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Texaco Refining
and Marketing Inc

3400 188th Street SW
Suite 630
Lynwood WA 98037

June 17, 1992

ENV - ENVIRONMENTAL MATTERS
Plan of Action for Interim Assessment and Remedial Measures, Riverside Property, SR522 and NE 180th Street, Bothell, Washington

Mr. John Stormon
Washington Department of Ecology
Northwest Region
3190 160th S.E.
Bellevue, Washington 98008-5452

Dear Mr. Stormon:

Per an agreement with the City of Bothell, Texaco Refining and Marketing Inc. (TRMI) has agreed to take the lead in resolving soil contamination issues, on behalf of the City and TRMI, at the above referenced site. Accordingly, we have prepared the enclosed Plan of Action (POA).

Remediation measures at this former service station site were initiated by the City of Bothell in August 1991. Approximately 4500 cubic yards of soil potentially contaminated with petroleum hydrocarbons and approximately 700 cubic yards of soil reported to be clean were excavated and stockpiled at the site. Currently, the excavation remains open and is partially filled with water. The stockpiled soils have been covered and the entire site is enclosed within temporary fencing.

The enclosed POA presents an approach for further soil and ground water assessment, treatment and/or disposal of the existing soil stockpiles, and backfilling of the open excavation. Due to the high profile nature of this project, Washington Department of Ecology review and concurrence with the proposed POA is requested.

Please provide any comments and/or concurrence with our plan in writing to this office. If you have any questions, please don't hesitate to call me at (206) 774-6090, ext. 227.

Sincerely,

D. Mark Wells

D. Mark Wells
Project Manager
Texaco Environmental Services

DMW
C:\RVRSIDE\WDOE.LTR

Enclosure

cc: Capt. Denny Wright, City of Bothell
Mr. Mark Nichols, Groundwater Technology Inc.
AMBurke-LAChun-JAWenker-File-PNWRead

pr: SDB

PLAN OF ACTION
INTERIM ASSESSMENT AND REMEDIAL MEASURES
RIVERSIDE PROPERTY
SR 522 AND NE 180th STREET
BOTHELL, WASHINGTON

INC# 2241

SR 7/13/92 EU
INTERIM
SOIL
JS

MAY 1992

WORK PLAN ONLY

Prepared for:

Mr. D. Mark Wells
Texaco Environmental Services
3400 188th Street SW, Suite 630
Lynnwood, WA 98037

On behalf of :

City of Bothell and
Texaco Refining and Marketing, Inc.

Prepared by:

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Lynn E. Pera, P.E.
Senior Civil Engineer

GROUNDWATER TECHNOLOGY

EXECUTIVE SUMMARY

This Plan of Action (POA) was prepared to address additional site assessment and site mitigation measures at the property located near the intersection of State Route 522 and NE 180th Street in Bothell, Washington. The property, commonly referred to as "Riverside", is currently owned by the City of Bothell; but, per agreement with the City of Bothell, Texaco Refining and Marketing, Inc. (TRMI) has agreed to take on oversight responsibility for soil contamination issues on behalf of the City and TRMI. TRMI has not assumed liability for the site.

Among various commercial enterprises, a retail gasoline facility reportedly operated on the property from the late 1940's through the early 1960's. Previous environmental site activity included assessment by records search, backhoe test pit logging and sampling, and remedial action through excavation and stockpiling of soil. The excavation is open and partially filled with water.

This POA provides an approach for further soil and groundwater assessment, treatment and/or disposal of the existing soil stockpiles and the backfilling of the open excavation. The initial phase of the operation will sort and segregate the existing soil stockpiles into Class 1, 2 and 3 soils, as defined by the Washington Department of Ecology (WDOE). Each stockpile will be either returned to the excavation, treated and returned to the excavation or disposed of at an appropriate landfill facility. Existing water in the excavation will be analyzed, treated if necessary, and pumped to the sanitary sewer. Sediments and soil at the bottom of the excavation will be characterized and handled appropriate to analytical results. Factors governing the treatment or disposal options include local groundwater conditions, time constraints for excavation restoration, and associated costs.

Further assessment of groundwater conditions will involve the installation of six monitoring wells. The wells will be used to identify and investigate both perched water and the presence of a local aquifer. If groundwater is contaminated, it will be the subject of further discussion and agreement between the City and TRMI.

This POA identifies major decision points and evaluates possible alternatives based on the current available data. However, as additional data is accumulated and evaluated, there may be sections of the plan which will require revision to meet project objectives.

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PLAN OF ACTION
INTERIM ASSESSMENT AND REMEDIAL MEASURES
RIVERSIDE PROPERTY
SR 522 AND NE 180th STREET
BOTHELL, WASHINGTON

1.0 INTRODUCTION

This Plan of Action (POA) was prepared for the former service station site, known as the Riverside Property, located near the intersection of State Route (SR) 522 and NE 180th Street. The property is presently owned by the City of Bothell. Texaco Refining and Marketing, Inc. (TRMI) has assumed soil contamination responsibility on behalf of the City and TRMI. This POA was prepared by Groundwater Technology, Inc. at the request of Texaco Environmental Services (TES). The site currently contains an open excavation partially filled with water, surrounded by stockpiles of excavated soils. The excavation and stockpiles are surrounded by temporary locked fencing. Major items addressed by this POA include:

- groundwater;
- soil stockpiles;
- standing water in the open excavation;
- sediment accumulated at the bottom of the excavation;
- *in-situ* soils at the excavation limits;
- and site restoration.

Areas requiring characterization, assessment and treatment or disposal are delineated by this POA. All activities have been evaluated with respect to timeframe, regulations and cost.

1.1 Site Background

The site is roughly triangular in shape covering approximately 1.9 acres. It is bordered on the north by SR 522, on the south and east by NE 180th Street, and on the west by a commercial restaurant (Figure 1). The southeastern edge of the property is approximately 100 feet from the Sammamish River and the northwest corner is approximately 500 feet from the river. According to an investigation conducted by SEACOR (Appendix A) for the City of Bothell, which included personal interviews and aerial photograph research, a Flying A gasoline retail facility operated on a portion of the property adjacent to SR 522 from the late 1940's until the early 1960's. The number, capacity and product type of underground storage tanks used at the station were not reported by SEACOR. It was reported that automobiles were serviced on the property for at least some portion of that time. Aside from the excavation and soil stockpile mentioned above, the site is relatively level. Currently, the site is unpaved and is used by the City of Bothell for automobile parking.

1.2 Previous Environmental Actions

Through environmental consulting firms, SEACOR and RZA AGRA, Inc. (RZA), the City of Bothell conducted site assessment and preliminary remediation activities in 1990 and 1991. SEACOR conducted the assessment activity with the logging and sampling of backhoe test pits in August, 1990 and January, 1991. The assessment was documented in the reports "Site Investigation" dated October 12, 1990 and "Preliminary Groundwater Investigation" dated February 22, 1991 (Appendix A and B). A total of 25 exploratory pits were dug during the two investigations. Thirteen soil and five water samples were analyzed for petroleum hydrocarbon compounds. Analytical results of the study identified soil and water with hydrocarbon concentrations above the Washington Department of Ecology (WDOE) Model Toxics Control Act[1] (MTCA) Method A Compliance Cleanup Level (CCL).

Subsequent corrective action at the site was conducted by RZA from August through October, 1991. Approximately 4,500 cubic yards (yds) of material purported to contain petroleum hydrocarbons and approximately 700 yds of purportedly clean material was excavated in August, 1991. The resultant excavation was approximately 120 feet by 130 feet in area and 8 to 9 feet in depth. Although the excavation was largely dry during the actual digging operations, except for occasional perched layers of wet soil and water filled pockets of buried debris, water soon accumulated in the open excavation. The source of the water was reported by RZA as perched groundwater seepage and precipitation (Appendix C). Samples were collected from the standing water in the excavation and analyzed. Reported hydrocarbon concentrations exceeded the CCL for total petroleum hydrocarbons (TPH). A bioremediation/aeration system was installed by RZA to treat the dissolved hydrocarbons. This system reportedly operated from late August through October, 1991. At present, the open excavation is partially filled with water and there are soil stockpiles totaling approximately 5,200 cubic yards (yds) remaining on site.

1.3 Site Geology

Descriptions of the soils at the site made during the previous assessments and corrective actions noted primarily sand which was locally gravelly and/or silty with areas of large cobbles. A lithologic boundary, peat, was observed at approximately eight to nine feet below grade (bg). Numerous perched and isolated water bearing layers were encountered in both the test pits and remedial excavations. The deepest subsurface exploration consisted of a test pit to a depth of 12 feet; no groundwater was encountered. A

[1] Promulgated in Washington Administrative Code 173-340

grey, dense, fine-grained sand was encountered at the bottom of the pit. It appears that neither a regional nor local continuous aquifer was encountered during assessment or remedial operations.

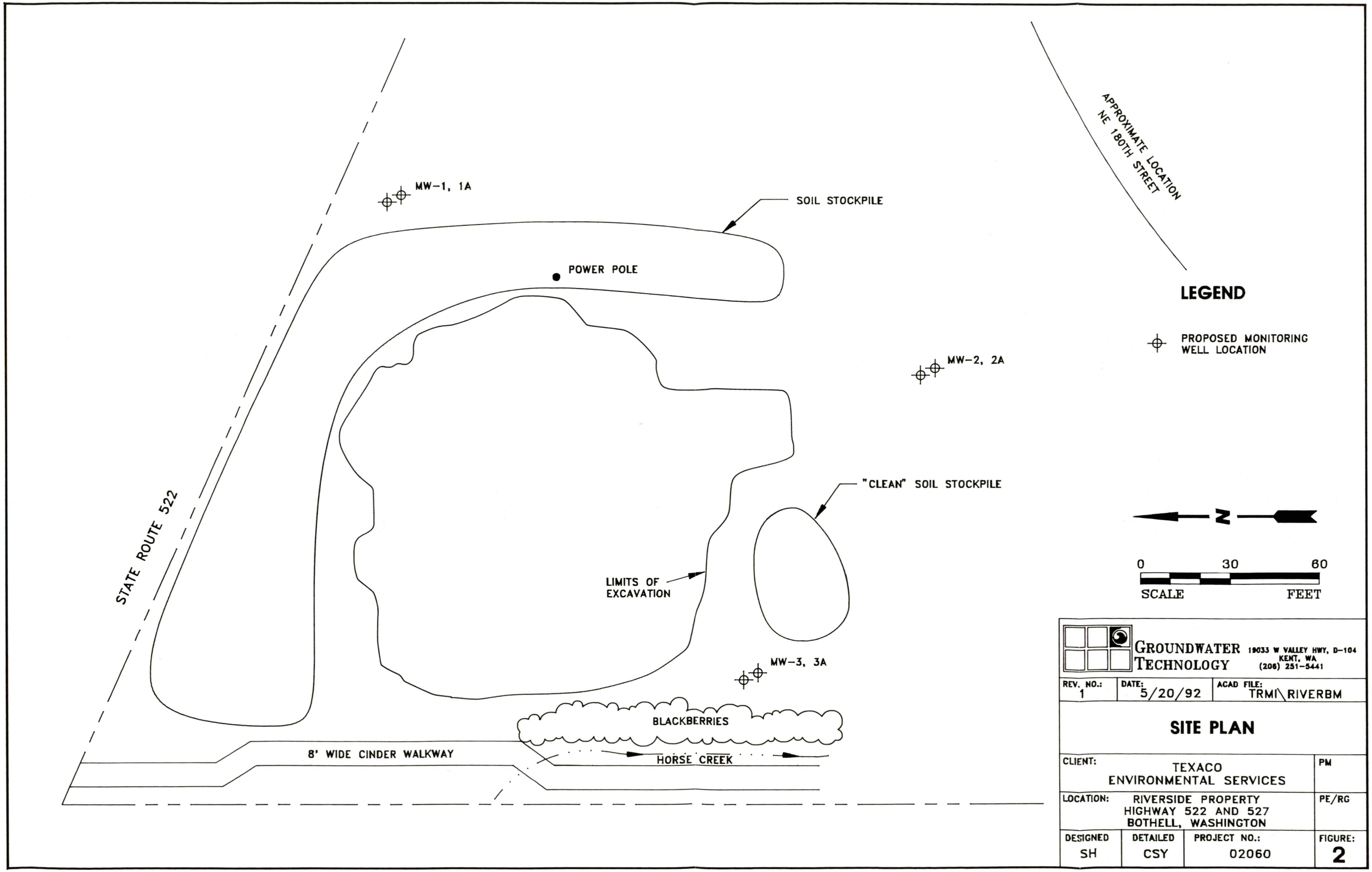
2.0 PURPOSE

The purpose of this POA is to characterize for disposition the existing soil stockpile, manage the water in the excavation, assess the excavation sediment and surrounding *in situ* soils, and conduct a preliminary assessment of the groundwater conditions. An attempt has been made to identify major decision points and to analyze the options available based on current data. However, modifications to the POA may be necessary as additional information is gathered during implementation.

3.0 SOIL STOCKPILE

There are currently two soil stockpiles on site; one consisting of approximately 700 yds of unsampled soil purported to be free of petroleum hydrocarbon compounds, and another approximately 4,500 yds of soil with unknown petroleum hydrocarbon concentrations. The smaller pile is reported by RZA as surface material which was stripped and stockpiled separately. The larger stockpile consists of material which RZA reports was excavated based on visual evidence of petroleum contamination with little or no supporting analytical data (Appendix C). At the conclusion of remedial excavation activity, the large stockpile was rearranged along the northern and eastern sides of the excavation (Figure 2). Two samples were collected from the 4,500 yds of material and tested for total petroleum hydrocarbons (TPH). TPH concentrations in both samples exceeded the CCL of 200 milligrams per Kilogram (mg/Kg).

As further discussed in this POA, the soil stockpiles will be characterized and segregated on the basis of analytical data. The soils will then be either returned to the excavation, treated and returned to the excavation or disposed of at an appropriate landfill facility. Prior to commencement of characterization and segregation operations, two large soil samples, approximately 0.5 cubic feet of material, will be collected and analyzed for grain size distribution, unit weight and maximum dry density (ASTM Test Method D-1557). This will allow realistic estimates of landfill disposal costs which are based on weight and to evaluate the applicability of on-site treatment technologies.


APPROXIMATE LOCATION
NE 180TH STREET
MW-1, 1A
SOIL STOCKPILE
POWER POLE
LEGEND
PROPOSED MONITORING
WELL LOCATION
MW-2, 2A
"CLEAN" SOIL STOCKPILE
N
0
30
60
SCALE
FEET
STATE ROUTE 522
LIMITS OF
EXCAVATION
MW-3, 3A
BLACKBERRIES
8' WIDE CINDER WALKWAY
HORSE CREEK
GROUNDWATER
TECHNOLOGY
19033 W VALLEY HWY, D-104
KENT, WA
(206) 251-5441
REV. NO.: 1
DATE: 5/20/92
ACAD FILE: TRMI\RIVERBM
SITE PLAN
CLIENT: TEXACO
ENVIRONMENTAL SERVICES
PM
LOCATION: RIVERSIDE PROPERTY
HIGHWAY 522 AND 527
BOTHELL, WASHINGTON
PE/RG
DESIGNED SH
DETAILED CSY
PROJECT NO.: 02060
FIGURE: 2

3.1 Characterization and Segregation

The objective of this workstep is to segregate the material into stockpiles of three distinct classes of petroleum affected material as defined by WDOE:

- Class 1 - clean soil including large gravel and cobbles (no detected hydrocarbons)
- Class 2 - soil containing hydrocarbon concentrations below MTCA CCL, and
- Class 3 - soil containing hydrocarbon concentrations above MTCA CCL.

Characterization of the 4,500 cubic yard soil stockpile and segregation by hydrocarbon concentration will be accomplished in one stage. The existing fence will be expanded to provide sufficient operating room and to prevent public access during this stage of the operation. A mobile laboratory will be set up on site to provide rapid turnaround for characterization analyses. Two front end loaders, two power screens and a backhoe will be used to move the materials. Approximately two weeks are anticipated to accomplish this stage of the plan, including fence construction, equipment mobilization and processing.

The soil will be processed through the screens using the front end loaders; sorting out gravel and cobbles of greater than 2-inch size. The material which passes through the screen will be examined by a geologist and segregated into stockpiles of one of the previously defined classes of soil. This will be a field decision based on observation and headspace analysis using a photo-ionization detector (PID). Soil samples will be collected from approximately every 25 or 30 yds of material which is added to each stockpile. Soil sample locations will be flagged pending results of laboratory analyses. These samples will be analyzed by the on-site laboratory for petroleum hydrocarbons (Table 1). The results of the analyses will be used to verify the correct segregation of the soils. If analytical data dictates a different soil classification than the field segregation then the flagged soils represented by that sample will be moved to the appropriate stockpile.

All sampling operations discussed in this POA will follow the appropriate Groundwater Technology standard operating procedure (SOP) included in Appendix D.

Additional characterization of Class 2 and Class 3 soils will be completed at an off-site laboratory. The specific number of samples to be analyzed will be based on the final quantity of material stockpiled. The analyses to be performed are summarized in Table 1. These analyses will be required to develop disposal or treatment alternatives.

TABLE 1
SUMMARY OF EXCAVATION LABORATORY ANALYSES

Location	No. of Samples	Media	Analysis	Analytical Method
A. Excavation Stockpile Sorting Analyses	2	Soil	Density	ASTM D-1557
B. Excavation Stockpile Segregation Analyses	Variable, Flat Fee Cost	Soil	TPH TPHG BTEX	418.1 8015 8020
C. Off-site Disposal Characterization	Quantity Dependent	Soil	TPH TPHG BTEX PCBs	418.1 8015 8020 8080
	Quantity Dependent	Soil	VOCs SVOCs TCLP Metals PAHs	8240 8270 6000/7000 8310
D. Standing Water Discharge Analyses	2	Water	FOG Lead BTEX pH	413 7420 8020 SM
E. Excavation Sediment Characterization Analyses	4	Sed.	TPH Total Metals PAHs	418.1 6010 8310
F. Excavation Underlying Native Characterization Analyses	10	Soil	TPH TPHG BTEX	418.1 Mod. 8015 8020

SM = Standard Methods
BTEX = benzene, toluene, ethylbenzene, xylenes
TPH = total petroleum hydrocarbons
TPHG = TPH-as-gasoline
TCLP = Toxicity Characteristic Leaching Procedure
FOG = Total Fats, Oil, and Grease
PAHs = polynuclear aromatic hydrocarbon
VOCs = volatile organic compounds
SVOCs = semi-volatile organic compounds

Material currently stockpiled on site as "clean" (700 yds) will be sampled and analyzed for hydrocarbons by the on-site laboratory. The analytical data will be used to segregate the material into one of the three soil classes discussed above.

3.2 Disposition

Disposition of the segregated soils will be evaluated after the volume and analyte concentrations are determined for the three classes of stockpiled soils. Several options exist for disposition of the stockpiled materials including:

- backfill at the site for material with acceptable concentration levels;
- treatment to acceptable levels prior to use on-site as backfill;
- disposal at local or regional landfills or;
- a combination of these alternatives.

3.2.1 Class 1 Soil

After confirmation by laboratory analysis, the soil in the Class 1 stockpile, regardless of the quantity, will be used as backfill when the excavation is reclaimed.

3.2.2 Class 2 Soil

Soil with petroleum concentrations below the MTCA CCL is permitted by the WDOE to be used as backfill at the site. The WDOE recommends, however, "that they not be used in or adjacent to: wetlands, surface water, ground water, drinking water wells or utility trenches"[2]. A subsurface assessment (Section 8.0) is planned at the site to investigate the current groundwater conditions. In addition, the water currently in the excavation will be pumped out and recharge will be monitored (Section 4.0). The Class 2 stockpile material will be used as backfill in the excavation, if it is determined from these investigations that no adverse effect to the groundwater is likely to result. If it is determined that groundwater may be impacted by returning the material to the excavation, it will be disposed of at the Coal Creek landfill in King County, Washington.

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[2] Guidance for Remediation of Releases from Underground Storage Tanks
WDOE Toxics Cleanup Program, July, 1991

3.2.3 Class 3 Soil

After characterization is completed for the Class 3 stockpiled material, a final disposition alternative will be selected. Assuming none of the material is classified as hazardous waste based on characterization tests, three basic alternatives are available to deal with this material:

- disposal at the Rabanco regional landfill in Roosevelt, Washington,
- on-site treatment prior to use as backfill; and
- on-site treatment prior to disposal at a local landfill.

Complete soil characterization is required prior to receiving disposal authorization at the Rabanco Facility. The Rabanco facility should accept Class 3 material without any pretreatment at the site. On-site treatment methods will remove or reduce hydrocarbon concentrations to Class 2 levels; therefore, the same provisions, as previously discussed in Section 3.2.2, governing the use of Class 2 material as backfill will apply. The treatability of compounds such as lead, arsenic or cadmium could eliminate on-site treatment as an alternative due to economic and/or technical constraints. Another option for the disposition of treated soil is to dispose of it at a local landfill. This option, however, is significantly more costly than direct disposal at the Rabanco facility and was ruled out as a viable alternative.

Preliminary evaluation of treatment and/or disposal options indicate that on-site soil treatment (assuming hydrocarbon removal only) is more economical than disposal. Two treatment methods appear feasible for on-site use; thermal desorption and bioremediation. Thermal desorption uses a processing unit to heat the soil and volatilize the hydrocarbons. Bioremediation uses naturally occurring microbes in the soil to degrade the hydrocarbons.

Thermal desorption involves mobilizing a front end loader and a semi-tractor trailer sized processing unit to the site. At an estimated processing rate of 25 to 30 tons per hour, treatment would likely require approximately 18 to 27 working days, depending on the quantity of material requiring treatment. Bioremediation would require a front end loader and soil mixing equipment to prepare and construct treatment cells. One or more high vacuum electric blowers would be installed to provide air flow through the cells. The treatment cells and excavation would be enclosed by a security fence. The bioremediation process would likely require 7 to 12 months.

An economic comparison chart (Figure 3) shows the differential costs associated with the treatment and disposal alternatives discussed in this section. The chart illustrates the approximate cost versus segregated volume for the identified soil treatment and disposal methods. The costs shown are differential, not total project cost. The approximate duration and completion date for the options discussed are presented in Section 12.0.

4.0 EXCAVATION WATER

Approximately three feet of water (about 350,000 gallons) is present in the existing open excavation. This water was sampled and treated as discussed in Section 1.2. A Municipality of Metropolitan Seattle (METRO) water discharge authorization was obtained by the City of Bothell in December, 1991, but no water was ever discharged. The authorization allows for intermittent water discharges for a period of six months. In order to comply with the authorization, samples must be collected and analyzed (Table 1) prior to discharge. A restriction placed on the site by the local sewer district is that the daily discharge remain under 20,000 gallons per day.

