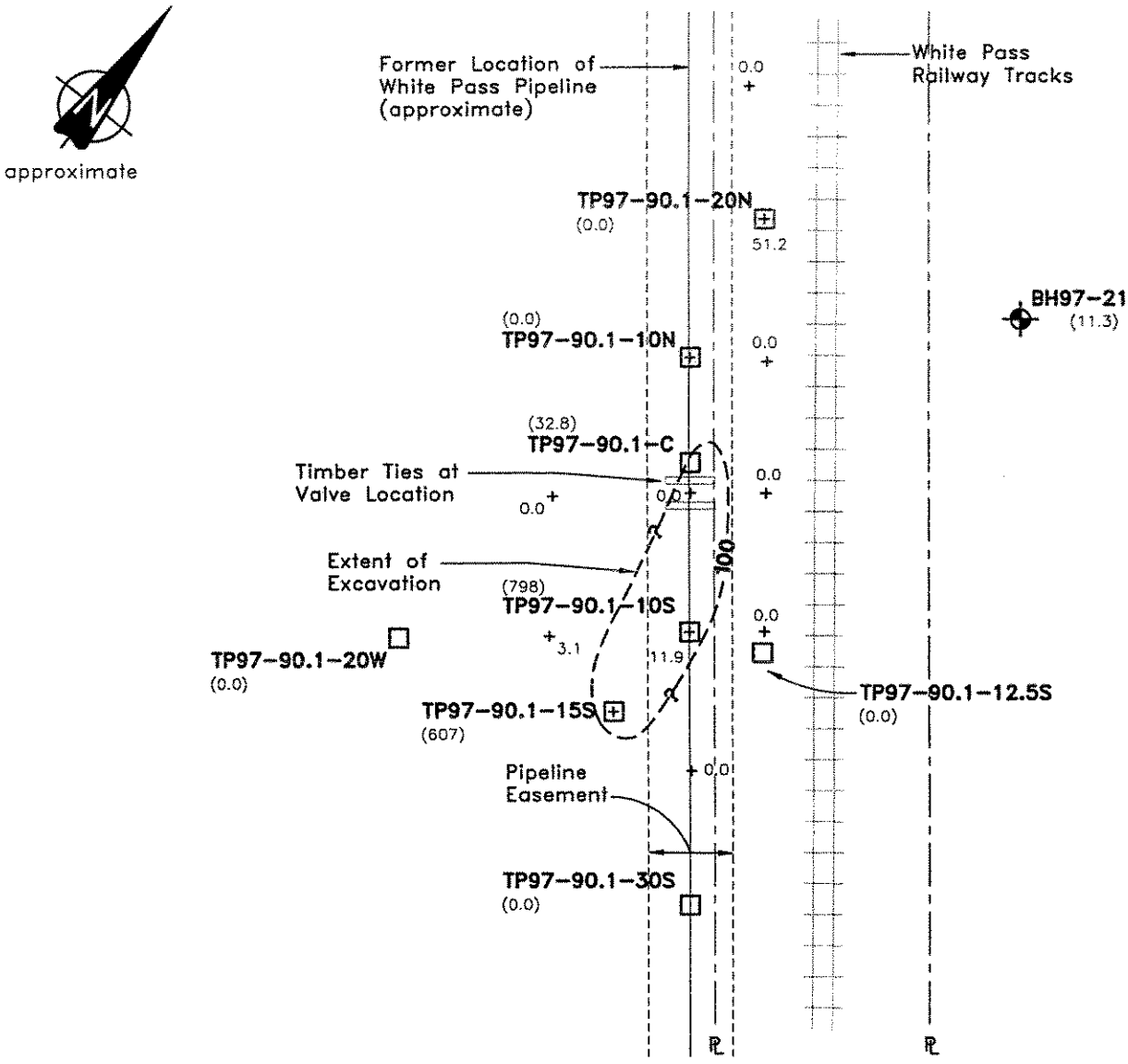


FIGURE FROM EBA REPORT 0105-96-12528, DATED JANUARY, 1997

Project No. 962-1818 Drawn S.S. Reviewed D.B. Date Feb.'98

Golder Associates	**KEY PLAN**	Figure **1**



LEGEND:

- □ Approximate Testpit Location
- \+ Approximate Soil Vapour Survey Location
- ⊕ Approximate Borehole Location
- (798) Maximum Dry Headspace Measurement from Soils at a Test Pit or Borehole (ppm)
- 0.0 Soil Vapour Survey Measurement (ppm)
- — — — 100 ppm Soil Vapour Contour

0 25m

Approximate Scale

Golder Associates

PIPELINE LOCATION NEAR RAILWAY MARKER MILE 90.1

Figure 2

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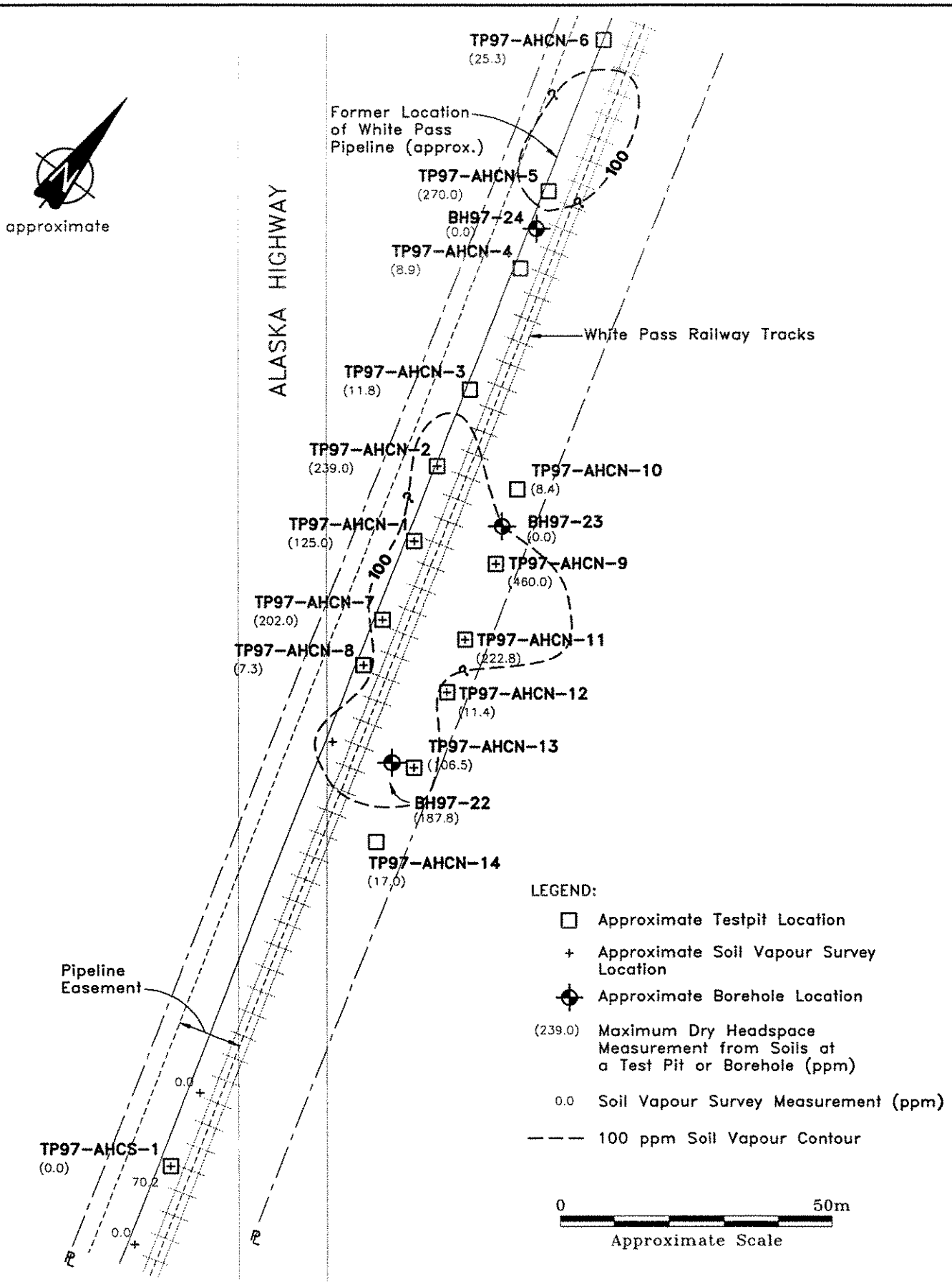