During the implementation of this POA, two samples will be collected from the standing water and submitted to an off-site laboratory for analysis of METRO discharge parameters. If the water can be discharged without additional treatment, permission will be obtained from METRO and the City of Bothell to discharge the entire quantity over a period of approximately three weeks. If additional treatment is necessary, arrangements will be made with METRO to pump the water through a carbon filtration system prior to entering the sewer system. Once the excavation is pumped dry, recharge of the pit, if any, will be monitored for several days. Based on the quantity and quality of water flowing into the excavation, additional analyses, treatment and disposal may be performed.

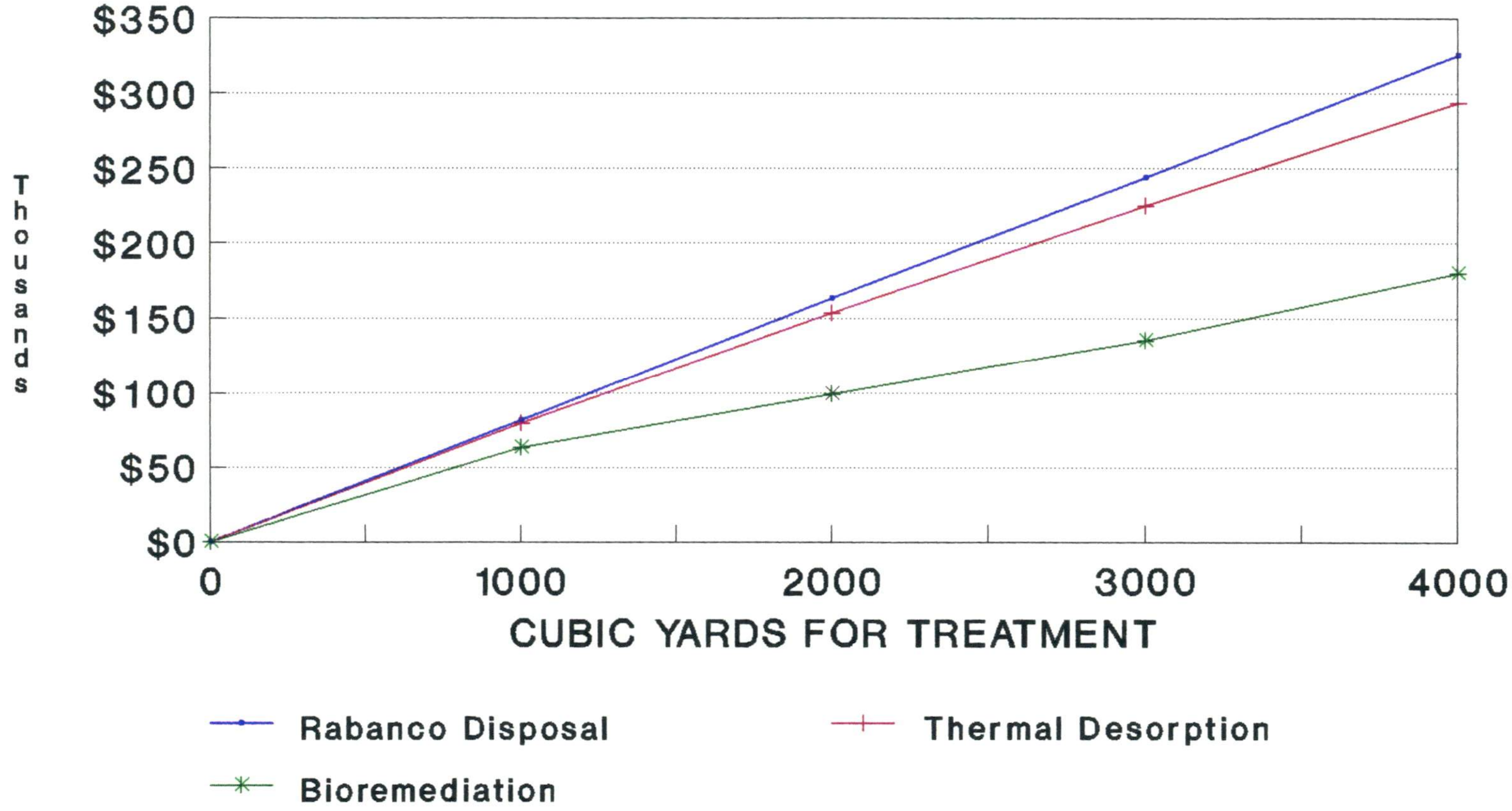
5.0 EXCAVATION SEDIMENT

RZA reported that during the bioremediation/aeration treatment conducted on the accumulated water (Section 1.2), sediment settled to the bottom of the excavation (Appendix C). This sediment, thickness unknown, was not treated with the water and could contain hydrocarbon, metal or polychlorinated biphenyls (PCB) concentrations which exceed MTCA CCLs. In order to characterize this material prior to backfilling the excavation, samples will be collected and analyzed. Once the pit is relatively water free, an excavator

POST SEGREGATION DISPOSITION

Differential Cost Comparison

FIGURE 3



INCLUDED COSTS

Rabanco-dispose & import
Thermal-treat & confirm sample
Bio-construct through confirm sample

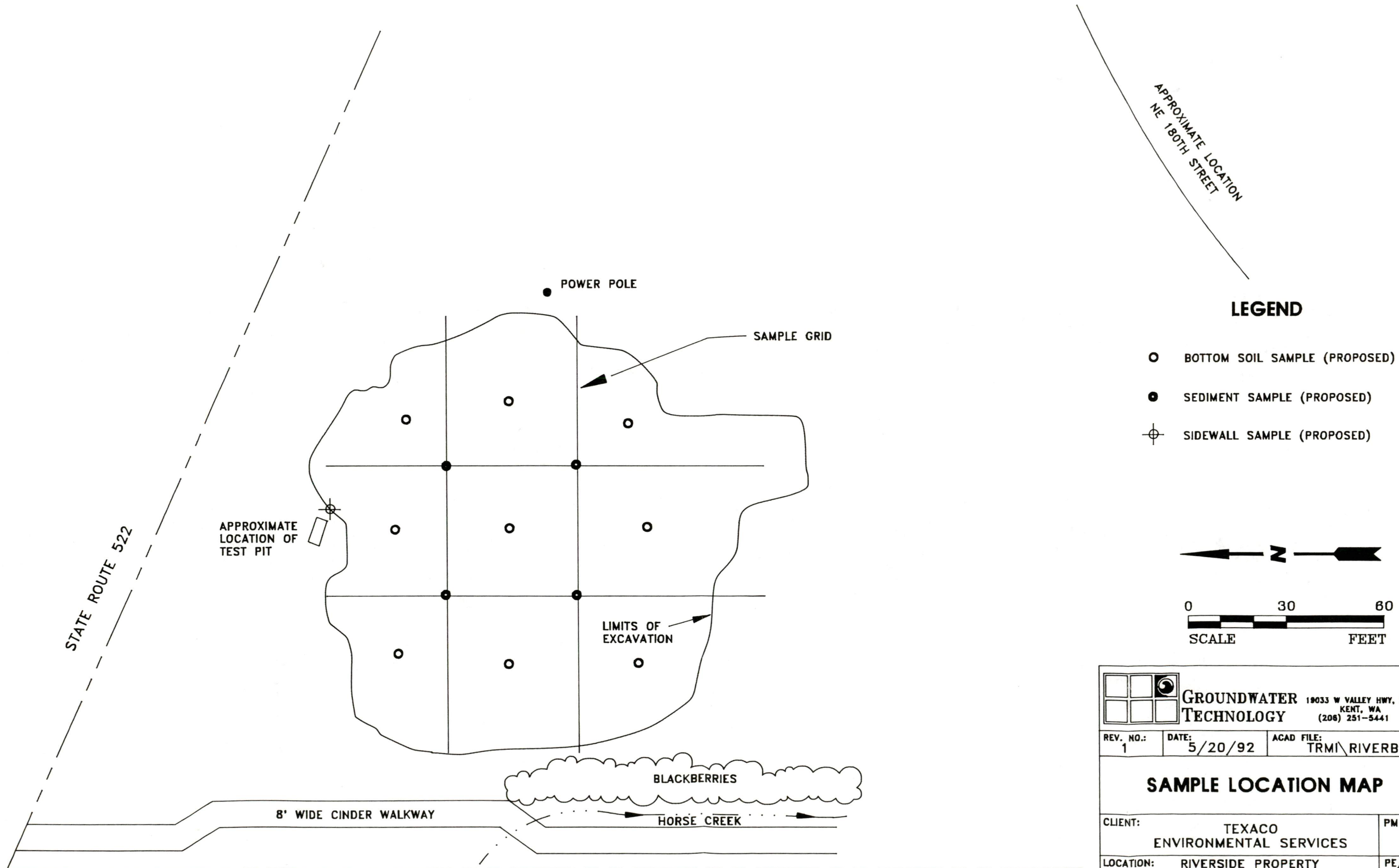
Rabanco must import fill, thermal and bioremediation use material as fill.

will be mobilized on-site and used to help obtain sediment samples. The excavation will be divided into a 40 foot by 40 foot grid pattern, roughly dividing the bottom into nine relatively equal areas (Figure 4). The excavator will collect a shovel of material from the central grid intersections. Discreet sediment samples will be obtained from each bucket following the soil sampling SOP in Appendix D. These samples will be analyzed by an off-site laboratory for the compounds listed in Table 1. If the reported analyte concentrations are below method detection limits the material will be left in place. If the sediment contains target analytes in concentrations exceeding the MTCA CCLs, or is Class 2 material and the groundwater assessment deems removal to be appropriate, a low-bearing pressure bulldozer will be used to scrape the material into an area of the pit where it can be removed by an excavator and stockpiled on plastic within ecology blocks. Once the material is dry enough to move it will be incorporated into the proper stockpile and handled as discussed in Section 3.2.

6.0 EXCAVATION LIMITS

Only limited sampling and analytical data is available for the soils underlying the bottom of the excavation. Therefore, concurrently with the sediment sampling, soil samples will be collected using an excavator and following the excavation sampling SOP in Appendix D. Soil samples will be obtained from approximately 12 inches below the current excavation bottom in order to obtain soil which has not been exposed to the atmosphere or standing water. The excavator will obtain soil from the center of each section outlined by the grid (Figure 4) described in Section 5.0. These samples will be submitted to an off-site laboratory for analysis (Table 1). If analyte concentrations exceed MTCA CCLs in given areas of the excavation, these areas will be deepened with the excavator and re-sampled until concentrations below MTCA CCLs are confirmed. Areas of the excavation bottom identified to contain hydrocarbon concentrations in detectable quantities, but below CCLs, will be evaluated at the time using the groundwater assessment data to determine an appropriate course of action. Excavated soils will be stockpiled and treated or disposed of in the same manner as described for the sediments in Section 5.0.

A backhoe test pit near the north side of the existing excavation, sampled during a previous investigation by SEACOR, found gasoline range hydrocarbon concentrations above the corresponding MTCA CCL's (Appendix A). This test pit was located immediately north of the existing excavation in an area which does not appear to have been excavated by RZA (Appendix C). Therefore, one sidewall sample will be collected for analysis from the north side of the excavation (Figure 4). The disposition of the soil in this area will be



GROUNDWATER TECHNOLOGY 19033 W VALLEY HWY, D-104 KENT, WA (206) 251-5441

REV. NO.: 1	DATE: 5/20/92	ACAD FILE: TRMI\RIVERBM	

SAMPLE LOCATION MAP

CLIENT:	TEXACO ENVIRONMENTAL SERVICES		PM
LOCATION:	RIVERSIDE PROPERTY HIGHWAY 522 AND 527 BOTHELL, WASHINGTON		PE/RG
DESIGNED SH	DETAILED CSY	PROJECT NO.: 02060	FIGURE: 4

handled using the same procedure described for bottom soil above. Any excavated soils will be stockpiled and treated or disposed of as previously discussed in Section 3.2.

7.0 SITE RESTORATION

The excavation will be backfilled and compacted to site grade after completion of the above characterization and remedial operations. Only material deemed suitable for backfill, Class 1 or Class 1 and 2 depending on the determination of the groundwater assessment, will be returned to the excavation. An adequate quantity of clean material will be imported as necessary to complete the backfilling process. Clean imported or Class 1 material will be used to cap the excavation (approximately one foot) to mitigate potential human contact with Class 2 soil; if it is returned to the excavation.

8.0 GROUNDWATER ASSESSMENT

Only limited assessment of the groundwater conditions at the site was performed during previous site activities. Therefore, a groundwater investigation will be initiated by this POA with the installation of six groundwater monitoring wells. The depth to or presence of a local continuous aquifer beneath the site is unknown at this time. For investigative purposes, exploration is planned to a depth of 50 feet below grade in three of the six wells. The remaining three wells will evaluate the perched water-bearing zones encountered during the previous site assessment and remedial activities. If groundwater is found to be contaminated, it will be the subject of further discussion and is beyond the scope of this POA.

The three exploratory soil borings, MW-1 through 3 (Figure 2), will be advanced to a depth of 50 feet or 10 feet below encountered water, whichever is less. During drilling, each borehole will be logged by a field geologist who will maintain a continuous record of the materials encountered and the occurrence of water. Soil samples will be collected at five foot intervals and two samples, based on water table proximity and PID values, will be submitted to the laboratory for the analyses listed in Table 2. All equipment used for drilling will be steam cleaned between boreholes to minimize the risk of cross-contamination. All soils produced as a result of drilling will be contained on and covered with plastic pending laboratory analyses results. If no water is encountered the borings will be backfilled with a bentonite-cement grout mixture. If water is encountered three monitoring wells (four-inch diameter) will be installed. The wells will be screened from

TABLE 2

SUMMARY OF MONITORING WELL LABORATORY ANALYSES

Location	No. of Samples	Media	Analysis	Analytical Method
A. Monitoring Well Borings, Subsurface Characterization	9	Soil	TPH TPHG BTEX Total Metals PAHs VOCs SVOCs	418.1 Mod. 8015 8020 6010 8310 8240 8270
B. Monitoring Wells, Groundwater Characterization	6	Water	TPH TPHG BTEX Total Metals PAHs VOCs SVOCs	418.1 Mod. 8015 8020 6010 8310 8240 8270

BTEX = benzene, toluene, ethylbenzene, xylenes
TPH = total petroleum hydrocarbons
TPHG = TPH-as-gasoline
PAHs = polynuclear aromatic hydrocarbon
VOCs = volatile organic compounds
SVOCs = semi-volatile organic compounds

the bottom of the well to approximately five feet above the water table. Each well will be constructed following the Groundwater Technology SOP for well construction (Appendix D) and Washington State regulations. A groundwater monitoring well construction detail is shown in Figure 5.

Three soil borings, MW-1A through 3A (Figure 2), will be advanced to a depth of approximately eight feet below grade and four-inch diameter groundwater monitoring wells will be installed. Soil samples will be collected at approximately three feet and eight feet below grade. One sample for each boring will be submitted to the laboratory for the analyses listed in Table 2. These wells will be screened from five to eight feet below grade, following the guidelines outlined for the deeper wells.

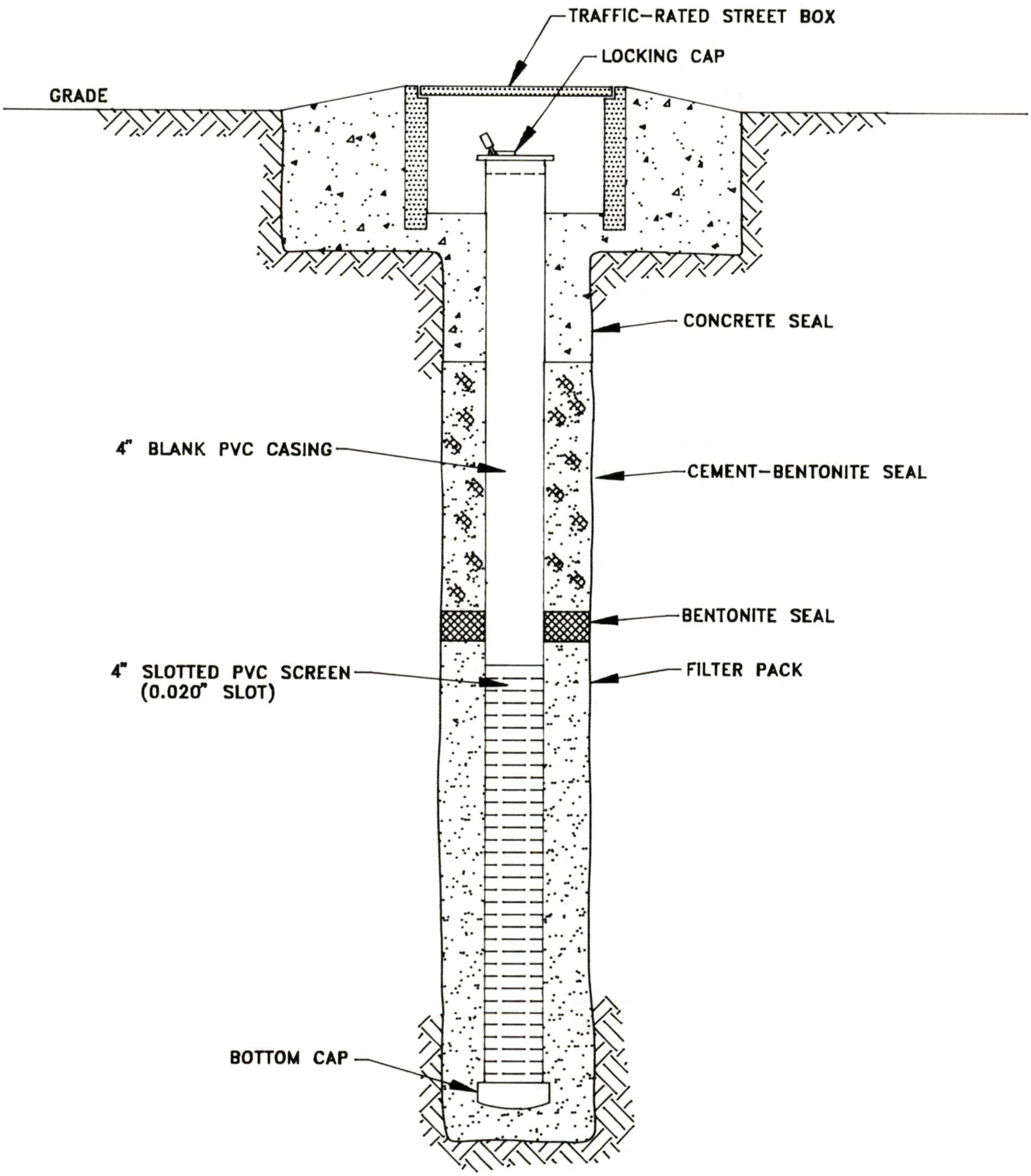
Each well will be surveyed to a common site datum. All wells will be developed by hand bailing or pumping approximately five to six well volumes of water from the well. Following groundwater stabilization to static levels, approximately 48 hours, the wells will be gauged for depth-to-water to determine the local groundwater flow direction and gradient. The wells will then be purged of three to four well volumes and sampled for the analyses listed in Table 2. All water produced as a result of development and sampling operations will be contained in DOT approved drums pending laboratory analyses results.

9.0 REPORTING

Individual reports will be prepared to document the preliminary groundwater assessment and site activities through completion of the project scope. Brief letter format reports will document soil segregation and the excavation characterization. Monthly updates will be furnished to TES which document the previous months activity and highlight the next months schedule.

10.0 PERMITS

Several permits will be required to complete this POA. A clear and grade permit will be obtained from the City of Bothell prior to commencing soil segregation. In addition, a hauling permit will be necessary if export or import of material is required. In order to receive these permits, a State Environmental Policy Act (SEPA) permit is required. Conversations with personnel at the Bothell Fire Department and city planning office indicate that a SEPA permit was obtained prior to the August, 1991 remedial excavation activity, however the permit limited excavation to approximately 500 yds of material with only minor import or export of soil.



NOT TO SCALE

GROUNDWATER TECHNOLOGY 19033 W VALLEY HWY, D-104 KENT, WA (206) 251-5441	**TYPICAL MONITORING WELL CONSTRUCTION**

CLIENT:	LOCATION:	REV. NO.:	DATE:
TEXACO ENVIRONMENTAL SERVICES	SR 522 & SR 527 BOTHELL, WA	0	5/29/92

PM	PE/RG	DESIGNED	DETAILED	ACAD FILE:	PROJECT NO.:	FIGURE:
			ML	MWELL.DWG	02060	5

If this permit can be amended to encompass at least the soil segregation phase of this POA then operations could commence with very little time delay. If, however, a new SEPA permit is required, a time delay of 60 to 90 days may be unavoidable. The WDOE recommends notification of the local health department prior to on-site soil treatment or export of Class 2 or 3 soil. If thermal desorption is used to treat soil on site a Puget Sound Air Pollution Control Authority (PSAPCA) permit will also be required.

11.0 COST ESTIMATE

Cost estimates for specific phases of the POA will be prepared as timeframes, soil quantities and analyte concentrations become available. Cost estimates based on assumed quantities of Class 3 material were prepared for the three treatment/disposal alternatives discussed Section 3.2. These estimates include soil segregation - characterization costs and disposal or treatment costs associated with the assumed soil quantity and Class. The estimates allow a relative comparison based on a fixed set of variables. The estimates are summarized in Table 3.

12.0 ESTIMATED SCHEDULE

A project schedule which reflects the workscope outlined in this POA is provided in Figure 6. Each task has been scheduled to allow for time dependent relationships with other POA activities. Sixty days was allotted for the acquisition of a new SEPA permit prior to commencing soil segregation operations. The shortest estimated timeframe to accomplish the plan objective is approximately three months following WDOE approval of the POA. This shortest action path entails the transport of all Class 3 soil to the Rabanco regional landfill. The longest project duration accompanies the bioremediation Class 3 soil treatment alternative, which extends the project completion by a minimum of seven months (Table 3). There are several areas where the project duration may deviate from the planned schedule. For example, no time was allotted for remedial efforts to address excavation bottom soil which does not meet MTCA CCLs. However, the major project items have been accounted for in the schedule. Major delays in the project of several months are not anticipated.

TABLE 3 SUMMARY OF SOIL REMEDIATION ALTERNATIVES COST AND DURATION			
ALTERNATIVE	ASSUMPTIONS	ESTIMATED DURATION Post Segregation	ESTIMATED COST*
Disposal	Class 1 – 700 yds as backfill Class 2 – 1,000 yds to Coal Creek Class 3 – 3,500 yds to Rabanco	2 weeks	$ 395,000
Disposal and Backfill	Class 1 – 700 yds as backfill Class 2 – 1,000 yds as backfill Class 3 – 3,500 yds to Rabanco	2 weeks	$ 353,000
Thermal Desorption and Backfill	Class 1 – 700 yds as backfill Class 2 – 1,000 yds as backfill Class 3 – 3,500 yds treat & backfill	5 weeks	$ 325,000
Bioremediation and Backfill	Class 1 – 700 yds as backfill Class 2 – 1,000 yds as backfill Class 3 – 3,500 yds treat & backfill	7 – 12 months	$ 226,000

* Includes:
Soil segregation and characterization
Permits
Disposal and import of fill
Treatment
Site restoration

BOTHELL/RIVERSIDE

PLAN OF ACTION SCHEDULE

Task Name	End Date
Commence Project	24-May-93
Plan of Action (POA)	24-Jun-92
Draft revisions	10-Jun-92
Submit POA to WDOE	10-Jun-92
WDOE "Approval" of POA	24-Jun-92
Permits: SEPA, etc.	26-Aug-92
Groundwater Assessment	6-Aug-92
Excavation Water	30-Jul-92
Confirm/renew METRO	1-Jul-92
Sample Water	9-Jul-92
Discharge Approval	9-Jul-92
Discharge Water	30-Jul-92
Excavation Assessment	20-Aug-92
Stockpile	15-Sep-92
Sieve & Density Sampling	31-Aug-92
Sort and Segregate	10-Sep-92
Disposal vs Treatment	15-Sep-92
Disposal/Treatment	28-Apr-93
Landfill Disposal	29-Sep-92
Thermal Desorption	23-Oct-92
Bioremediation	28-Apr-93
Reporting	24-May-93

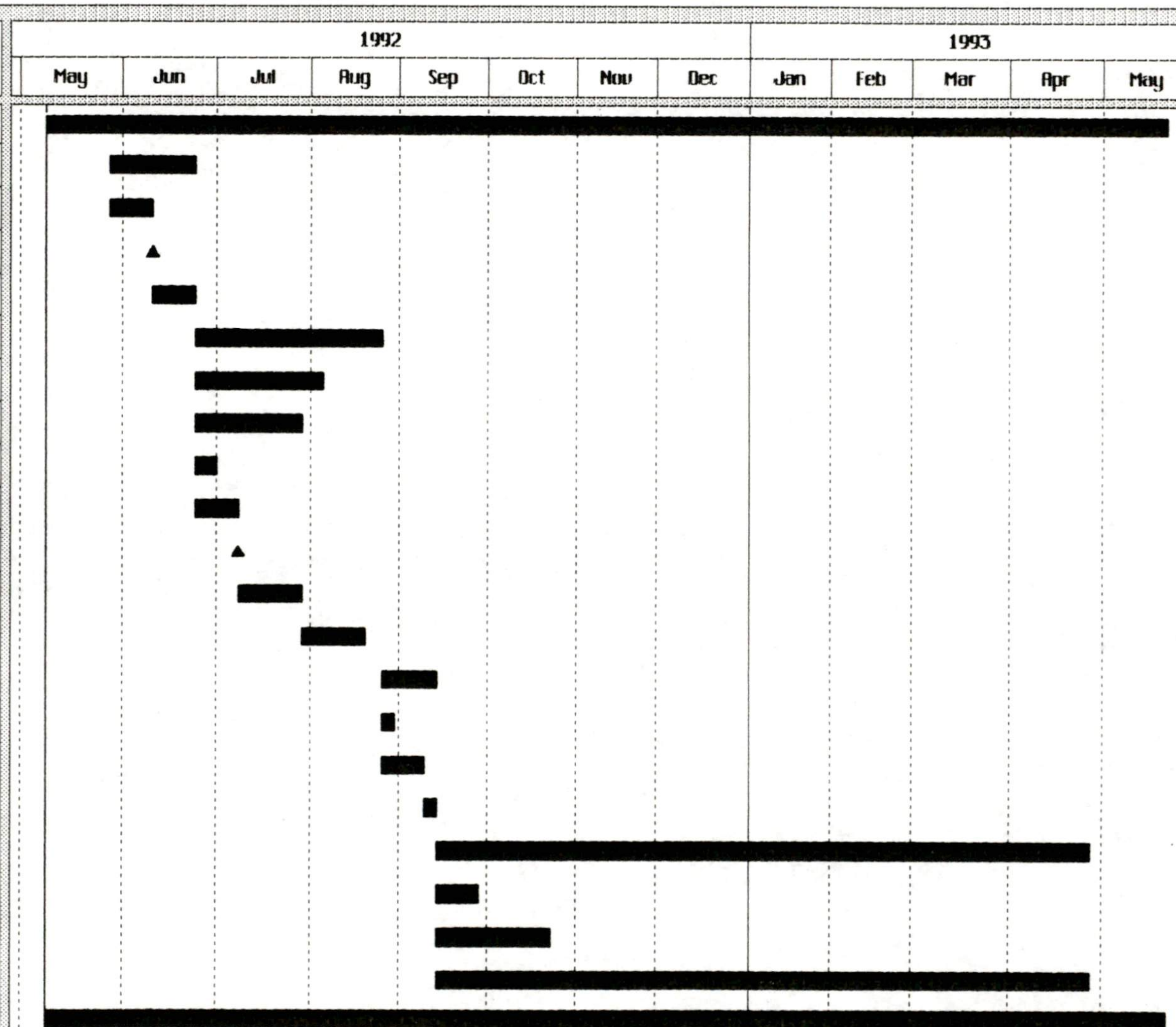
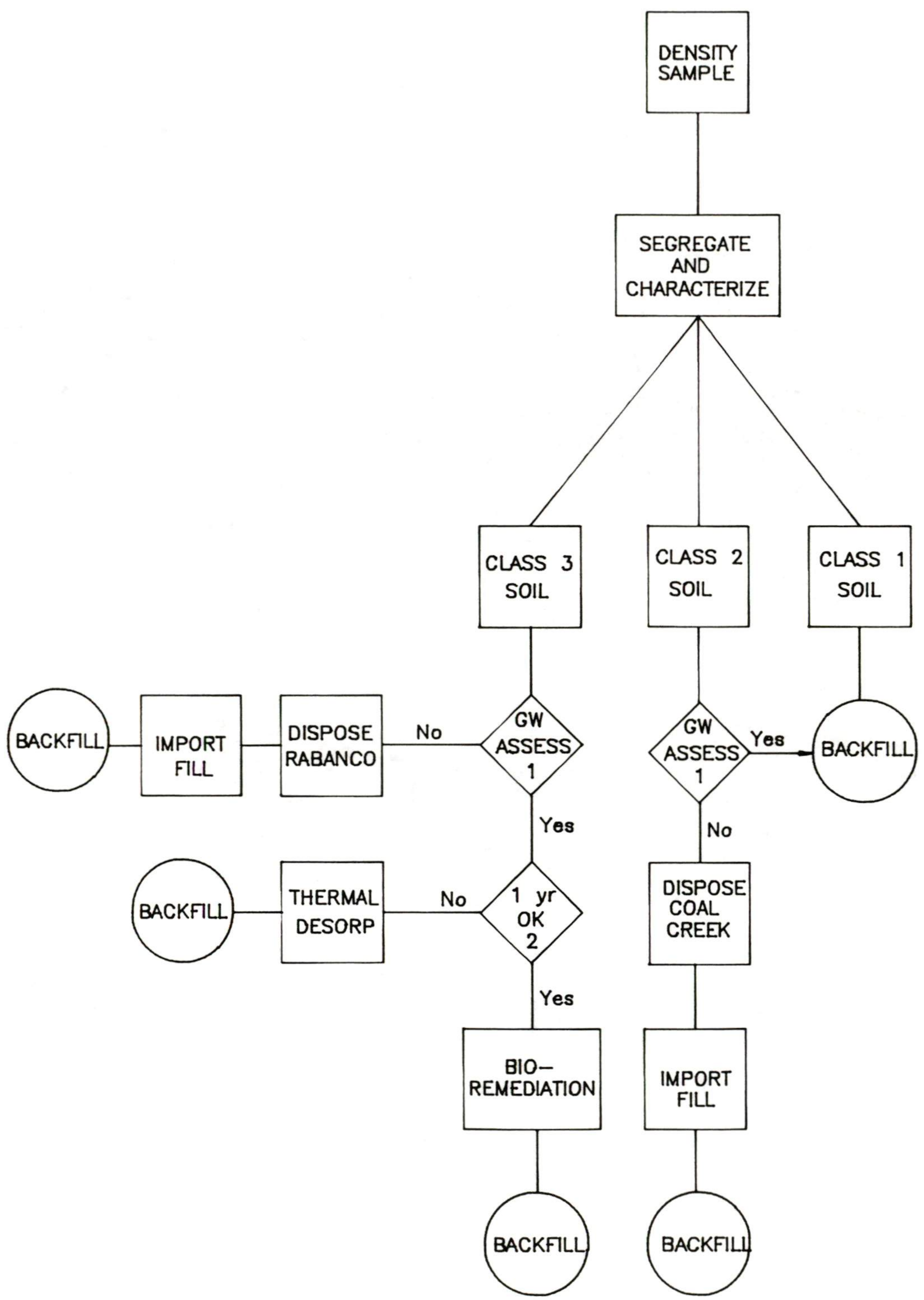


FIGURE 6

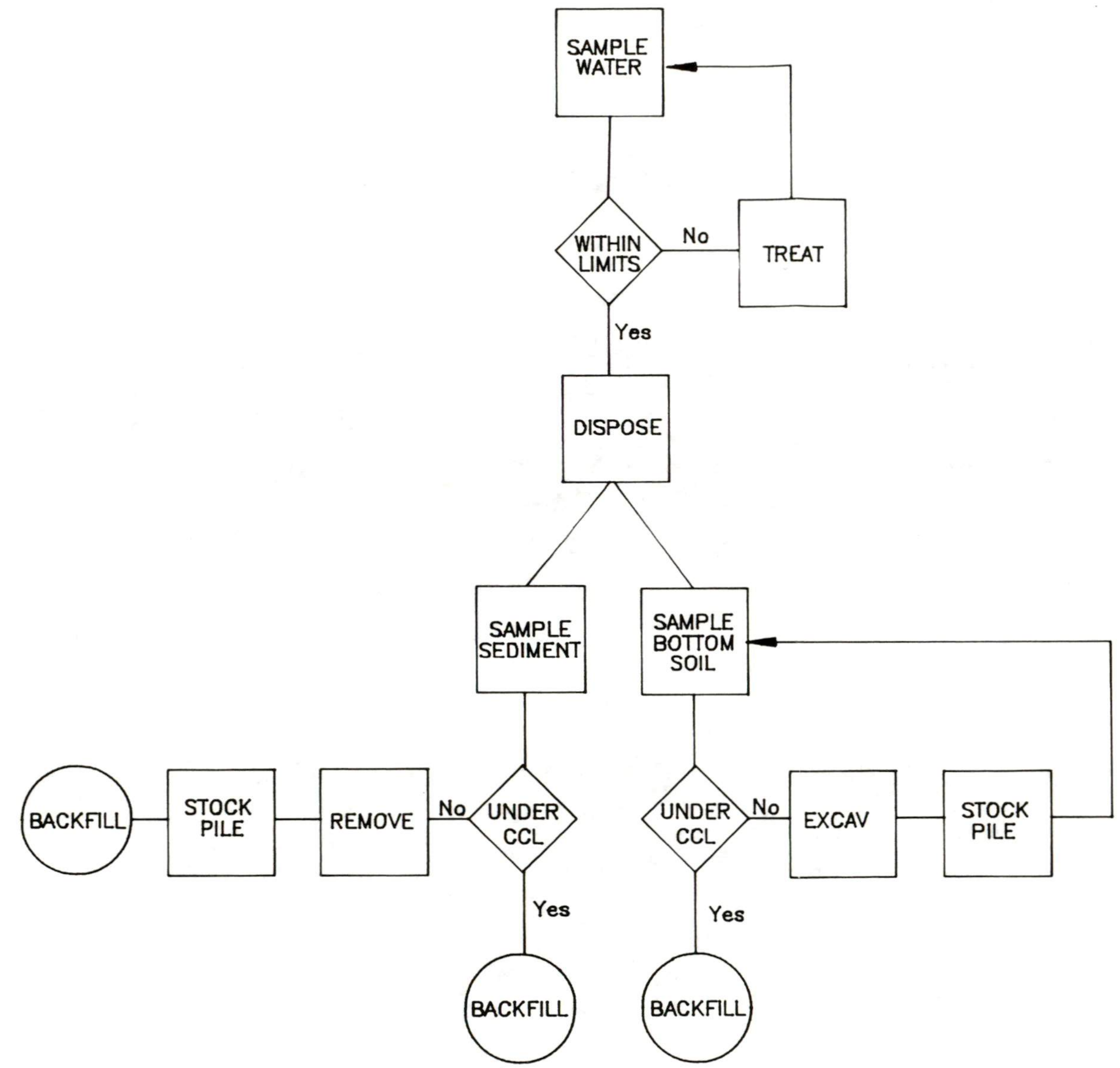
13.0 SUMMARY OF REMEDIATION/DISPOSAL ALTERNATIVES

The path selected through the Action Flow Chart (Figure 7) will be driven by either cost or time. Landfill disposal and on-site treatment are two distinct paths for management of the soil. Disposal of all Class 3 soil at the Rabanco regional landfill can be accomplished within four months of POA approval by the WDOE. However, a savings of approximately $127,000, verses disposal, may be realized if the project completion date can be extended by 7 to 12 months to allow for bioremediation of the soil. A savings of approximately $28,000, verses disposal, may be realized if the project completion date can be extended by approximately 5 weeks to allow for thermal desorption of the soil. This comparison is based on the estimates prepared in Section 11.0. It also assumes that the results of the preliminary groundwater assessment will eliminate concerns regarding the use of Class 2 soil as backfill material.

SOIL PILE



EXCAVATION



CCL – COMPLIANCE CLEANUP LEVEL
DTW – DEPTH TO WATER (CONTINUOUS AQUIFER)
1 GROUNDWATER ASSESSMENT ALLOWS USE OF CLASS 2 MATERIAL AS BACKFILL
2 TREATMENT TIME

GROUNDWATER TECHNOLOGY
19033 W. VALLEY HWY.
SUITE D–104
KENT, WA
(206) 251–5441

REV. NO.: 1	DATE: 5/11/92	ACAD FILE: TRMI\RIVERFC.DWG	

ACTION FLOW CHART
SOIL AND EXCAVATION

CLIENT: TEXACO ENVIRONMENTAL SERVICES WITCO CORPORATION	PM
LOCATION: 522 & BOTHELL HWY. BOTHELL, WA	PE/RG

DESIGNED	DETAILED	PROJECT NO.:	FIGURE:
SH,MN	SH	02060	7

A

GROUNDWATER
TECHNOLOGY

APPENDIX A

SITE INVESTIGATION
SEACOR OCTOBER 12, 1990

GROUNDWATER
TECHNOLOGY

SITE INVESTIGATION

CITY OF BOTHELL
RIVERSIDE PROPERTY
BOTHELL, WASHINGTON

SEACOR PROJECT NUMBER 00030-002-01

REVISED OCTOBER 12, 1990

SEACOR

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1.0 INTRODUCTION

This report documents a site investigation conducted on August 16, 1990 at the City of Bothell property located east of Petosa's Restaurant on State Route 522 (SR 522) in Bothell, Washington. The City property is herein referred to as the Riverside property.

1.1 Site Description

The Riverside property is a triangular-shaped parcel approximately 1.9 acres in size, located just east of Petosa's Restaurant on SR 522 in Bothell, Washington. The property is bounded on the north by SR 522, on the south by N.E. 180th Street, and on the west by Horse Creek and the Bothell Landing commercial development (see Figure 1). Except for a small cluster of trees near the northwest corner of the site, the sparse vegetation on the site consists of grasses, weeds and blackberry vines. Although the site is currently vacant, during the 1940's, 1950's and 1960's there were several businesses located along the SR 522 frontage.

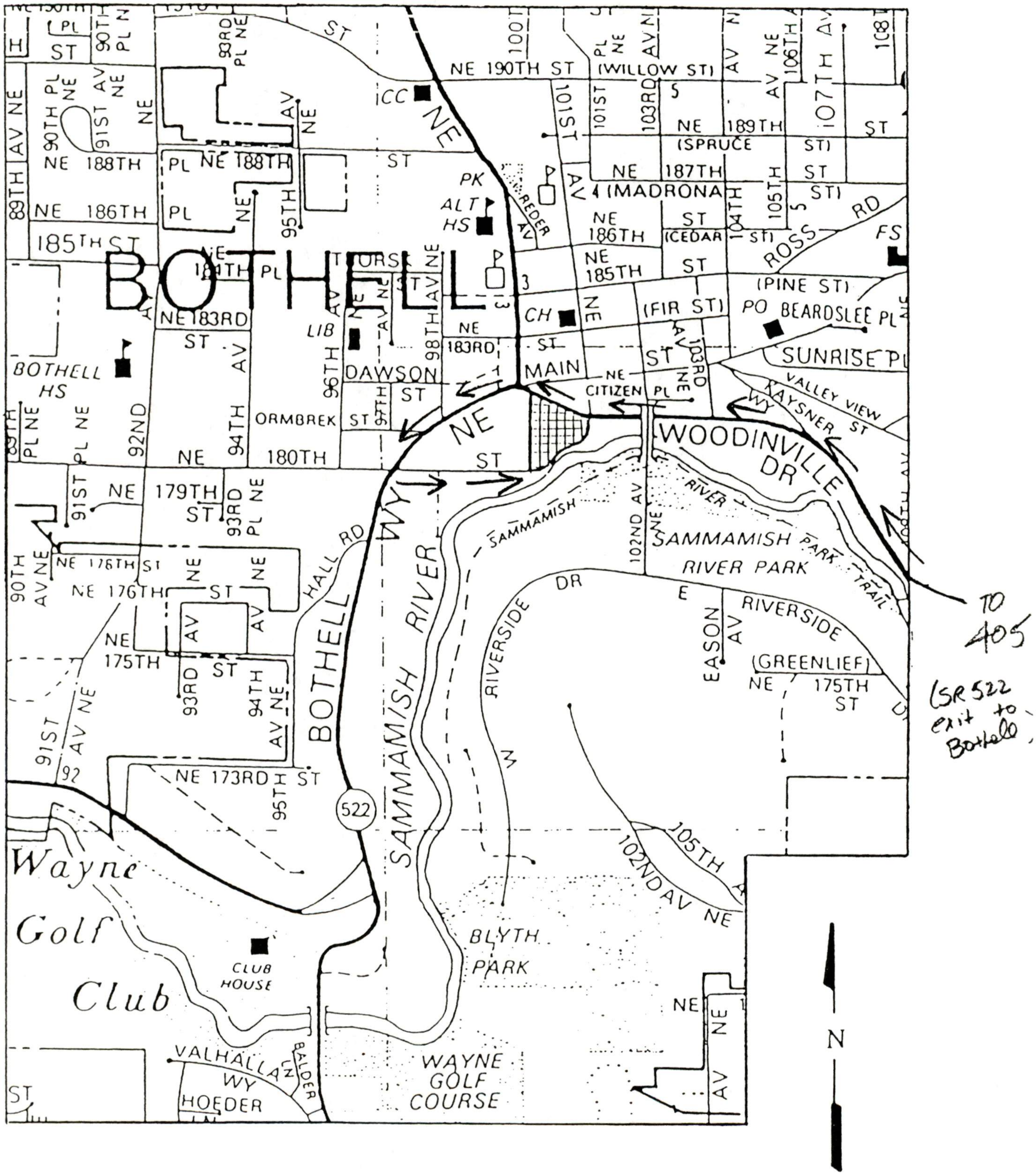
The property was purchased by the City of Bothell in early 1990 with the intent of establishing a City park at the site.

1.2 Purpose and Scope of Work

The purpose of the site investigation at the Riverside property was four-fold:

- Verification of the presence of and extent of petroleum hydrocarbons present in soil and/or groundwater at the site;
- Identification and quantification of petroleum hydrocarbons present in soil and/or groundwater at the site;
- Identification of possible historic sources of petroleum hydrocarbons present in soil and/or groundwater at the site; and,
- Identification of options for remediation of petroleum-affected soil and/or groundwater at the site.

FIGURE 1
SITE LOCATION



SEACOR

RIVERSIDE PROPERTY

SEACOR contracted directly with the City of Bothell to provide environmental consultation and testing services associated with accomplishing the stated purpose of the site investigation. The investigation included evaluation of soil and groundwater conditions at the site as well as examination of historical records dealing with the site. SEACOR's specific scope of work included:

- Interviews with the property owner and other appropriate personnel regarding the history of the property;
- Inspection of historic aerial photographs and records pertaining to the property; and,
- Supervision and observation during the construction of test pits on site;
- Collection of soil and water samples from the test pits;
- Analysis of selected soil and water samples in order to determine the concentrations of total petroleum hydrocarbons (TPH), BTEX compounds (benzene, toluene, ethyl benzene and xylene) and, in some cases, organic lead and PCB.
- Estimation of the extent of petroleum hydrocarbon contamination at the site;
- Evaluation of options for remediation of petroleum-affected soil and/or groundwater at the site; and
- Preparation of this report.