Golder Associates

ALASKA HIGHWAY PIPELINE CROSSING AT MacRAE

Figure 3

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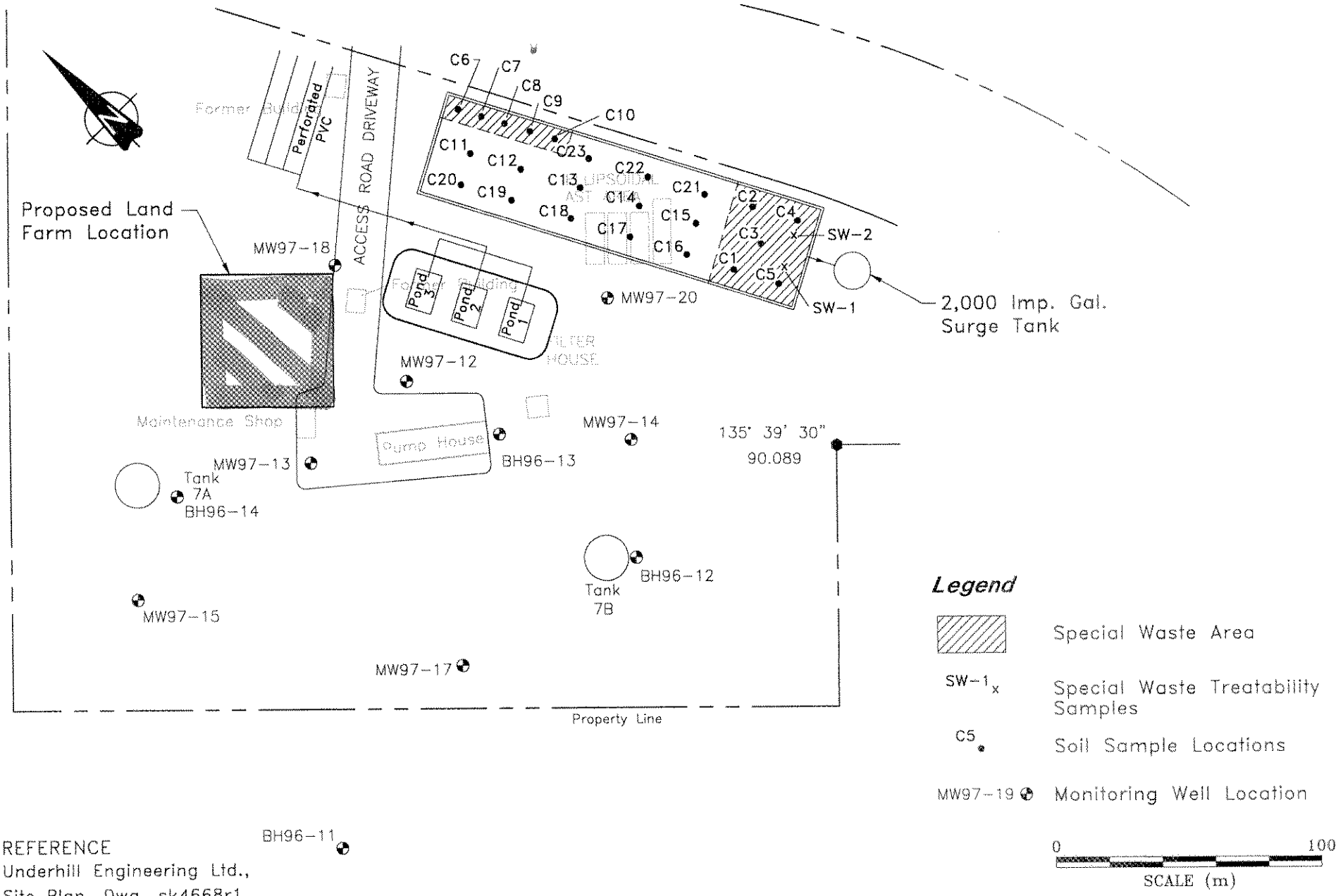

REFERENCE
Underhill Engineering Ltd.,
Site Plan ,Dwg. sk4668r1

Project No.: 962-1818b Drawn: s.s.s Reviewed: D.E.G. Rev.: 5-MAY-98	Golder Associates	LAND FARM LOCATION, CARCROSS PUMP STATION	Figure 4