2.0 SITE BACKGROUND

2.1 Personal Interviews and Records Research

The following long term residents of Bothell were interviewed regarding the historic land use and site operation at the Riverside property:

- Mr. Chuck Gaylord--Bothell resident since 1946 and former gas station operator

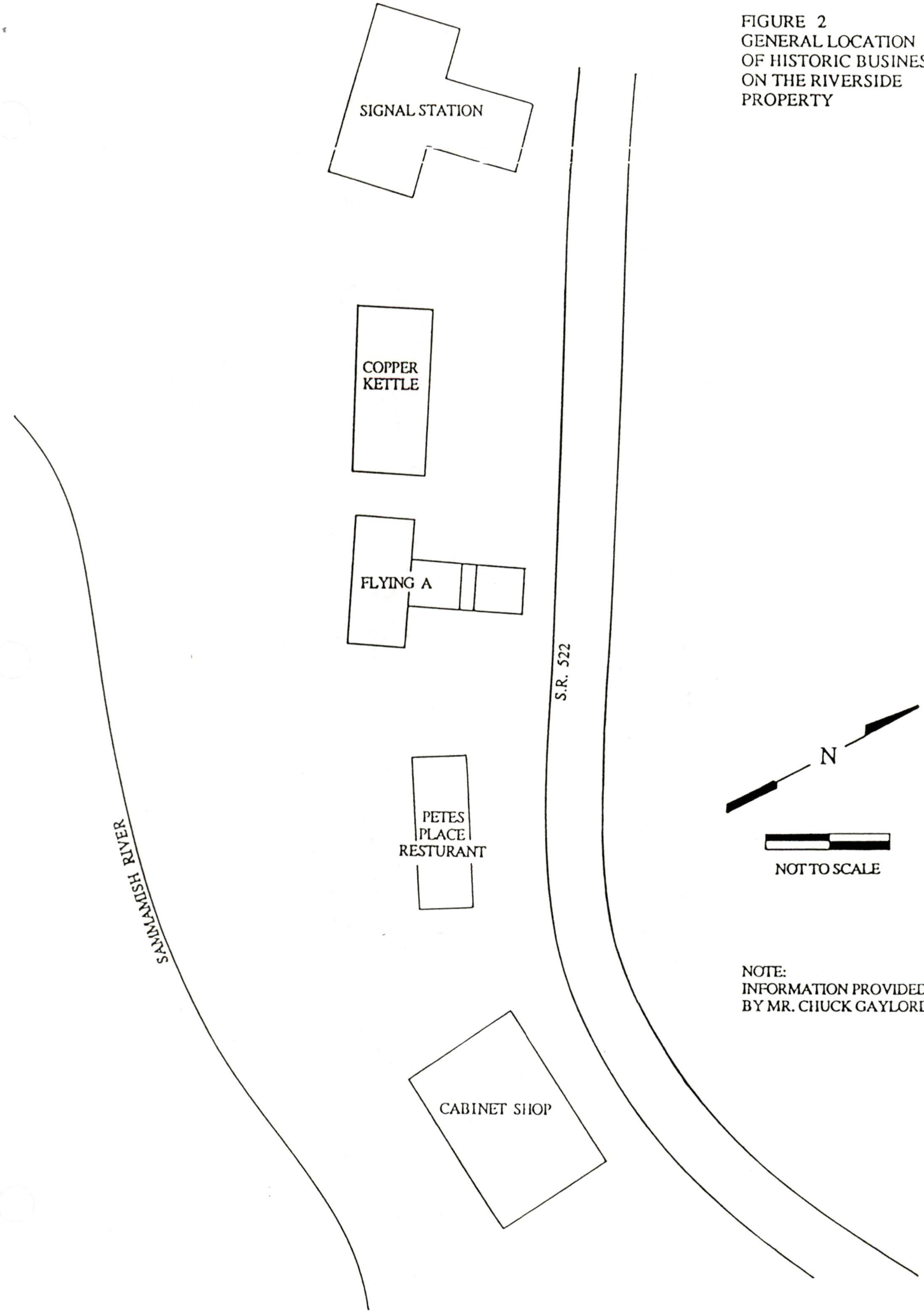
- Mr. Don Sunde--Former Bothell resident and employee of the Bothell Department of Public Works

- Mr. Bob Stinson--Life time resident of Bothell and member of the Bothell Fire Department

All parties interviewed stated that they were familiar with the subject property and that there was a gasoline station located on a portion of the property for many years during the 1940's, 1950's and 1960's. Mr. Gaylord was most familiar with the site since he operated a Chevron gasoline station just northwest of this property for seventeen years. Mr. Gaylord specified that the gasoline station at this site was a Flying A station built circa 1947. The station was operated by Mr. Joe Kuntz until the early 1960's when the station was closed. Mr. Gaylord, who was personally acquainted with Mr. Kuntz, stated that very little auto repair work of any type was done at the Flying A station. There was, however, a "shade tree" mechanic who performed auto repair in the area just east of the gas station. Mr. Gaylord provided a sketch showing the general layout of businesses which were present along the SR 522 frontage of the City property (see Figure 2). He was also able to relate information regarding the area behind the Flying A station where the soils were found to contain debris and heavy petroleum hydrocarbons. According to Mr. Gaylord, this area was lower in elevation than the surrounding area and somewhat swampy. Over the years the area was used as a dumping ground for debris of all types including bricks, wood, metal cans and bottles. After the Flying A station and other businesses on the property were closed and torn down, the rear portion of the property was filled to provide a level site for possible future development.

There were no City records available concerning the subject property. The City of Bothell did not require business licenses until 1974.

FIGURE 2
GENERAL LOCATION
OF HISTORIC BUSINESS
ON THE RIVERSIDE
PROPERTY



2.2 Aerial Photographic Review

Historic aerial photographs from Walker and Associates, Inc. of Seattle, Washington were inspected in order to assist in identification of historic land use on the subject property. Aerial photographs from 1946, 1956, 1960 and 1974 were examined. There is a building present on the 1956 and 1960 photographs which matches the description given by Mr. Chuck Gaylord of the Flying A gasoline station. The building is a small square structure with a long narrow extension running north almost to the southern edge of SR 522. The extension visible in the photograph is apparently the service station canopy.

2.3 ENVIRONMENTAL SETTING

The environmental setting was established through visual inspection of the site and thorough examination of the U.S.D.A. soil survey of this area.

2.3.1 Regional Physiographic Conditions

The subject property is located in an area of relatively flat (0 to 2 percent) slope near the Sammamish River. Historic research revealed that the site was originally low and swampy and has been filled in stages over the course of the past 40 years. There are no storm sewer facilities on site and no active utility services. The property apparently drains via sheetflow towards the Sammamish River south of the site and Horse Creek on the west.

Native soils beneath this site are classified as Everett gravelly sandy loam and Puget soils (U.S.D.A. Soil Survey of King County Area Washington, 1973).

Everett series soils are excessively drained soils underlain by very gravelly sand. They are formed in very gravelly glacial outwash and are suitable for timber production, pasture land and urban development. This type of soil is present along the SR 522 frontage of the Riverside property.

Puget soils are poorly drained soils formed under sedges and grasses in small depressions of the river valleys. These soils are present on the southern 60 to 70 percent of the property. Puget soils are suitable for row crops and pasture production.

2.3.2 Hydrogeologic Conditions

No groundwater studies are known to have been conducted in the vicinity of the site. The Washington State Department of Ecology has plans to establish a program to compile groundwater information, but to date has not implemented that program due to staffing requirements. Typically, in cases where a lack of groundwater data (i.e., depth and direction of flow) exists, flow direction can be estimated by examination of the surface topography. Groundwater typically flows from the recharge areas of higher elevation and discharges into lower-lying areas (such as streams and lakes). The ground surface in the vicinity of the subject property slopes very gently towards the southwest (towards Horse Creek and the Sammamish River). Therefore, groundwater flow is expected to be in the same direction.

3.0 FIELD INVESTIGATION

The field investigation at this site consisted of the excavation of numerous test pits at various locations on site in order to evaluate subsurface soil and groundwater conditions. The City of Bothell supplied a backhoe and an equipment operator, which were utilized to construct the test pits. The location of the test pits is shown in Figure 3.

3.1 Sampling Techniques

All soil samples collected during the investigation were taken with a clean stainless steel scoop and were contained in pre-cleaned glass jars with teflon-lined caps. Prior to the collection of each sample, the steel scoop was washed in an aqueous solution of trisodium phosphate, rinsed in tap water and rinsed a second time in distilled, deionized water. Soil samples were labeled and stored in a cooler on ice pending delivery under chain-of-custody to an analytical laboratory for testing.

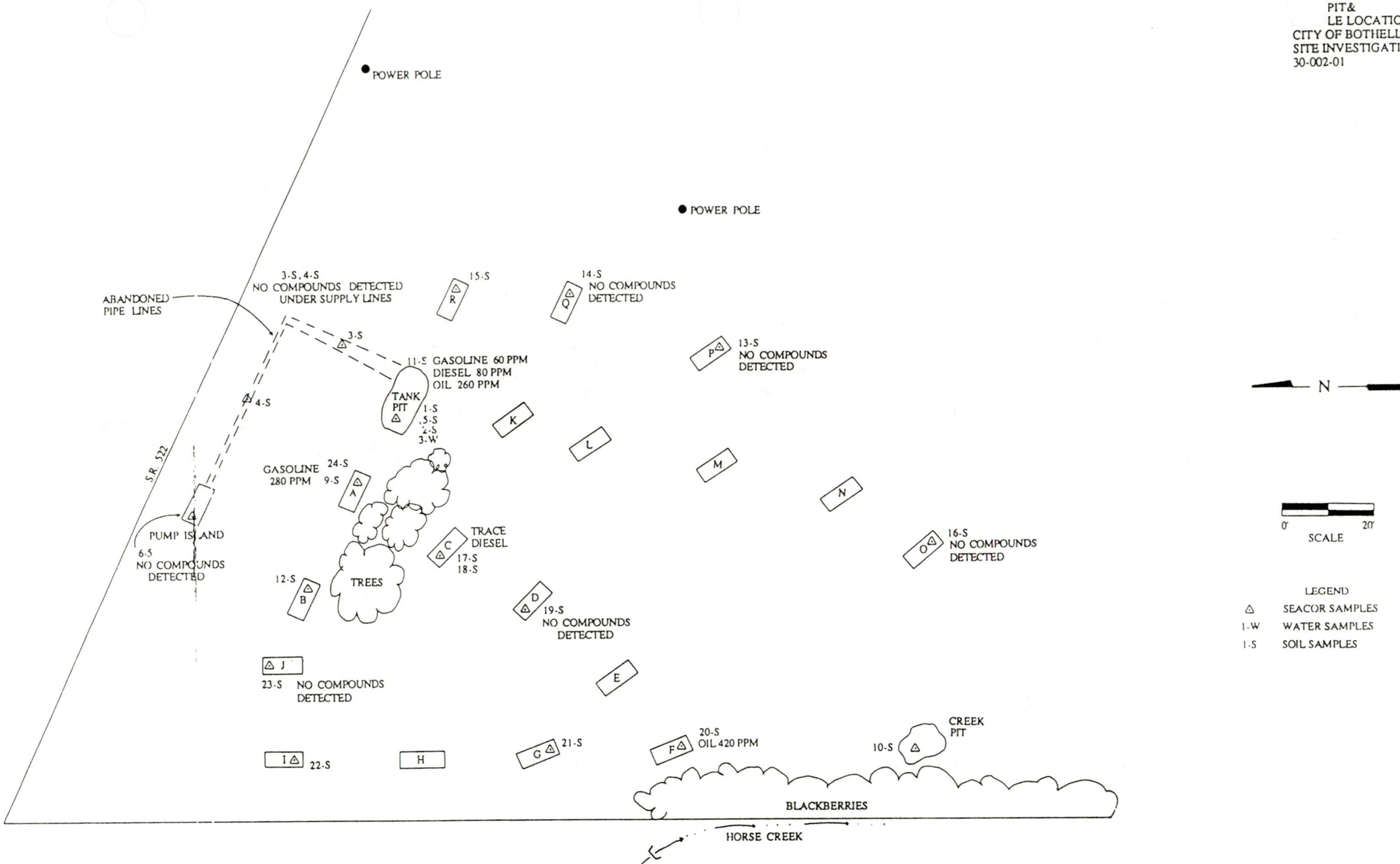
All water samples collected during the investigation were contained in pre-cleaned VOA vials with teflon-lined caps. The samples were labeled and placed in a cooler on ice pending delivery under chain-of-custody to an analytical laboratory for testing.

3.2 Excavation of Test Pits

Excavation began with a test pit along the western boundary of the property near Horse Creek. This location was selected in an effort to examine the condition of groundwater leaving the site and entering the creek or the Sammamish River to the south. Although this pit was excavated to a depth of approximately twelve feet, no groundwater was encountered. This result may have been due to the fact that the investigation took place in August and there had been little or no rainfall in the 30-day period preceding the investigation.

The second test pit was excavated in a location suspected to be the former underground storage tank site for the Flying A gasoline station. Two small diameter pipes extended north from this location toward SR 522 and then west approximately 30 feet. It was assumed that these lines were supply lines for former gasoline pumps. It was determined that the southern end of the piping was the logical location for underground gasoline storage tanks. In addition, during an earlier, informal study of the property, the City of Bothell discovered pieces of concrete tank bedding and old tank piping at this location. No tanks were encountered during this previous investigation.

:E 3
PIT&
LE LOCATIONS
CITY OF BOTHELL
SITE INVESTIGATION
30-002-01



SEACOR

At a depth of approximately four feet in this test pit dark soil with a slippery texture and gasoline odor was encountered. The color and texture of the soil was characteristic of petroleum-affected soils. A sample of this soil was collected for analysis. At a depth of approximately six feet, a four-inch thick layer of perched water was encountered and the soil type changed to peat. The peat had a slight odor but did not have any visual indications of petroleum contamination. At a depth of approximately twelve feet a hard, gray, fine-grained soil was encountered. This soil had no odor and the light gray color appeared to be natural. A second soil sample was collected from the pit at this depth to confirm that this soil layer had not been effected by the petroleum hydrocarbons which were presumed to be present in the upper soil layers.

The third test pit was excavated near SR 522 at the west end of the abandoned pipe lines. This is the suspected location of the gasoline pumps for the Flying A station. Slight odors were detected in this test pit at a depth of approximately four feet. This depth was the interface between a sandy, silty loam and an underlying layer of peat. Again, as in the tank pit, perched water was encountered at this interface. A sample of the soil above the peat layer was collected for analysis. A sample of the perched water which seeped into the test pit was also collected for analysis.

Following completion of the pump island test pit, eighteen additional pits were excavated at various locations on site in order to determine the extent of petroleum-affected soil at the site. In test pit A, just west of the tank pit, gasoline odors were detected at a depth of approximately six feet. This was the only pit, in addition to the tank pit, where soils had a distinct gasoline odor. In test pits C through F and K through N oil cans (some bearing the Flying A logo), small barrels, bricks, wood and other assorted types of debris were encountered, as well as soil which was dark colored and had a distinct petroleum odor (diesel or oil). Samples were collected from several of these pits for analysis and pictures were taken in order to document the debris in these pits. In test pits G through J and O through R there were no visible or olfactory indications of petroleum-affected soils. Samples were collected from several of these pits for possible analysis. Analysis of samples from these pits would assist SEACOR in estimating the total area and volume of soil affected by petroleum contamination.

3.3 Soil Sample Analysis

Thirteen selected soil samples and two water samples collected during this investigation were submitted to National Chemlab of Ephrata, Washington for analytical testing. All samples were analyzed to determine the concentrations of TPH and BTEX present. Several of the samples were also tested for the presence of other petroleum related compounds such as organic lead and polychlorinated biphenols (PCBs). The sample taken from the suspected underground tank location was subjected to a complete hydrocarbon fingerprinting process in an effort to date the petroleum compounds present at the site. A summary of the sample locations, the analyses run on each sample and the analytical test results are given in Table 1. The analytical laboratory report and chain-of-custody records are contained in Appendix B. In general, these results indicate that gasoline-affected soils are limited to the suspected vicinity of the former underground storage tanks for the Flying A station. It is estimated that approximately 100 cubic yards of soil has been affected by gasoline. However, a significant volume of soil at this site appears to be contaminated with used motor oil. The amount of oil-affected soil is estimated at 600 cubic yards, and is located in the area south of the old gasoline station site.

The majority of the petroleum-affected soil at this site appears to contain concentrations of petroleum hydrocarbons above the Washington Department of Ecology (Ecology) cleanup levels presented in the draft "Model Toxics Control Act Cleanup Regulation and Proposed Amendments" dated July 27, 1990. These cleanup levels are expected to be approved prior to January 1991. The proposed cleanup levels for soil are:

Gasoline	100 parts per million (ppm)
Diesel	200 ppm
Other petroleum products	200 ppm

3.4 Water Sample Analyses

Two water samples collected during this investigation were submitted to National Chemlab for analytical testing. Samples were analyzed to determine the concentrations of TPH and BTEX present. Neither of the water samples contained detectable concentrations of TPH or BTEX. A summary of the analysis data for the water samples is presented in Table 1. The analytical laboratory report and chain-of-custody records are presented in Appendix B.

TABLE 1

Summary of Analytical Test Results

mple	Type of		TPH	B	T	E	X[2]	PCB's	Organic
No.	Sample	Location	(ppm)[1]		(ppm)			(ppm)	Lead (ppm)
2-s	Soil	Tank pit @ 11'	< 10	<.1	<.1	<.1	<.1	nt[3]	nt
3-s	Soil	Under east supply line	<10	<.1	<.1	<.1	<.1	nt	nt
4-s	Soil	Under west supply line	<10	<.1	<.1	<.1	<.1	nt	nt
6-s	Soil	Under pump island @4'	<10	<.1	<.1	<.1	<.1	nt	nt
9-s	Soil	Hole A	280 (gas) <10 (diesel)	<.1	.68	3.8	3.5	nt	nt
11-s	Soil	Tank pit @ 6'	60 (gas) 80 (diesel) 280 (other)[5]	.23	.62	.78	.79	nd[4]	<1.0
13-s	Soil	Hole P	<10	<.1	<.1	<.1	<.1	nt	nt
14-s	Soil	Hole Q	<10	<.1	<.1	<.1	<.1	nt	nt
16-s	Soil	Hole O	<10	<.1	<.1	<.1	<.1	nt	nt
17-s	Soil	Hole C	trace diesel <10 gas	<.1	<.1	<.1	<.1	nt	nt
19-s	Soil	Hole D	<10	<.1	<.1	<.1	<.1	nt	nt
20-s	Soil	Hole F	420 (other)	<.1	<.1	<.1	<.1	nt	nt
23-s	Soil	Hole J	<10	<.1	<.1	<.1	<.1	nt	nt
2-w	Water	Pump Island	<10	<.1	<.1	<.1	<.1	nt	nt
3-w	Water	Tank pit	<10	<.1	<.1	<.1	<.1	nt	nt

[1]ppm - parts per million

[2]BTEX - benzene, toluene, ethyl benzene, xylene

[3]nt - not tested

[4]nd - not detected

[5]other - TPH had structure and characteristics of used motor oil

4.0 CONCLUSIONS AND RECOMMENDATIONS

Based upon observations made during the site investigation, historic data for this site and the results of analytical soil and water testing, SEACOR has reached the following conclusions:

- Approximately 600 cubic yards of soil at this site is estimated to be affected by used motor oil;

- The used motor oil at this site originated from an unknown source, but may be the results of operations at the Flying A gasoline station formerly at this site, repair operations performed by the "shade tree" mechanic located east of the Flying A station, and/or dumping of refuse on the site, which took place over a period of approximately 40 years;

- Approximately 100 cubic yards of soil at this site is estimated to be effected by gasoline; and,

- The majority of petroleum-affected soils at this site contain concentrations of petroleum hydrocarbons above draft Ecology cleanup standards.

Based on these conclusions, SEACOR makes the following recommendations:

- Test pits should be excavated during the winter in order to evaluate the condition of groundwater beneath this site.

- If groundwater at the site has been affected by petroleum hydrocarbons, the City of Bothell should take appropriate steps to remediate groundwater contamination.

- Petroleum-affected soils at this site, which contain concentrations of petroleum hydrocarbons above draft Ecology cleanup levels should be remediated.

- The existence of petroleum-affected soils at this site should be promptly reported to Ecology. The normal notification period is 90 days from the date of confirmation of affected soil or water.

- Upon completion of site remediation, a report detailing the cleanup process should be submitted to Ecology.

Standard Limitations

The findings and conclusions documented in this report have been prepared for the specific application to this project and have been developed in a manner consistent with that level of care and skill normally exercised by members of the environmental science profession currently practicing under similar conditions in the area. No warranty, expressed or implied, is made. This report is for the exclusive use of the City of Bothell and their representatives.

A potential always remains for the presence of unknown, unidentified, or unforeseen subsurface contamination. Further evidence against such potential site contamination would require additional subsurface exploration and testing.

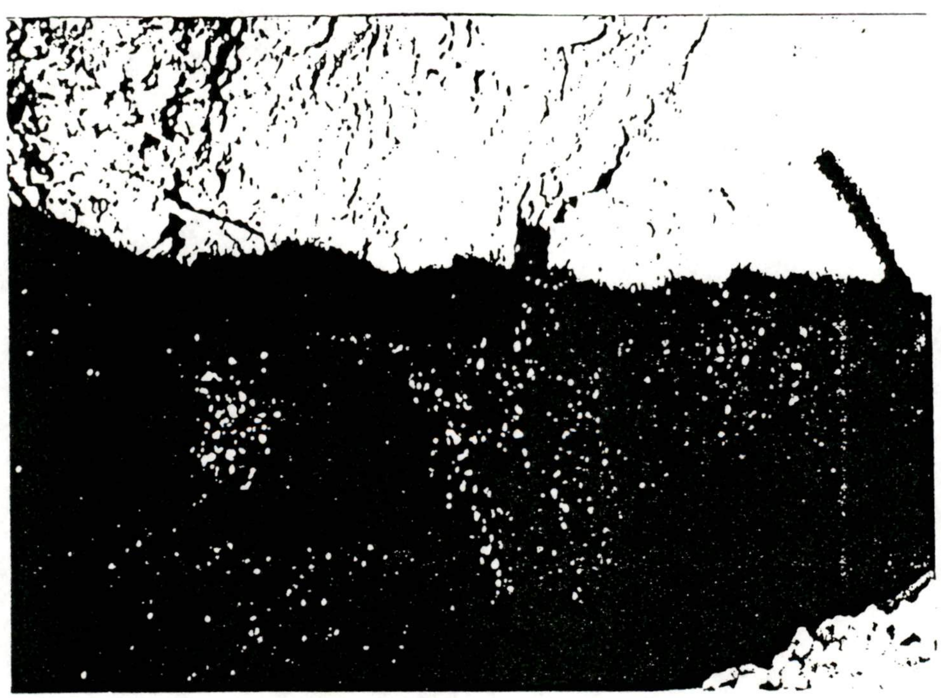
If new information is developed in future site work (which may include excavations, borings, or other studies), SEACOR should be requested to re-evaluate the conclusions of this report, and to provide amendments as required.

APPENDIX A

Photographs

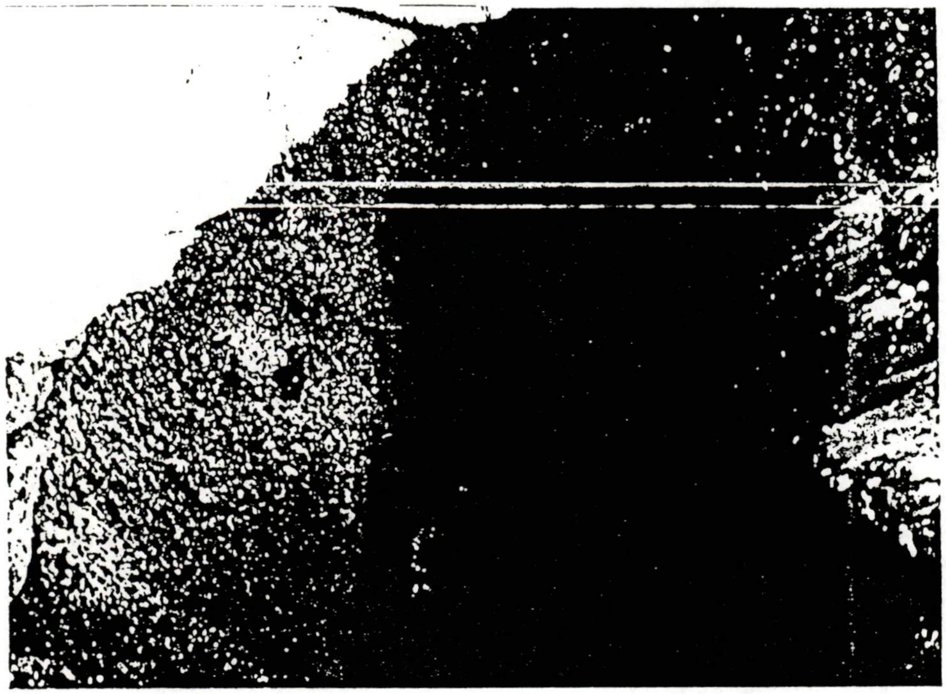
PHOTOGRAPH #1

Excavation at suspected former underground tank location

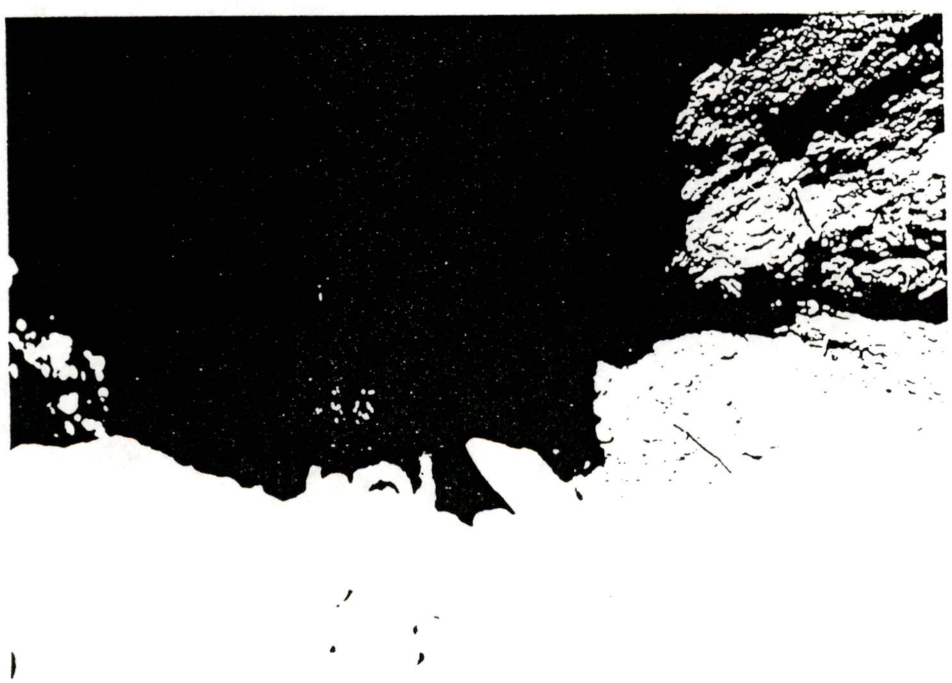


PHOTOGRAPH #2

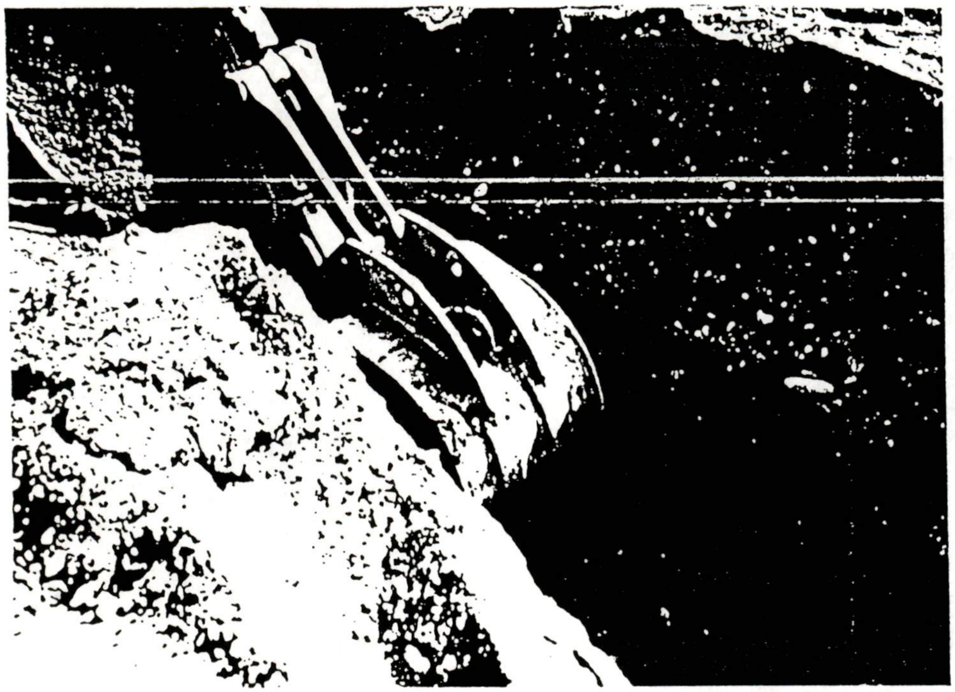
Perched groundwater seeping into the tank pit excavation at the 6-foot depth, just above the peat layer.



PHOTOGRAPH #3
East wall of the tank pit excavation showing the soil horizons present at this site. The dark brown material is peat, which is underlain by fine-texture, gray silt or silty clay.

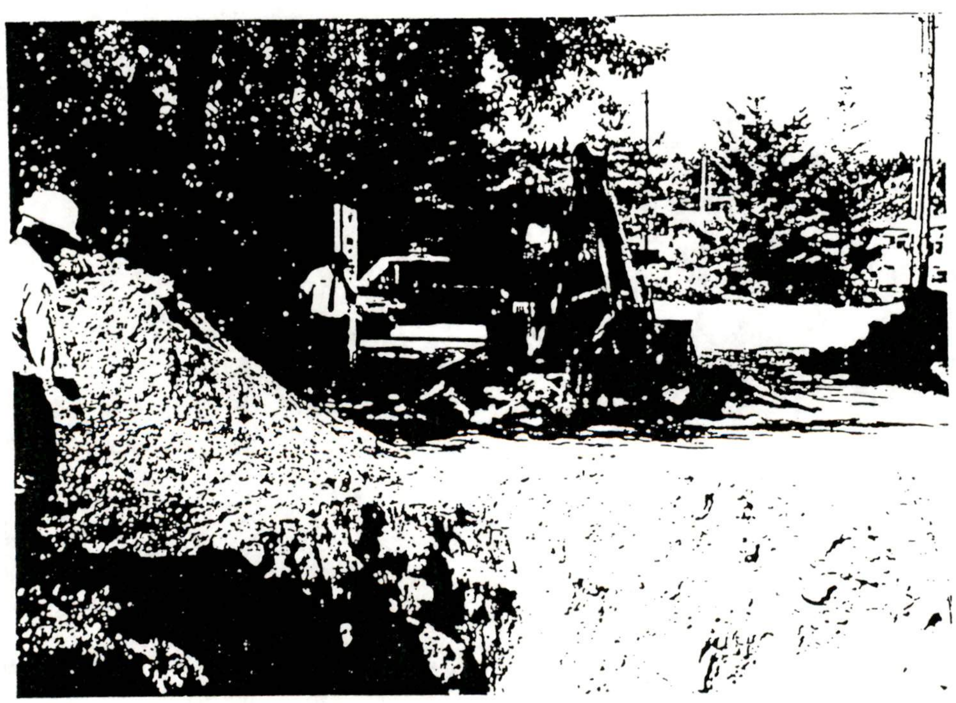


PHOTOGRAPH #4
Perched groundwater ponding in the bottom of the tank pit excavation



PHOTOGRAPH #5

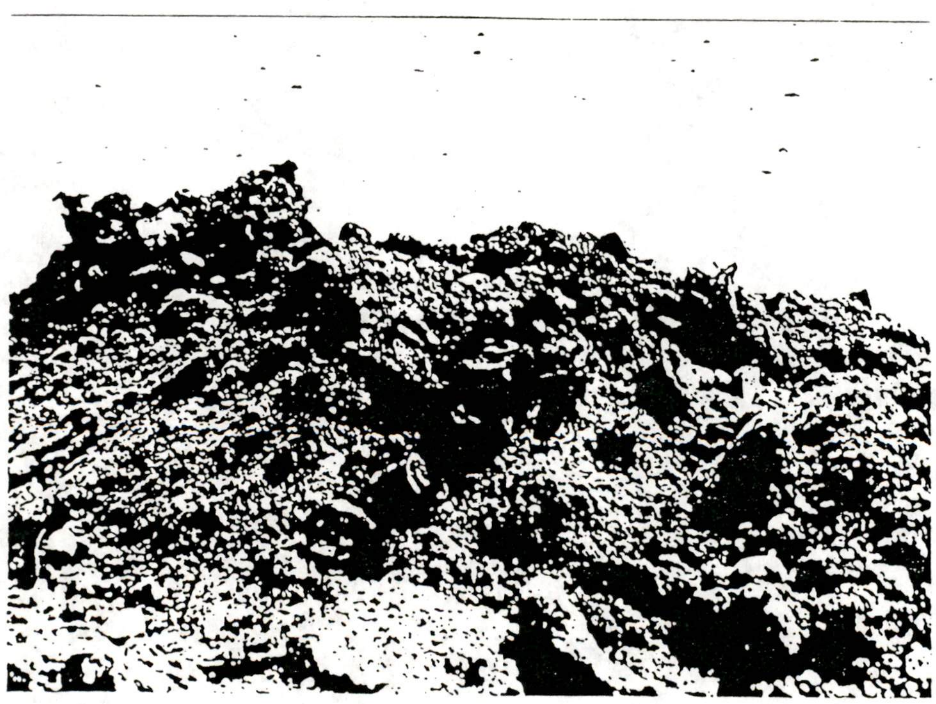
Excavation of the old supply pipelines betwenn the suspected former tank location and the suspected former pump island location for the Flying "A" gasoline station.



PHOTOGRAPH #6

Excavation of test pit A. The tank pit excavation is in the foreground, and material excavated from the pump island test pit is seen at the left side of the photograph

PHOTOGRAPH #7
Debris excavated from test pit D, including small storage drum with a sticky black coating on the interior, wood, and straw.



PHOTOGRAPH #8
Debris excavated from test pit K. This debris in this test pit included old oil cans, some with the Flying "A" logo, broken glass bottles, and a dark gummy substance with an oily sheen.

APPENDIX B

Analytical Results and Chain-of-Custody Records

NATIONAL CHEM LAB
103 12th. Ave. SW
Ephrata, WA 98823
Phone (509) 754-5725 FAX (509) 754-4239

SEACOR	Client Project ID: 30-002-01	Sampled: Aug 16, 90
330 112th Ave. NE #104	Matrix Descript: Soil/Water	Received: Aug 18, 90
Bellevue, WA 98004	Analysis Method: EPA 8015/8020	Analyzed: 21-26, 90
Attn. Carol Hutley	First Sample: 2-S	Reported: Sep 14, 90

TOTAL PETROLEUM HYDROCARBONS with BTEX DISTINCTION (EPA 8015/8020)

Sample Number	Sample Descrip.	Low/Med. B.P. Hydrocarbons mg/Kg	Benzene mg/Kg	Toluene mg/Kg	Ethyl Benzene mg/Kg	Xylenes mg/Kg	Date/ Time Analyzed
2-S	Tank Pit bottom @ 11'	<10	<0.1	<0.1	<0.1	<0.1	8/24/90 05:26
3-S	Under East Supply Line	<10	<0.1	<0.1	<0.1	<0.1	8/24/90 06:03
4-S	Under West Supply Line	<10	<0.1	<0.1	<0.1	<0.1	8/24/90 07:20
6-S	Under Pump Is @ 4' (> peat)	<10	<0.1	<0.1	<0.1	<0.1	8/24/90 08:01
9-S	Hole A @ 6'	Gasoline 280 Diesel/Kerosene <10	<0.1	0.68	3.8	3.5	8/27/90 06:19
11-S	Tank Pit @ 6'3 > peat layer	Gasoline 60 Diesel 80 Kerosene <10 Organic Lead <1.0 mg/Kg Other TPH 260 mg/Kg	0.23	0.62	0.73	0.79	8/26/90 21:55
13-S	Hole P @ 6'	<10	<0.1	<0.1	<0.1	<0.1	8/26/90 08:29
14-S	Hole Q @ 6'	<10	<0.1	<0.1	<0.1	<0.1	8/24/90 12:02
16-S	Hole O @ 6'	<10	<0.1	<0.1	<0.1	<0.1	8/24/90 22:59

17-S Hole C side wall @ 6'	Diesel trace Gasoline/Kerosene <10	<0.1	<0.1	<0.1	<0.1	8/21/90 23:40
19-S Hole D @ 6'	<10	<0.1	<0.1	<0.1	<01.	8/24/90 04:49
20-S Hole F @ 6' (near Creek)	<10 Other TPH 420 mg/Kg	<0.1	<0.1	<0.1	<0.1	8/24/90 19:02
23-S Hole J @ 6'	<10	<0.1	<0.1	<0.1	<0.1	8/24/90 19:02
2-W Pump Island pit bottom	<10	<0.1	<0.1	<0.1	<0.1	8/26/90 21:02
3-W Tank Pit Bottom	<10	<0.1	<0.1	<0.1	<0.1	8/26/90 23:40
Detection Limits:	10	0.1	0.1	0.1	0.1	

Analyst:

Kurt Larsen

Please Note: Trace = BTEX 0.05 - 0.1 mg/Kg
TPH 1.0 - 10 mg/Kg

NATIONAL CHEM LAB PCB TEST REPORT 09/17/90

565
SEACOR
330 112TH AVE. NE #104
BELLEVUE, WA 98004
Attn: JIM FLYNN

NATIONAL CHEM LAB
103 12TH S.W.
EPHRATA, WA 98823
GLENDA NELSON, Chemist

Lab Report #: E0091716

Below is a listing of the samples received on 09/17/90 together with the laboratory results on their respective PCB content. Please contact the lab at 509-754-5725 if you have any questions regarding these sample results.

UTILITY SERIAL NO.	COMPANY #	MISC.	AROCLOR	PPM	NCL #
	20-S			ND	OE0092300

Kurt [signature]

Lab Report #:E0091716 Page 1 Number of samples: 1

SEACOR

CHAIN-OF-CUSTODY RECORD

SEACOR 330 112th Ave. NE, #104 Bellevue, WA 98004	PHONE: (206) 646-0280	PROJECT MANAGER: Del Christenson	PROJECT NUMBER/NAME: 30-002-01
SAMPLER: (Sign and print name) Carol Hutley *Carol Hutley*	LABORATORY: National Chemlab	LABORATORY ID NUMBER:	

SAMPLE ID NUMBER	DATE	TIME	SAMPLE TYPE	STATION/LOCATION	ANALYSIS REQUESTED/REMARKS
2-S	8/16/90	10:00	grab	Tank Pit Bottom @ 11½	Diesel, oil, gas distinction & BTEX
3-S		10:30		Under east Supply line	↓
4-S		10:35		Under west Supply line	↓
6-S				Under pump island @ 4' (above peat)	↓
~~8X8~~ 9-S		1:00		Hole A @ 6'	↓
13-S		3:30		Hole P @ 6'	↓
14-S		4:00		Hole O @ 6'	↓

RELINQUISHED BY: (Signature)	DATE/TIME	RECIEVED BY: (Signature)	RELINQUISHED BY: (Signature)	DATE/TIME	RECIEVED BY: Signature
Del Christenson	DATE: 8/18 TIME: 14:10	*[signature]*		DATE: TIME:	
RELINQUISHED BY: (Signature)	DATE: TIME:	RECIEVED BY: (Signature)	RELINQUISHED BY: (Signature)	DATE: TIME:	RECIEVED BY: Signature
RELINQUISHED BY: (Signature)	DATE: TIME:	RECIEVED FOR LABORATORY BY: (Signature)			REMARKS:

SEACOR

CHAIN-OF-CUSTODY RECORD

SEACOR 330 112th Ave. NE, #104 Bellevue, WA 98004	PHONE: (206) 646-0280	PROJECT MANAGER: Del Christenson	PROJECT NUMBER/NAME: 30-002-01
SAMPLER: (Sign and print name) Carol Hutley Carol Hutley	LABORATORY: National Chemlab		LABORATORY ID NUMBER:

SAMPLE ID NUMBER	DATE	TIME	SAMPLE TYPE	STATION/LOCATION	ANALYSIS REQUESTED/REMARKS
16-S	8/16/90	3:00 ~~xxxx~~	grab	Hole O @ 6'	Diesel, oil, gasoline distinction & BTEX
17-S		1:30		Hole C sidewall @ 6'	↓
19-S		1:35		Hole D @ 6'	↓
20-S		1:45		Hole F @ 6' (near creek)	↓
23-S		2:30		Hole J @ 6'	↓
11-S		11:00	grab	Tank Pit @ 6' above peat layer	Fuel fingerprint & organic lead
~~XXX~~ 2-W		11:10	grab	Pump island pit bottom	Diesel, oil, gasoline distinction $ BTEX

RELINQUISHED BY: (Signature)	DATE: / TIME:	RECIEVED BY: (Signature)	RELINQUISHED BY: (Signature)	DATE: / TIME:	RECIEVED BY: Signature
Del Christenson	DATE: 8/18 TIME: 14:10	[signature]		DATE: TIME:	
RELINQUISHED BY: (Signature)	DATE: TIME:	RECIEVED BY: (Signature)	RELINQUISHED BY: (Signature)	DATE: TIME:	RECIEVED BY: Signature
RELINQUISHED BY: (Signature)	DATE: TIME:	RECIEVED FOR LABORATORY BY: (Signature)			REMARKS:

SEACOR

CHAIN-OF-CUSTODY RECORD

SEACOR 330 112th Ave. NE, #104 Bellevue, WA 98004	PHONE: (206) 646-0280	PROJECT MANAGER: Del Christenson	PROJECT NUMBER/NAME: 30-002-01
SAMPLER: (Sign and print name) X Carol Hutley [signature]	LABORATORY: National Chemlab	LABORATORY ID NUMBER:	

SAMPLE ID NUMBER	DATE	TIME	SAMPLE TYPE	STATION/LOCATION	ANALYSIS REQUESTED/REMARKS
3-W	~~8XIX~~ 8/16/90	1:20	grab	Tank pit bottom	Diesel, oil, gasoline distinction & BTEX
					↓

RELINQUISHED BY: (Signature) [signature: Del Christenson]	DATE: 8/18 TIME: 14:10	RECIEVED BY: (Signature) [signature]	RELINQUISHED BY: (Signature)	DATE: TIME:	RECIEVED BY: Signature
RELINQUISHED BY: (Signature)	DATE: TIME:	RECIEVED BY: (Signature)	RELINQUISHED BY: (Signature)	DATE: TIME:	RECIEVED BY: Signature
RELINQUISHED BY: (Signature)	DATE: TIME:	RECIEVED FOR LABORATORY BY: (Signature)			REMARKS:

SEACOR

CHAIN-OF-CUSTODY RECORD

SEACOR 330 112th Ave. NE, #104 Bellevue, WA 98004	PHONE: (206) 646-0280	PROJECT MANAGER: Del Christenson	PROJECT NUMBER/NAME: 30-002-01
SAMPLER: (Sign and print name) Carol Hurley Carol Hurtley	LABORATORY: National Chemlab	LABORATORY ID NUMBER:	

SAMPLE ID NUMBER	DATE	TIME	SAMPLE TYPE	STATION/LOCATION	ANALYSIS REQUESTED/REMARKS
1-S	8/16/90		grab	Tankpit ± 6' (above peat)	Hold for possible future analysis
5-S	↓		grab	Tank pit (peat layer)	↓
7-S	↓		grab	Pump Island (Till)	↓
8-S	↓		Grab	Pump Island (peat)	↓
10-S	↓		grab	Creek pit	↓
~~11-S~~	↓				↓
12-S	↓		grab	Hole B 6-7'	↓

RELINQUISHED BY: (Signature)	DATE / TIME	RECIEVED BY: (Signature)	RELINQUISHED BY: (Signature)	DATE / TIME	RECIEVED BY: Signature
C Hurtley	DATE: 8-20-90 TIME: 3:00			DATE: TIME:	
RELINQUISHED BY: (Signature)	DATE: TIME:	RECIEVED BY: (Signature)	RELINQUISHED BY: (Signature)	DATE: TIME:	RECIEVED BY: Signature
RELINQUISHED BY: (Signature)	DATE: TIME:	RECIEVED FOR LABORATORY BY: (Signature)			REMARKS:

SEACOR

CHAIN-OF-CUSTODY RECORD

SEACOR 330 112th Ave. NE, #104 Bellevue, WA 98004	PHONE: (206) 646-0280	PROJECT MANAGER: Del Christenson	PROJECT NUMBER/NAME: 30-002-01
SAMPLER: (Sign and print name) Carol Hutley Carol Hutley	LABORATORY: National Chemlab	LABORATORY ID NUMBER:	

SAMPLE ID NUMBER	DATE	TIME	SAMPLE TYPE	STATION/LOCATION	ANALYSIS REQUESTED/REMARKS
15-S	8/16/90		grab	Hole R	Hold for possible future analysis
18-S	↓		grab	Hole G bottom	↓
21-S			grab	Hole G	
22-S			grab	Hole I	
1-W	↓		grab	Pump Island sidewall	↓
24-S	↓		grab	Hole A peat	↓

RELINQUISHED BY: (Signature)	DATE: / TIME:	RECIEVED BY: (Signature)	RELINQUISHED BY: (Signature)	DATE: / TIME:	RECIEVED BY: Signature
C Hutley	DATE: 8-20-90 TIME: 2:00			DATE: TIME:	
RELINQUISHED BY: (Signature)	DATE: TIME:	RECIEVED BY: (Signature)	RELINQUISHED BY: (Signature)	DATE: TIME:	RECIEVED BY: Signature
RELINQUISHED BY: (Signature)	DATE: TIME:	RECIEVED FOR LABORATORY BY: (Signature)			REMARKS:

SEACOR CHAIN-OF-CUSTODY RECORD

SEACOR 330 112th Ave. NE, #104 Bellevue, WA 98004	PHONE: (206) 646-0280	PROJECT MANAGER: Del Christenson	PROJECT NUMBER/NAME: 30-002-01
SAMPLER: (Sign and print name) Carol Hutley *Carol Hutley*	LABORATORY: National Chemlab	LABORATORY ID NUMBER:	

SAMPLE ID NUMBER	DATE	TIME	SAMPLE TYPE	STATION/LOCATION	ANALYSIS REQUESTED/REMARKS
2-S	8/16/90	10:00	grab	Tank Pit Bottom @ 11'	Diesel, oil, gas distinction & BTEX
3-S		10:30		Under east Supply line	↓
4-S		10:35		Under west Supply line	↓
6-S				Under pump island @ 4' (above peat)	↓
~~8X8~~ 9-S		1:00		Hole A @ 6'	↓
13-S		3:30		Hole P @ 6'	↓
14-S		4:00		Hole Q @ 6'	↓

RELINQUISHED BY: (Signature)	DATE/TIME	RECIEVED BY: (Signature)	RELINQUISHED BY: (Signature)	DATE/TIME	RECIEVED BY: Signature
Del Christenson	DATE: 8/18 TIME: 14:10	*[signature]*		DATE: TIME:	
RELINQUISHED BY: (Signature)	DATE: TIME:	RECIEVED BY: (Signature)	RELINQUISHED BY: (Signature)	DATE: TIME:	RECIEVED BY: Signature
RELINQUISHED BY: (Signature)	DATE: TIME:	RECIEVED FOR LABORATORY BY: (Signature)			REMARKS:

SEACOR

CHAIN-OF-CUSTODY RECORD

SEACOR 330 112th Ave. NE, #104 Bellevue, WA 98004	PHONE: (206) 646-0280	PROJECT MANAGER: Del Christenson	PROJECT NUMBER/NAME: 30-002-01
SAMPLER: (Sign and print name) Carol Hutley *Carol Hutley*	LABORATORY: National Chemlab	LABORATORY ID NUMBER:	

SAMPLE ID NUMBER	DATE	TIME	SAMPLE TYPE	STATION/LOCATION	ANALYSIS REQUESTED/REMARKS
16-S	8/16/90	3:00 ~~xxxx~~	grab	Hole O @ 6'	Diesel, oil, gasoline distinction & BTEX
17-S		1:30		Hole C sidewall @ 6'	↓
19-S		1:35		Hole D @ 6'	↓
20-S		1:45		Hole F @ 6' (near creek)	↓
23-S		2:30		Hole J @ 6'	↓
11-S		11:00	grab	Tank Pit @ 6' above peat layer	Fuel fingerprint & organic lead
~~XXX~~ 2-W		11:10	grab	Pump island pit bottom	Diesel, oil, gasoline distinction $ BTEX H_2O

RELINQUISHED BY: (Signature)	DATE/TIME	RECIEVED BY: (Signature)	RELINQUISHED BY: (Signature)	DATE/TIME	RECIEVED BY: Signature
Del Christenson	DATE: 8/18 TIME: 4:10	*[signature]*		DATE: TIME:	
RELINQUISHED BY: (Signature)	DATE: TIME:	RECIEVED BY: (Signature)	RELINQUISHED BY: (Signature)	DATE: TIME:	RECIEVED BY: Signature
RELINQUISHED BY: (Signature)	DATE: TIME:	RECIEVED FOR LABORATORY BY: (Signature)			REMARKS:

SEACOR

CHAIN-OF-CUSTODY RECORD

SEACOR 330 112th Ave. NE, #104 Bellevue, WA 98004	PHONE: (206) 646-0280	PROJECT MANAGER: Del Christenson	PROJECT NUMBER/NAME: 30-002-01
SAMPLER: (Sign and print name) X Carol Hutley Carol Hutley	LABORATORY: National Chemlab		LABORATORY ID NUMBER:

SAMPLE ID NUMBER	DATE	TIME	SAMPLE TYPE	STATION/LOCATION	ANALYSIS REQUESTED/REMARKS
3-W	XXXX 8/16/90	1:20	grab	Tank pit bottom	Diesel, oil, gasoline distinction & BTEX H_2O

RELINQUISHED BY: (Signature) Del Christenson	DATE: 8/16 TIME: 14:10	RECIEVED BY: (Signature) [signature]	RELINQUISHED BY: (Signature)	DATE: TIME:	RECIEVED BY: Signature
RELINQUISHED BY: (Signature)	DATE: TIME:	RECIEVED BY: (Signature)	RELINQUISHED BY: (Signature)	DATE: TIME:	RECIEVED BY: Signature
RELINQUISHED BY: (Signature)	DATE: TIME:	RECIEVED FOR LABORATORY BY: (Signature)			REMARKS:

B

GROUNDWATER
TECHNOLOGY

APPENDIX B

PRELIMINARY GROUNDWATER INVESTIGATION
SEACOR FEBRUARY 22, 1991

SEACOR

RECEIVED
FEB 25 1991
BOTHELL FIRE DEPT.

February 22, 1991

Captain Denny Wright, F.M.
Bothell Fire Department
10726 Beardsley Boulevard
Bothell, Washington 98011

PRELIMINARY GROUNDWATER INVESTIGATION, RIVERSIDE PROPERTY, BOTHELL, WASHINGTON (SEACOR PROJECT NO. 00030-003-01)

Dear Captain Wright:

SEACOR is pleased to submit the following report which describes a preliminary groundwater investigation performed at the Riverside property in Bothell, Washington. This report has been prepared in accordance with our proposal to you dated December 31, 1990 and revised January 23, 1991.

BACKGROUND

During the site investigation conducted by SEACOR on August 16, 1990, petroleum-affected soil was encountered in the area of the former gasoline station site and in test pit "F" near the western boundary of the property (Figure 1). It is estimated that approximately 600 cubic yards of soil is affected by used motor oil and approximately 100 cubic yards of soil is affected by gasoline. Although some pits were excavated to a depth of twelve feet, no groundwater was encountered. This result may have been due to the fact that the investigation took place in August and followed a 30-day period of little or no rainfall. Based on the observations made during this investigation SEACOR recommended that a groundwater investigation be conducted during the winter. This report presents the results of the recommended groundwater investigation.

FIELD INVESTIGATION

On January 30, 1991 a preliminary groundwater investigation was performed at the Riverside property owned by the City of Bothell. The investigation included excavating four test pits for the purpose of examining and sampling groundwater beneath the subject property. The excavation of each test pit was accomplished using a backhoe and operator supplied by the City of Bothell. The excavation supervision and groundwater sampling was performed by a SEACOR geologist, registered in the State of Washington to do environmental assessments.

330 112th Northeast
#104
Bellevue, WA 98004
206.646.0280

Test pits 1 and 2 (TP-1 and TP-2) were excavated along the western property boundary, between the former gasoline station site and Horse Creek. Test pit 3 (TP-3) was excavated between the former gasoline station site and the Sammamish River to the south. Test pit 4 (TP-4) was excavated approximately thirty feet south of the former gasoline station site. TP-4 was excavated in order to evaluate groundwater conditions near the area of confirmed soil contamination. Descriptions of the materials encountered in each test pit are included in Appendix A.

The soil encountered in TP-1 and TP-2 consisted of interbedded silty sand, sand, and gravelly sand down to a depth of approximately eight feet. At a depth of eight feet, a layer of peat was encountered. A moderate amount of debris was encountered at the surface of TP-2. The soil in TP-3 consisted of a gravelly sand from the surface to a depth of three feet and a silty, slightly organic, clay was encountered from depths between three and ten feet. The soil encountered in TP-1 through TP-3 showed no characteristics of being petroleum-affected. The soil encountered in TP-4 was a dark gray gravelly sand with abundant brick and debris and had a distinct petroleum odor and texture. Soil samples were collected from each test pit but were not analyzed.

GROUNDWATER SAMPLING

The depth to perched water and flow rate varied in each test pit. In TP-1, water was slowly seeping in from the sidewall at approximately eight feet. In TP-2, a moderate flow of water was entering from the sidewall at approximately seven feet. Groundwater was not encountered in TP-3. In TP-4, a rapid flow of water from five feet quickly filled the bottom of the test pit. The water in TP-4 had black and dark brown petroleum product on the surface. The groundwater which was encountered in TP-1, TP-2 and TP-4 was likely due to local pearched water and not the regional water table.

After sufficient water had entered the test pits, disposable bailers were lowered into the water to collect samples. The samples were then transferred into VOA vials, labeled and stored on ice in a cooler pending delivery under chain-of-custody to North Creek Analytical in Bothell, Washington.

GROUNDWATER ANALYSIS

The water samples collected during this investigation were submitted to North Creek Analytical to determine the concentrations of total petroleum hydrocarbons (TPH) as gasoline and diesel using EPA method 8015, modified, and TPH as oil and grease using EPA method 418.1. Analysis for benzene, toluene, ethyl benzene and xylenes (BTEX) using EPA method 8020 was also performed on each water sample. Analytical results are compiled in Table 1. Laboratory reports and chain-of-custody records are contained in Appendix B.

In TP-1 and TP-2 the concentrations of TPH, as diesel and gasoline, and BTEX were all below laboratory detection limits. However, the concentrations of TPH as heavier oils were 10 parts per million (ppm) in TP-1 and 5.7 ppm in TP-2. These concentrations exceed the Department of Ecology's (Ecology) draft cleanup level of 1 ppm for TPH in groundwater. Proposed cleanup standards are presented in Table 2. The concentrations of petroleum hydrocarbons in the water sample from TP-4 exceeded the proposed cleanup standards for all compounds tested.

CONCLUSIONS AND RECOMMENDATIONS

Based on observations and analytical results, SEACOR makes the following conclusions:

- The perched groundwater at TP-4 in the area of the former gasoline station is affected with high concentrations of petroleum related compounds.

  The groundwater encountered in TP-1 and TP-2, along the western property boundary contains concentrations of petroleum oil which exceed draft Ecology cleanup standards.

- It is not possible to determine if the contaminates in TP-1 and TP-2 are the direct result of groundwater migrating from the former gasoline station site to the western property boundary or indicative of background concentrations in the groundwater beneath the site.

- The regional water table beneath the site was not encountered.

Based on these conclusions, SEACOR makes the following recommendations:

- The previously assessed petroleum-affected soils at this site should be remediated;

- Three groundwater monitoring wells should be installed at the site in order to further evaluate the extent of petroleum-hydrocarbon in groundwater and direction of groundwater movement beneath the site;

- Appropriate steps should be taken to monitor and/or remediate groundwater contamination beneath the site; and,

- Upon completion of site remediation, a report detailing the cleanup process should be submitted to Ecology.

STANDARD LIMITATIONS

The findings and conclusions documented in this report have been prepared for the specific application to this project and have been developed in a manner consistent with that level of care and skill normally exercised by members of the environmental science profession currently practicing under similar conditions in the area. No warranty, expressed or implied, is made. This report is for the exclusive use of the City of Bothell and their representatives.

A potential always remains for the presence of unknown, unidentified, or unforseen subsurface contamination. Further evidence against such potential site contamination would require additional subsurface exploration and testing.

If new information is developed in future site work (which may include excavations, borings, or other studies), SEACOR should be requested to re-evaluate the conclusions of this report, and to provide amendments as required.

Sincerely yours,

Del Christenson

Del Christenson
Principal Scientist

Del Christenson FOR:

John Gieber
Geologist

JG/mkl

TABLE 1
ANALYTICAL RESULTS (PPM)
WATER SAMPLING SUMMARY

Sample ID	TPH (As Oil)	TPH (As Diesel)	TPH (As Gas)	Benzene	Toluene	Ethyl Benzene	Xylenes
TP-1-H2O	10	<5.0	<0.09	<0.0009	<0.0009	<0.0009	<0.0009
TP-2-H2O	5.7	<5.0	<0.09	<0.0009	<0.0009	<0.0009	<0.0009
TP-4-H2O	4,700	2,100	3,800	36	42	28	22
MTCA Cleanup Level	1.0	1.0	1.0	0.005	0.040	0.020	0.020

NOTE:

Cleanup levels as listed in Model Toxics Control Act Cleanup Regulations and Proposed Amendments dated July 2, 1990 (Chapter 173-230)

APPENDIX A

TEST PIT BORING LOGS

TEST PIT BORING LOGS

Boring TP-1

Sample I.D.	Depth (Feet)	USCS Symbol	Description
	0-2.0	OL	Brown sandy silt, slightly moist, organic.
	1.3-3.0	SP	Light brown sand with local large cobbles, slightly moist.
	3.0-4.0	SM	Gray silty sand, moist, native.
	4.0-7.0	SW	Light brown gravelly sand, moist.
	7.0-8.0	OL	Gray clayey silt with organic seams, wet, odiferous.
TP-1-H_20	8.0		Pearched water seep.
	8.0-9.0	PT	Dark brown peat, wet, organic.

Boring TP-2

Sample I.D.	Depth (Feet)	USCS Symbol	Description
	0-1.0	SM	Light brown gray silty sand, dry, compact.
	1.0-3.0	SP	Light Brown sand with moderate asphalt and brick debris.
	3.0-6.0	SP	Light brown gravelly sand, slightly moist.
	6.0		Small Water Seep.
	6.0-7.0	SP	Light brown gravelly sand, dry, compact.
TP-2-H_20	7.0		Pearched water.
	7.0-8.0	SM	Gray silty sand, moist.
	8.0-9.0	PT	Dark brown peat, moist, organic.

TP = Test Pit
USCS = United Soil Classification System

TEST PIT BORING LOGS (CONT.)

Boring TP-3

Sample I.D.	Depth (Feet)	USCS Symbol	Description
	0-3.0	SP	Light brown and gray gravelly sand, dry.
	3.0-10.0	OL	Gray silty clay, slightly moist, some organics, odiferous.

Boring TP-4

Sample I.D.	Depth (Feet)	USCS Symbol	Description
	0-5.0	SP	Dark gray gravelly sand with abundant brick and debris, moist, petroleum odor and oily texture.
TP-4-H_20	5.0		Groundwater with black and brown floating product.

TP = Test Pit
USCS = United Soil Classification System

APPENDIX B

LABORATORY REPORTS

AND

CHAIN-OF-CUSTODY RECORDS

NORTH
CREEK
ANALYTICAL

18939 120th Avenue N.E., Suite 101 • Bothell, WA 98011-2569
Phone (206) 481-9200 • FAX (206) 485-2992

SEACOR	Client Project ID:	City of Bothell		Sampled:	Jan 30, 1991
330 112th Avenue N.E., #104	Matrix Descript:	Water		Received:	Jan 30, 1991
Bellevue, WA 98004	Analysis Method:	EPA 418.1 (I.R. with clean-up)		Extracted:	Feb 12, 1991
Attention: Del Christenson	First Sample #:	101-0677		Analyzed:	Feb 12, 1991
				Reported:	Feb 13, 1991

TOTAL RECOVERABLE PETROLEUM HYDROCARBONS

Sample Number	Sample Description	Petroleum Oil mg/L (ppm)
101-0677	TP-1-H20	10
101-0678	TP-2-H20	5.7
101-0679	TP-4-H20	4,700

Detection Limits:	5.0

Analytes reported as N.D. were not present above the stated limit of detection. Because matrix effects and/or other factors required additional sample dilution, detection limits for this sample have been raised.

NORTH CREEK ANALYTICAL

Scot Cocanour
Laboratory Director

NORTH CREEK ANALYTICAL

18939 120th Avenue N.E., Suite 101 • Bothell, WA 98011-2569
Phone (206) 481-9200 • FAX (206) 485-2992

SEACOR	Client Project ID:	City of Bothell		Sampled:	Jan 30, 1991
330 112th Avenue N.E., #104	Matrix Descript:	Liquid		Received:	Jan 30, 1991
Bellevue, WA 98004	Analysis Method:	EPA 5030/8015/8020		Analyzed:	Feb 11, 1991
Attention: Del Christenson	First Sample #:	101-0677		Reported:	Feb 13, 1991

TOTAL PETROLEUM FUEL HYDROCARBONS with BTEX DISTINCTION (EPA 8015/8020)

Sample Number	Sample Description	Purgeable Hydrocarbons µg/L (ppb)	Benzene µg/L (ppb)	Toluene µg/L (ppb)	Ethyl Benzene µg/L (ppb)	Xylenes µg/L (ppb)
101-0677	TP-1-H20	N.D.	N.D.	N.D.	N.D.	N.D.
101-0678	TP-2-H20	N.D.	N.D.	N.D.	N.D.	N.D.

Detection Limits:		90	0.90	0.90	0.90	0.90

Purgeable (low to medium boiling point) Hydrocarbons are quantitated against a gasoline standard.
Analytes reported as N.D. were not present above the stated limit of detection. Because matrix effects and/or other factors required additional sample dilution, detection limits for this sample have been raised.

ORTH CREEK ANALYTICAL

Scot Cocanour
Laboratory Director

NORTH
CREEK
ANALYTICAL

18939 120th Avenue N.E., Suite 101 • Bothell, WA 98011-2569
Phone (206) 481-9200 • FAX (206) 485-2992

SEACOR	Client Project ID:	City of Bothell		Sampled:	Jan 30, 1991
330 112th Avenue N.E., #104	Matrix Descript:	Liquid		Received:	Jan 30, 1991
Bellevue, WA 98004	Analysis Method:	EPA 3510/8015		Extracted:	Feb 12, 1991
Attention: Del Christenson	First Sample #:	101-0677		Analyzed:	Feb 13, 1991
				Reported:	Feb 13, 1991

TOTAL PETROLEUM FUEL HYDROCARBONS (EPA 8015)

Sample Number	Sample Description	Extractable Hydrocarbons mg/L (ppm)
101-0677	TP-1-H20	N.D.
101-0678	TP-2-H20	N.D.

Detection Limits:	5.0

Extractable (high boiling point) Hydrocarbons are quantitated against a diesel fuel standard.
Analytes reported as N.D. were not present above the stated limit of detection.

ORTH CREEK ANALYTICAL

Scot Cocanour
Laboratory Director

NORTH CREEK ANALYTICAL

18939 120th Avenue N.E., Suite 101 • Bothell, WA 98011-2569
Phone (206) 481-9200 • FAX (206) 485-2992

SEACOR	Client Project ID:	City of Bothell	Sampled:	Jan 30, 1991
330 112th Avenue N.E., #104	Sample Descript.:	Liquid, TP-4-H20	Received:	Jan 30, 1991
Bellevue, WA 98004	Analysis Method:	EPA 5030/8015/8020	Analyzed:	Feb 11, 1991
Attention: Del Christenson	Lab Number:	101-0679	Reported:	Feb 13, 1991

TOTAL PETROLEUM FUEL HYDROCARBONS WITH BTEX DISTINCTION (EPA 8015/8020)

Analyte	Detection Limit mg/kg (ppm)	Sample Results mg/kg (ppm)
Purgeable Hydrocarbons	30	3,800
Benzene	0.30	36
Toluene	0.30	42
Ethyl Benzene	0.30	28
Xylenes	0.30	22

Purgeable (low to medium boiling point) Hydrocarbons are quantitated against a gasoline standard.
Analytes reported as N.D. were not present above the stated limit of detection.

NORTH CREEK ANALYTICAL

Scot Cocanour
Laboratory Director

NORTH CREEK ANALYTICAL

18939 120th Avenue N.E., Suite 101 • Bothell, WA 98011-2569
Phone (206) 481-9200 • FAX (206) 485-2992

SEACOR	Client Project ID:	City of Bothell		Sampled:	Jan 30, 1991
330 112th Avenue N.E., #104	Matrix Descript:	Liquid		Received:	Jan 30, 1991
Bellevue, WA 98004	Analysis Method:	EPA 3550/8015		Extracted:	Feb 12, 1991
Attention: Del Christenson	First Sample #:	101-0679		Analyzed:	Feb 13, 1991
				Reported:	Feb 13, 1991

TOTAL PETROLEUM FUEL HYDROCARBONS (EPA 8015)

Sample Number	Sample Description	Extractable Hydrocarbons mg/kg (ppm)
101-0679	TP-4-H20	2,100

Detection Limits:	5.0

Extractable (high boiling point) Hydrocarbons are quantitated against a diesel fuel standard.
Analytes reported as N.D. were not present above the stated limit of detection. Because matrix effects and/or other factors required additional sample dilution, detection limits for this sample have been raised.

NORTH CREEK ANALYTICAL

Scot Cocanour
Laboratory Director

NORTH
CREEK
ANALYTICAL

18939 120th Avenue N.E., Suite 101 • Bothell, WA 98011-2569
Phone (206) 481-9200 • FAX (206) 485-2992

SEACOR
330 112th Avenue N.E., #104
Bellevue, WA 98004
Attention: Del Christenson

Client Project ID: City of Bothell
Sample Matrix: Water
QC Sample Group: 101-0677 to -0679

Reported: Feb 13, 1991

QUALITY CONTROL DATA REPORT

ANALYTE	Benzene	Toluene	Ethyl Benzene	Xylenes	Petroleum Oil
EPA Method:	8020	8020	8020	8020	418.1
Analyst:	B. Fletcher	B. Fletcher	B. Fletcher	B. Fletcher	K. Stark
Reporting Units:	µg/L	µg/L	µg/L	µg/L	mg/L
Date Analyzed:	Feb 10, 1991	Feb 10, 1991	Feb 10, 1991	Feb 10, 1991	Feb 12, 1991
QC Sample #:	101-0663	101-0663	101-0663	101-0663	BLK021291
Sample Conc.:	N.D.	N.D.	N.D.	N.D.	N.D.
Spike Conc. Added:	2.5	2.5	2.5	7.5	15.6
Conc. Matrix Spike:	2.3	2.4	2.6	7.4	14.0
Matrix Spike % Recovery:	92	96	104	99	90
Conc. Matrix Spike Dup.:	2.5	2.6	2.7	7.9	14.0
Matrix Spike Duplicate % Recovery:	100	104	108	105	90
Relative % Difference:	8.3	8.0	3.8	6.5	0

NORTH CREEK ANALYTICAL

Scot Cocanour
Laboratory Director

% Recovery: $\frac{\text{Conc. of M.S. - Conc. of Sample}}{\text{Spike Conc. Added}} \times 100$

Relative % Difference: $\frac{\text{Conc. of M.S. - Conc. of M.S.D.}}{(\text{Conc. of M.S. + Conc. of M.S.D.}) / 2} \times 100$

SEACOR

CHAIN-OF-CUSTODY RECORD

1990 PNCOS / 0214

SEACOR 330 112th Ave. NE, #104 Bellevue, WA 98004	PHONE: (206) 646-0280	PROJECT MANAGER: D. Christensen	PROJECT NUMBER/NAME: City of Bothell
SAMPLER: (Sign and print name) John M. Gicken John M Gicken	LABORATORY: North Creek	LABORATORY ID NUMBER: 1990 PNCOS	

SAMPLE ID NUMBER	DATE	TIME	SAMPLE TYPE	STATION/LOCATION	ANALYSIS REQUESTED/REMARKS
TP-4 @4.5	1/30/91	11:00 ~~soil~~	soil	Test pit #4 @ 4.5 feet	Hold
TP-4 - 1120	↓	1130	water	water at 5.0'	8015 | 8020 8015 mod | 418.1

John will call with analyses later. 10 day TAT for soil. H.A.

RELINQUISHED BY: (Signature)	DATE/TIME	RECIEVED BY: (Signature)	RELINQUISHED BY: (Signature)	DATE/TIME	RECIEVED BY: Signature
John M. Gicken	DATE: 1-30 TIME: 1700			DATE: TIME:	
RELINQUISHED BY: (Signature)	DATE: TIME:	RECIEVED BY: (Signature)	RELINQUISHED BY: (Signature)	DATE: TIME:	RECIEVED BY: Signature
RELINQUISHED BY: (Signature)	DATE: 1/30 TIME: 1700	RECIEVED FOR LABORATORY BY: (Signature) [signature]			REMARKS:

SEACOR

CHAIN-OF-CUSTODY RECORD

0213

SEACOR 330 112th Ave. NE, #104 Bellevue, WA 98004	PHONE: (206) 646-0280	PROJECT MANAGER: D. Christensen	PROJECT NUMBER/NAME: City of Bothell
SAMPLER: (Sign and print name) John M. Greber John M. Gieber	LABORATORY: North Creek	LABORATORY ID NUMBER: 1990 PRICES	

SAMPLE ID NUMBER	DATE	TIME	SAMPLE TYPE	STATION/LOCATION	ANALYSIS REQUESTED/REMARKS
TP-1@7.5	1/30/91	9:00	soil	Test pit #1 @7.5 feet	Hold
TP-1@8.5	↓	9:15	↓	@ 8.5 feet	Hold
TP-1 H2O		11:00	water	water @ 8.0'	8015/8020 8015 mod. 418.1
TP-2@6.5		0930	soil	Test pit #2 @ 6.5 feet	Hold
TP-2@8.0		0950	↓	@ 8.0 feet	Hold
TP-2-H2O		11:15	water	water @ 7.0'	8015/8020 8015 mod. 418.1
TP-3@10'	↓	1030	soil	Test pit #3 @ 10 feet	Hold

RELINQUISHED BY: (Signature)	DATE:	RECIEVED BY: (Signature)	RELINQUISHED BY: (Signature)	DATE:	RECIEVED BY: Signature
John M. Gieber	DATE: 1-30 TIME: 1200			DATE: TIME:	
RELINQUISHED BY: (Signature)	DATE: TIME:	RECIEVED BY: (Signature)	RELINQUISHED BY: (Signature)	DATE: TIME:	RECIEVED BY: Signature
RELINQUISHED BY: (Signature)	DATE: 1/30 TIME: 12:00	RECIEVED FOR LABORATORY BY: (Signature) [signature]			REMARKS:

12' high pile

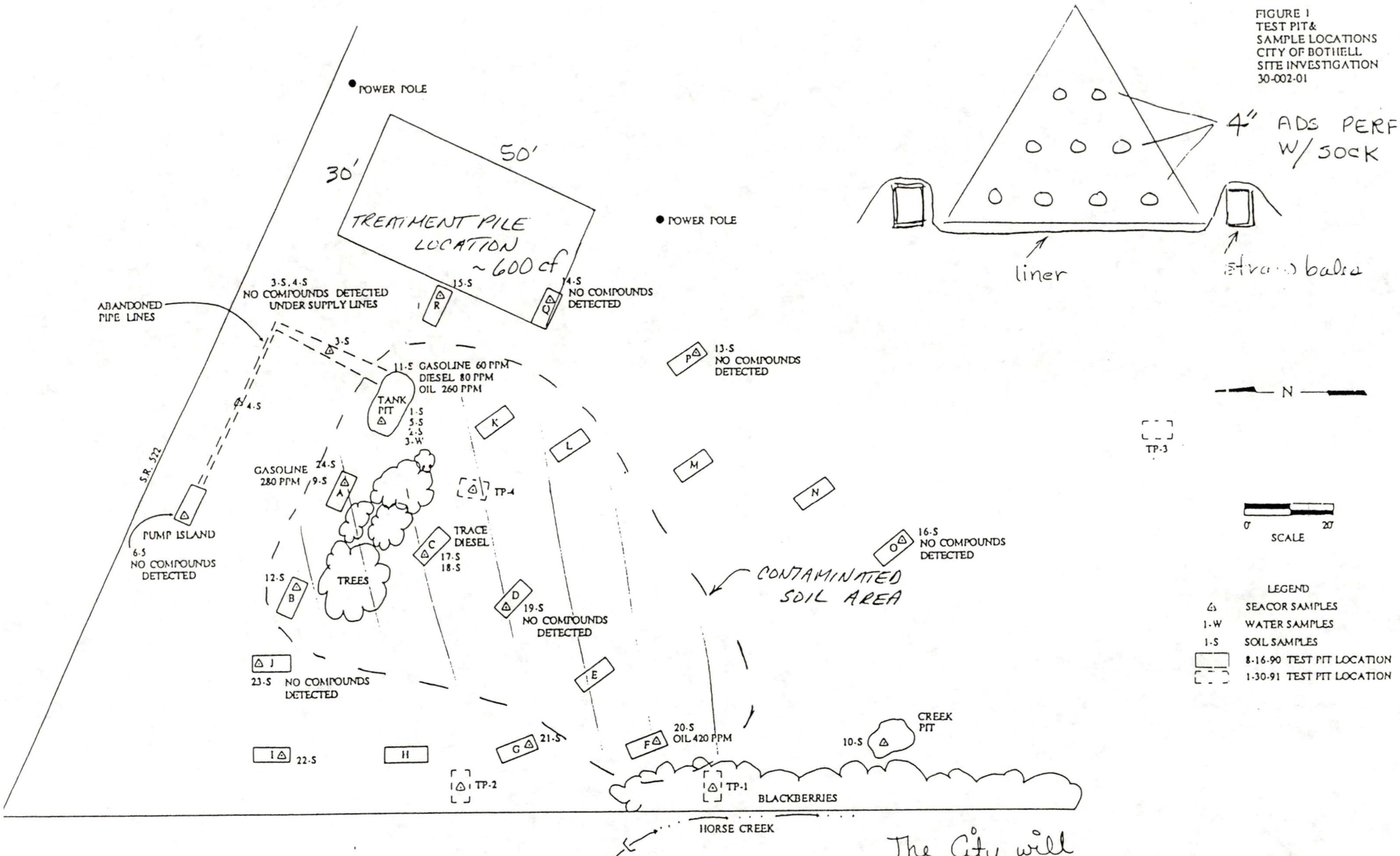
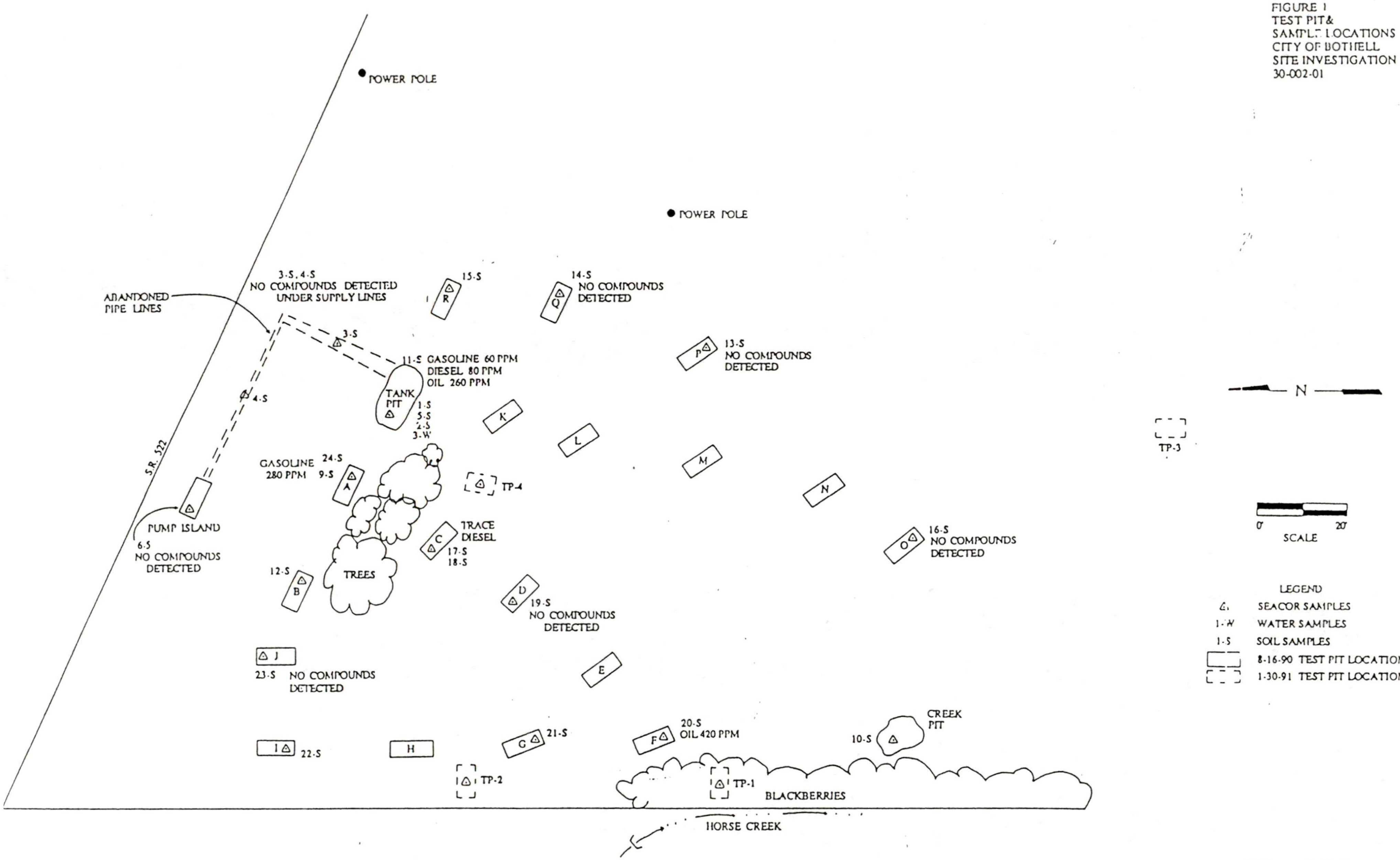


FIGURE 1
TEST PIT & SAMPLE LOCATIONS
CITY OF BOTHELL
SITE INVESTIGATION
30-002-01

The City will supply backhoe equipment & operators

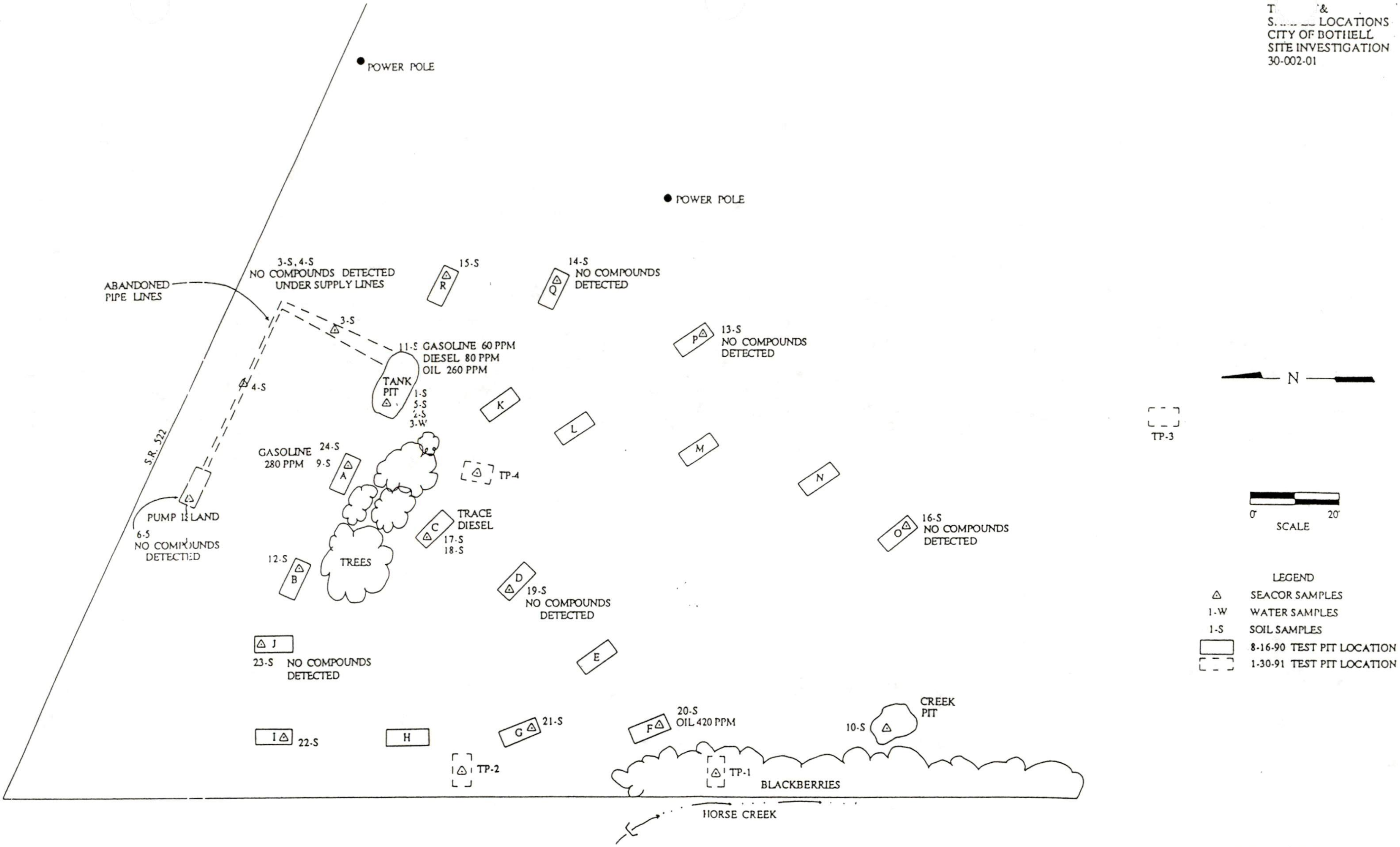
SEACOR

FIGURE 1
TEST PIT&
SAMPLE LOCATIONS
CITY OF BOTHELL
SITE INVESTIGATION
30-002-01



SEACOR

FI... I
T... &
S... LOCATIONS
CITY OF BOTHELL
SITE INVESTIGATION
30-002-01



SEACOR

C

GROUNDWATER
TECHNOLOGY

APPENDIX C

SITE REMEDIATION
PHASE - RZA AGRA, INC. APRIL 1992

SITE REMEDIATION - PHASE I

Riverside Property
State Route 522 @ Bothell-Everett Highway
Bothell, Washington

Prepared for
TEXACO REFINING AND MARKETING, INC.
Environmental Services Division

Prepared by
RZA AGRA, Inc.
11335 - 122nd Way, Suite 100
Kirkland, Washington

W-8043
April 1992

TABLE OF CONTENTS

LIST OF FIGURES, TABLES, & APPENDICES

SITE REMEDIATION - PHASE I
RIVERSIDE PROPERTY
BOTHELL, WASHINGTON

1.0 SUMMARY

RZA AGRA, Inc. (RZA) has completed Phase I of a soil remediation project being conducted at the above referenced site. This project is a voluntary cleanup, in accordance with the Washington Department of Ecology (Ecology) Model Toxics Control Act (MTCA) Cleanup Regulation (173-340 WAC). The scope of work for this phase of the project consisted of excavating petroleum-affected soil at the site, stockpiling the soil on site, collecting representative soil samples from the excavation and soil stockpiles, analyzing the soil samples to determine the concentrations of petroleum compounds present, and preparing a letter report documenting our activities, findings, and conclusions. A second phase of work was planned for this project, which consisted of thermal treatment of petroleum-affected soils; placement of the treated soil back into the excavation; and, installation of groundwater monitoring wells for the purpose of assessing post soil treatment groundwater quality. This phase of the project was not implemented due to the fact that the volume of petroleum-affected soil encountered was approximately eight times greater than anticipated. Since thermal desorption is a very expensive treatment option, re-evaluation of remediation options was warranted. This work was performed under contract to the City of Bothell. We have received authorization from the City to prepare a detailed report of our activities for Texaco Environmental Services. For your convenience, a brief summary of our activities and findings is presented below:

- Approximately 4500 cubic yards of petroleum-affected soil and debris was excavated at the Riverside Property. This material has been stockpiled in a 15-foot tall berm surrounding the open excavation. The berm and excavation have been surrounded with a six-foot tall chain-link fence in order to secure the site.

- Post-excavation soil samples were collected from the sides and bottom of the excavation in accordance with the Washington Department of Ecology's (Ecology's) "Guidance for Remediation of Releases from Underground Storage Tanks". Laboratory analysis of these samples revealed that the effective limits of contamination had been reached.

- Two soil samples were collected from the stockpiled soils for the purpose of evaluating the general condition of this soil with respect to petroleum hydrocarbon contamination.

Analysis of these samples revealed that they contained petroleum compounds at concentrations of <10 parts per million (ppm) and 2400 ppm, utilizing EPA Method 8015 modified, and from 860 ppm to 9,300 ppm, utilizing EPA Method 418.1.

- Two interim soil samples were collected during excavation; one from the area identified as the former tank pit for the Flying "A" service station, and one from an area of buried cans and debris. The sample collected from the tank pit contained short-chain hydrocarbons (gasoline and diesel) at a concentration of 870 ppm. The sample collected from the buried debris contained long-chain hydrocarbons (heavy oil) at a concentration > 5000 ppm. The results of these tests indicate that specific areas of the site were significantly impacted by both light and heavy hydrocarbons; however, the majority of the contamination observed in the field appeared to be related to heavy petroleum compounds such as motor oil and diesel.

- Perched groundwater seepage and precipitation have combined to form a pond in the excavation which ranges between six inches and three and one-half feet in depth. Initial analysis of water samples indicated that the water contained total petroleum hydrocarbon (TPH) concentrations ranging from 13 ppm to 235 ppm (EPA Method 418.1). The water was treated utilizing bioremediation techniques and subsequent testing revealed that the TPH concentration was below State cleanup standards for groundwater. During the treatment period, it was determined that heavy petroleum compounds originally present in the groundwater had settled with the sediment in the water. Mechanical agitation was added to the treatment routine in order to resuspend the TPH for treatment; however, there remain several areas in the southeast corner of the excavation where sediment from the groundwater may contain heavy petroleum compounds in excess of the allowable limits. Treatment of the sediment was not continued due to unfavorable weather conditions and the transfer of management responsibilities for the site to Texaco.

This summary is intended to provide a general overview of our Phase I project work and should be used only in conjunction with the full text of this report. A complete reading of this report is necessary for a thorough understanding of the conditions or limitations effecting the use of the information contained herein. Provision of this summary and report is not intended as a waiver of any work product or attorney/client privilege by the City of Bothell.

2.0 INTRODUCTION

This report documents Phase I of a soil remediation project in progress at the Riverside Property in Bothell, Washington (see Figure 1). The project was halted following completion of Phase I due to the fact that the volume of petroleum-affected soil encountered at the site was approximately eight times greater than originally anticipated. Following review of the MTCA guidelines and discussions with Ecology and RZA, the City of Bothell determined that the change in scope of the project warranted re-evaluation of soil remediation alternatives prior to completion of the project. The site boundaries, the limits of Phase I excavation, and other pertinent site features are illustrated on Figure 2, the Site Plan.

The purpose of the Phase I project work at this site was to excavate all soil significantly impacted by petroleum hydrocarbons, in preparation for on-site remediation of the soil. Studies formerly conducted at this site have identified petroleum contamination problems associated with historical site use. The City of Bothell was concerned with continuing environmental liability associated with the off-site disposal of petroleum contaminated soil and potential groundwater issues relating to petroleum contamination. In addition, the City sought a cost-effective remediation option consistent with MTCA requirements and Ecology guidelines for remediation of releases from underground storage tanks. Based on these concerns, the City requested that all contaminated material remain on site for future remediation.

The specific scope of work for this phase of the project consisted of:

(1) excavation of petroleum-affected soil;

(2) collection of representative samples from the excavation and from excavated soils;

(3) analysis of soil samples to determine the nature and extent of petroleum contamination; and,

(4) preparation of a summary report documenting site activities and presenting the results of the analytical testing.

This scope of work was designed to address both the requirements of the State with respect to cleanup of petroleum contaminated sites and the requirements of the City with respect to continuing environmental liability associated with the contamination at this site.

This report has been prepared for the exclusive use of Texaco Environmental Services and its agents, for specific application to this project site. Field work for the project and report activities have been conducted in general accordance with accepted environmental engineering practices. No other warranty, express or implied, is made.

3.0 SITE CONDITIONS

The Riverside Property is a triangularly-shaped parcel approximately 1.9 acres in size. The parcel is located along the eastern boundary of State Route 522 (SR 522), near Petosa's Restaurant in Bothell, Washington. The site is bounded on the northeast by SR 522, on the southeast by NE 180th Street, and on the west by Horse Creek. The Sammamish River is located just south of the property, directly across NE 180th Street. The Bothell Landing Shopping Center is located just west of the site, on SR 522. The site was vacant at the time of our work and had been surfaced with compacted, crushed rock and gravel to facilitate its use as a public parking area. Site vegetation prior to our field work consisted of a two alder trees, several small native shrubs (Scotch Broom), grasses, weeds, and blackberry vines.

Previous studies indicate that the site was the location of several small businesses during the 1940's, 1950's, and 1960's. These businesses included a two restaurants, a cabinet shop, and a Flying "A" service station. The site was purchased by the City of Bothell in 1990 with the intent of constructing an unpaved parking area and/or additional park space for use by community residents.

3.1 Regional Geology

The predominant surface geology units in the vicinity are Everett series soils and Puget soils. The Everett soils are glacially derived gravelly, sandy loams which are excessively drained. Surface soils in this series consist of brown to pale reddish-brown, gravelly sand loam to a depth of approximately 10 inches, underlain by yellowish-brown, gravelly loam to a depth of approximately 24 inches. Soils below 24 inches are made up of poorly assorted, grayish sands and gravel. Boulders and stones are common throughout the underlying drift, which contains stratified sandy pockets, lenses, and cross-bedded layers. The Everett series soils are present on this site in a narrow strip adjacent to SR 522, along the northeast boundary of the property. Puget soils are heavy textured, poorly drained soils associated with fluvial deposits in large stream valleys. The top three inches of soil is typically a light grayish-brown or brownish-gray, silty, clay loam lightly mottled with rust brown. The soil between three and 14 inches is light brownish-gray silt, clay loam somewhat laminated and lightly mottled with rust brown. The underlying layers are typically light gray, stratified and laminated, silty clay and clay mottled with iron stains. This soil is present on the southern two-

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3.2 Regional Hydrogeology

No groundwater studies have been conducted in the site vicinity; however, the groundv ate may be estimated based upon surface topography of the site and its proximity to the Sa Horse Creek. Groundwater typically flows from areas of higher elevation, or pressu elevation or pressure. The topography of this site slopes gently southwest toward the riv r a border the property. Groundwater flow would typically be expected to be in this same

4.0 EXCAVATION

Excavation at the site was performed by Custom Backhoe and Kelly's Excavating, uti in standard size backhoe, and a small dozer. All work was performed under the direct su project engineer. The work was conducted between 18 August 1991 and 22 August 1 91.

Approximately 4500 cubic yards of petroleum-affected soil and debris were excavated a site. This estimate is based on the earthwork calculations presented on Figure 3, Calcul io Volume. The finished excavation pit measured roughly 150 feet by 130 feet by 8.5 feet. was stockpiled in a 15-foot tall berm surrounding the excavation pit and was covered w h to prevent the generation of contaminated runoff from the site. At the completion of th a six-foot, tall chain-link fence was placed around the excavation pit to limit access and e su

✓Prior to beginning excavation, the Bothell Fire Department wetted the entire site t he generation of fugitive dust during excavation. Next, a two-foot thick layer of clean fill ma ri and stockpiled in the southwest corner of the site. In accordance with Washington Dep (Ecology) "Guidance for Remediation of Releases from Underground Storage Tanks", 1 is be analyzed for TPH content at a rate of one sample per 100 cubic yards of soil, if the r back into the excavation without any treatment for potential petroleum contamination.

Excavation began in the northwest corner of the site and proceeded eastward toward ne of the Flying "A" service station. The fill material excavated on day one was interbedded

encountered nea
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4.1 Subsurf

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4.2 Subsur

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gray-colored material which exuded moderate to heavy petroleum odors. The layering was so prevalent that it was impossible to separate regular fill from the suspect materials. The apparent western limits of this material were reached on the first day of excavation; however, no break in the material was encountered to the east. It was apparent after the first day of excavation that the previously estimated volume of petroleum-affected soil was very low. Since there is not an effective, feasible, in-situ treatment for soils contaminated with heavy petroleum hydrocarbons (oil, diesel, etc.), the City of Bothell made the decision, to continue excavation and remove all of the significantly-affected soil. We concurred with this decision since Ecology does not generally favor in-situ remediation of soils contaminated with heavy petroleum compounds. It is difficult to monitor and control in-situ remediation, and results are often poor. Specific to this site, the proximity of the Sammamish River and Horse Creek makes the use of phosphate and nitrate containing fertilizers, which are associated with in-situ bioremediation, unfavorable from an ecological perspective.

As excavation progressed toward the historical service station site, an abandoned corrugated metal pipe (CMP) septic tank was unearthed. A zone of very moist, gray sand was encountered which was apparently the leach field for the septic tank. This material had a moderately strong gasoline odor and was excavated for treatment. Surface materials in this area did not appear to be impacted by petroleum hydrocarbons. These materials were excavated and stockpiled in the Northwest corner of the site, south of the petroleum-affected soil.

South of the historical service station site, a large pile of buried oil cans and debris was found. Soils were black and had an oily texture. This material also had a strong oil-like odor. Groundwater leaching from the buried debris was discolored and had an iridescent sheen and strong petroleum odor. The lower limits of this debris were located at depths of approximately eight to nine feet, where native peat was encountered. The southerly limit of this material was located approximately 130 feet south of the historical station site. The soils in this area were also black colored, but burn debris was evident and the soils did not have any petroleum odor. The natural bio-degradation taking place in the fire debris may have served as a passive lateral barrier for the petroleum compounds moving underground.

Near the previously identified location of the underground storage tanks for the service station, a zone of saturated, gray sand was encountered. The liquid in the sand had a noticeable iridescent sheen and the sand had a very strong gasoline odor. Steel pipes were unearthed in this area, that may have been relics from the service station product delivery system. Several abandoned, 4-inch diameter drains were also wells for the purpose of assessing post soil treatment water quality and obtaining data regarding the groundwater flow direction and depth. Groundwater conditions may vary significantly based upon seasonal precipitation, land use, and direct or indirect influence by nearby water bodies. As noted in the previous section, the channel of the Sammamish River has been relocated twice in the past by the United States Army Corps of Engineers. These adjustments in the river channel may have significantly effected the groundwater conditions on site.

5.0 BIOREMEDIATION OF GROUNDWATER

Groundwater which leached from within areas of buried debris at the site was significantly impacted by petroleum compounds. Although groundwater remediation was not included in the original scope of work for the project, RZA conducted bioremediation of the contaminated water on a promotional basis. The project offered an opportunity to test new field equipment and bioremediation techniques in an above-ground impoundment. A remediation system combining a subsurface sparging unit, a subsurface bubbler, and a dispersion unit was installed at the site. Water was pumped out of the excavation into a 500 gallon Baker tank where it was mixed with fertilizer and surfactant. The water was aerated as it was returned to the pond via a dispersion unit placed approximately three feet above the water surface. The intake for the pump was located across the pond from the dispersion unit in order to encourage circulation within the pond. Initial testing indicated that the water in the pond contained concentrations of TPH between 13 and 235 ppm; however, as remediation progressed, it became apparent that a majority of the heavy petroleum compounds in the water had settled out. Analytical testing following agitation of the sediment, indicated that the ponded water contained TPH at a concentration of 520 ppm. Following this discovery, the pond was mechanically agitated two to three times weekly in order to facilitate treatment of the contaminated sediment layer. In addition, surfactant was added directly to the pond to break up petroleum hydrocarbons floating on the surface of the pond. The remediation system was operated for approximately three months, until analytical testing indicated that the water in the excavation did not contain petroleum hydrocarbons at levels above the State cleanup requirements. It should be noted that heavy petroleum hydrocarbons are likely to settle out of solution. There are several areas at the bottom of the pond where groundwater sediments may contain elevated levels of petroleum compounds. These areas are located generally in the southwest corner of the excavation.

In late October, RZA received a phone call from the Bothell Fire Marshall, Denny Wright. He reported that Park Department staff members performing maintenance work in the Horse Creek channel adjacent to the site had detected petroleum odors and had observed an iridescent sheen on the creek water. The Park

Department staff notified the Ecology Spill Response Team, believing that the apparent contamination had originated in the treatment pond on site. RZA personnel met with the Fire Marshall on site to evaluate the problem. At that time, it was observed that the sheen and odor originated at the outfall of a culvert which conveys Horse Creek through downtown Bothell. The Fire Marshall indicated that a portion of the City storm drain system outfalls to Horse Creek and that this type of problem occurs frequently. RZA determined that the water quality problem had not originated at the Riverside Property. The Fire Marshall concurred with our determination. The Ecology spill response team member assigned to investigate the complaint by the Bothell Parks Department was a long term resident of Bothell and was familiar with the continuing problems with Horse Creek. He found no evidence that the Riverside property was contributing to the problem.

6.0 SAMPLING PROCEDURES

Soil samples were obtained during and after excavation directly from the trackhoe bucket. Samples were taken from approximately six inches below the soil surface in the bucket and were placed by hand in laboratory cleaned, glass jars sealed with Teflon-lined screw caps. A fresh pair of disposable latex gloves was donned before each sample was collected to prevent cross contamination between samples. All soil samples were placed in a cooler, on ice, and transported to the analytical laboratory under strict RZA chain-of-custody protocol. Soil sample locations are illustrated on Figure 4 and a physical description of each sample is presented in Table 1. Table 1 also includes a listing of the sampling locations.

Groundwater samples were collected directly from the open excavation, generally following manual agitation of the water in the excavation to facilitate even distribution of petroleum compounds. Samples to be analyzed utilizing EPA Method 8015 modified were collected in laboratory cleaned glass VOA vials sealed with Teflon-lined septa screw caps. Samples to be analyzed utilizing EPA Method 418.1 were collected in 500 ml, laboratory cleaned, plastic bottles sealed with screw caps. All water samples were placed in a cooler, on ice, and transported to the analytical laboratory under strict RZA chain-of-custody protocol.

7.0 ANALYTICAL RESULTS

Analytical testing for this project was performed by Sound Analytical Services, of Tacoma, Washington, and North Creek Analytical, of Bothell, Washington. All laboratory testing was performed in accordance with the then current Washington State analytical requirements.

7.1 Soil

Soil samples collected were analyzed for petroleum hydrocarbons utilizing EPA Method 8015 modified for gas and diesel and EPA Method 418.1 for total petroleum hydrocarbons (TPH). Selected soil samples were also analyzed for lead, polychlorinated biphenyls (PCBs), and chlorinated solvents. Based upon the laboratory detection limits for these analytes, none of the samples tested contained detectable lead, PCBs, or chlorinated hydrocarbons.

Twelve soil samples were collected from the sidewalls and bottom of the excavation; two from each sidewall and four from the bottom. Each pair of sidewall samples was composited into a single sample for analysis. The four bottom samples were composited into two samples; one comprised of the samples from the east half of the excavation and one comprised of the two samples from the west half of the excavation. Compositing was done in an effort to reduce analysis costs. Analysis of the samples revealed that one sidewall composite (south wall) and one bottom composite (east half) contained petroleum hydrocarbons at levels above the action levels published in the Washington State Model Toxics Control Act (MTCA) Cleanup Regulation. Since the individual samples had not been properly held in refrigeration, four new samples were collected from the areas in question and analyzed separately for petroleum compounds. This new round of testing did not reveal any petroleum concentrations above the cleanup limits, thereby demonstrating compliance with State cleanup criteria for underground storage tank sites. Soil sample locations are illustrated on Figure 4.

Two samples were collected from the soils stockpiled on site and submitted for analysis. One of these samples did not contain petroleum hydrocarbons at levels above the state cleanup criteria when analyzed utilizing EPA Method 8015 for gasoline and diesel; however, the same sample contained significant levels of petroleum hydrocarbons based upon analysis with EPA Method 418.1. The second sample contained very significant amounts of petroleum based upon either analysis.

The results of soil analyses are summarized in Table 1 in this report. Laboratory reports and chain-of-custody records are contained in Appendix A.

7.2 Groundwater

Six groundwater samples collected from the excavation during the coarse of this project were submitted to the laboratory for analysis. Initial samples were analyzed utilizing EPA Method 8015 modified for gas and diesel and EPA Method 418.1 for TPH. Interim treatment samples were analyzed utilizing EPA Method 418.1 only. Samples submitted at the close of water treatment were also utilizing EPA Method 418.1 analyzed using both petroleum methods. Prior to treatment, groundwater samples contained levels of petroleum compounds ranging from 13 ppm to 500 ppm. The final water samples collected and analyzed following bioremediation did not contain any detectable hydrocarbons, based upon the laboratory detection limits for EPA Method 418.1.

The results of analytical testing of groundwater are summarized in Table 3. Laboratory reports and chain-of-custody records are presented in Appendix A.

8.0 CONCLUSIONS AND RECOMMENDATIONS

Based upon our observations during the project field work, and upon the results of analytical soil and water testing, we believe that the majority of soils containing petroleum hydrocarbons at levels above the MTCA cleanup levels have been removed from the subsurface matrix. There may be limited amounts of petroleum-affected sediment remaining below the ponded groundwater seepage in the open excavation; predominately in the southeast corner of the excavation. It may be prudent to pump out this sediment with a slurry pump and add it to the soil already stockpiled for treatment. This would eliminate any uncertainty regarding this material. A second alternative would be to collect sediment samples from the pond bottom and have the samples analyzed to determine whether or not petroleum hydrocarbons are present at levels above the State cleanup action levels.

The hydrology of the site and the quality of groundwater (post soil treatment) should be evaluated utilizing three or more groundwater monitoring wells. Data obtained by monitoring these wells over time would provide a basis for calculations to determine the groundwater gradient. In addition, analytical data obtained from sampling the monitoring wells could be used to demonstrate that petroleum contamination has not migrated off site via groundwater movement.

The open excavation on site should be backfilled with clean material following removal of the ponded groundwater seepage. Backfilling the excavation without removing the ponded water may result in significant settlement problems or other problems related to soil strength. Fill material could either be generated by remediation of the petroleum-impacted soils which are stockpiled on site or could be brought in from an off-site source. We believe that the most satisfactory remediation alternative would be to treat the contaminated soil on site and use this material to backfill the excavation. This is based upon our knowledge of current disposal costs for petroleum contaminated soil and upon the current regulatory climate which favors on-site treatment of petroleum-impacted soils and groundwater.

There are several options available for treatment of the petroleum-affected soils at the site. These options include bio-remediation and thermal desorption. Thermal desorption is relatively expensive with average unit costs of $60 to $65 per ton for soil treatment. This method is very rapid however, and full remediation could likely be accomplished in approximately 45 days. Bioremediation is much more time consuming, requiring three to nine months to complete on the average. This method of remediation has unit costs ranging from $40 to $50 per cubic yard.

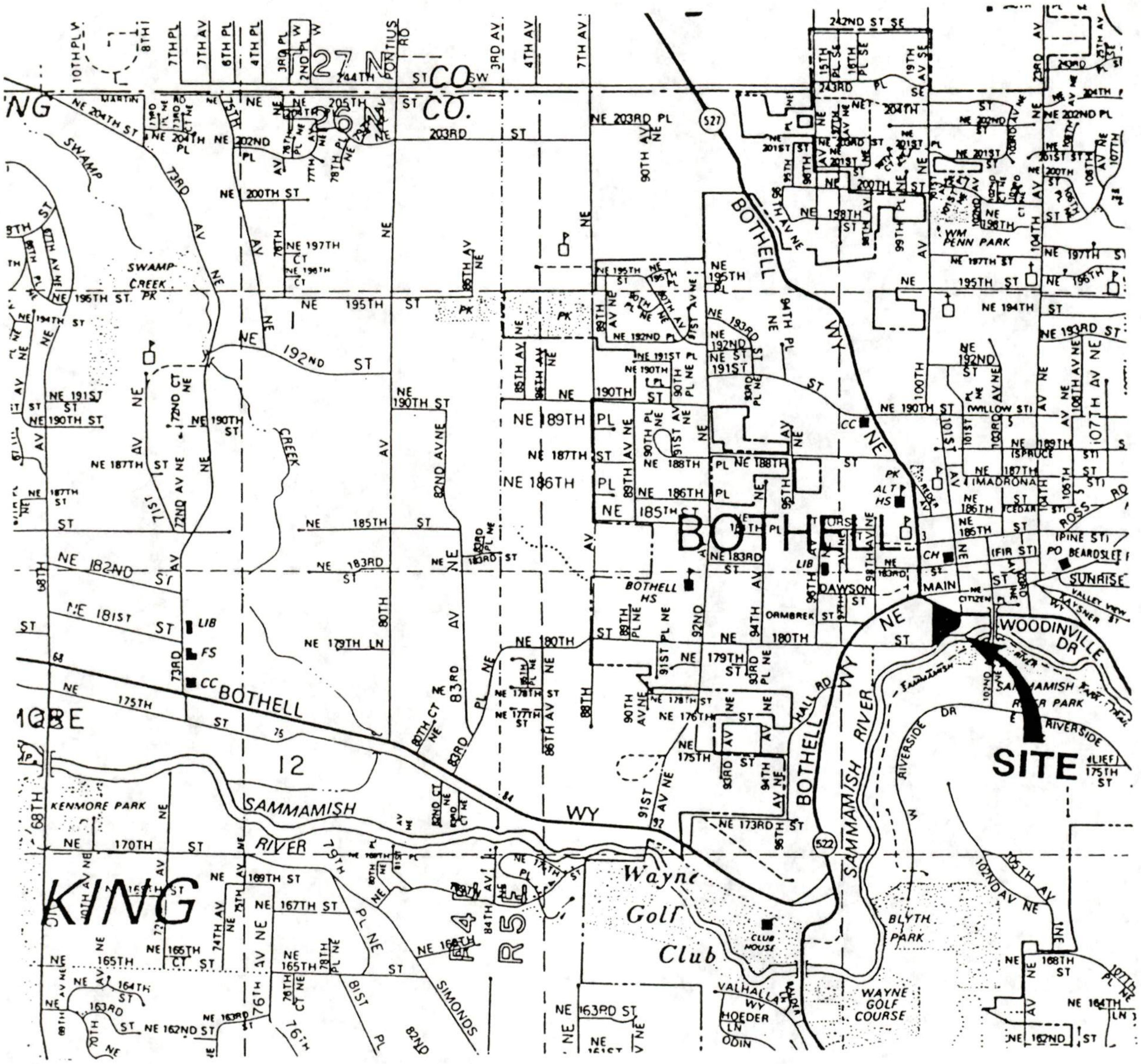
We do not believe that in-situ treatment was ever a viable option for the petroleum contaminated soils at this site. This is based on the evidence that heavy petroleum hydrocarbons do not respond well to this type of treatment. In addition, Ecology does not favor in-situ remediation as an option for most contamination problems because it is difficult to monitor and control the process. Lastly, the proximity of this site to the Sammamish River and Horse Creek makes the use of phosphate and nitrate containing fertilizers associated with in-situ remediation a risky prospect.

We appreciate the opportunity to be of service to Texaco and its Environmental Services Division. If you have any questions or comments regarding the information contained in this report, please do not hesitate to contact our office.

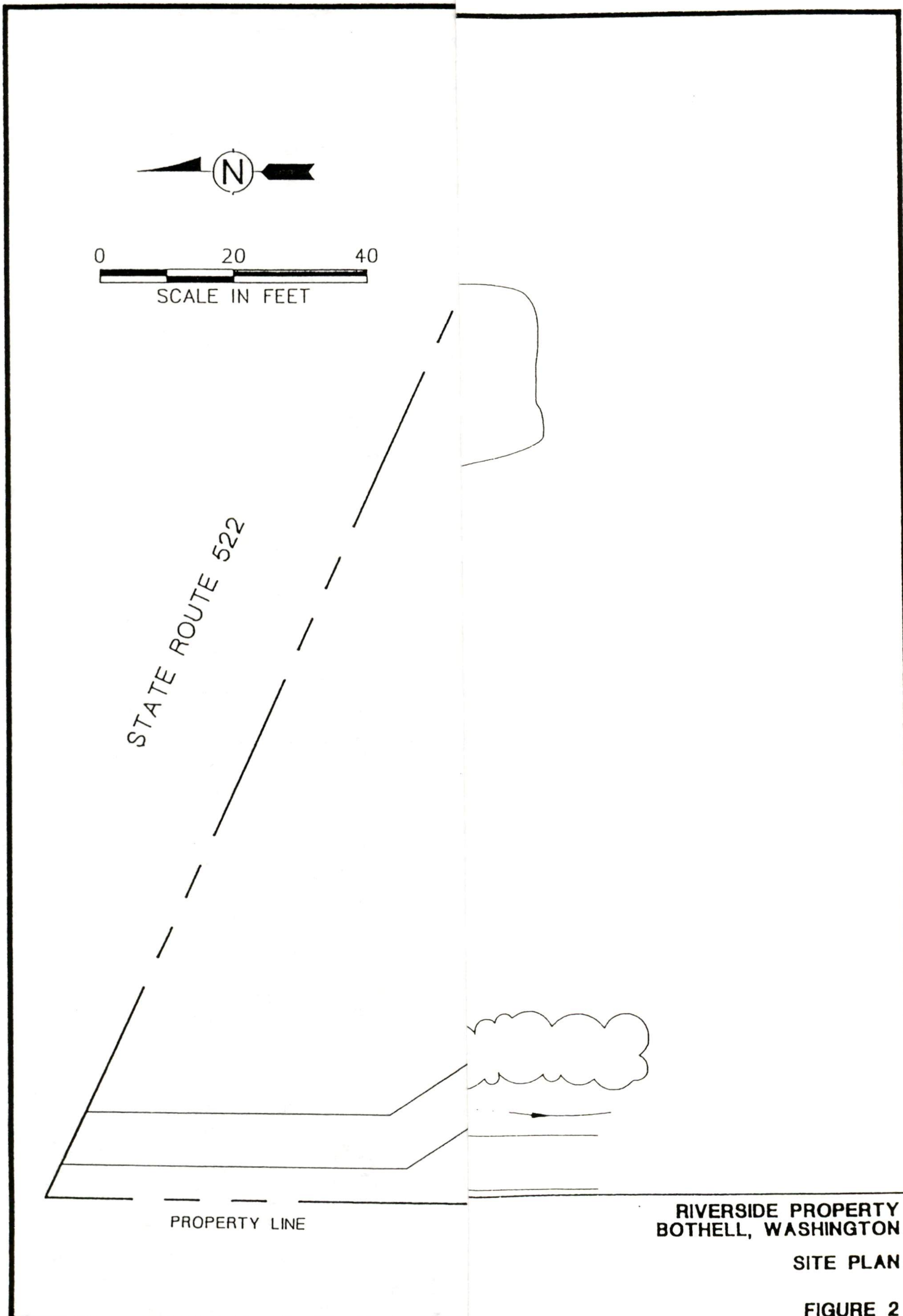
Respectfully Submitted,

Carol A. Hutley, P.E.
Project Environmental Engineer

Lee Dorigan
Associate Environmental Scientist



RZA-AGRA ENGINEERING & ENVIRONMENTAL SERVICES *11335 N.E. 122nd Way* *Suite 100* *Kirkland, Washington* *98034-6918*	W.O. W-8043 DESIGN CAH DRAWN MJF DATE FEB 1992 SCALE N.T.S.	**RIVERSIDE PROPERTY** **BOTHELL, WASHINGTON** **VICINITY MAP** **FIGURE 1**



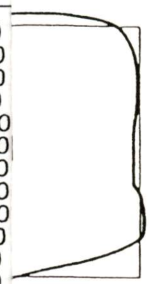
RIVERSIDE PROPERTY
BOTHELL, WASHINGTON

SITE PLAN

FIGURE 2

DRAWING NO. \8A\W-8043\SITE.DWG

AREA DESIGNATION	SIZE (SQUARE
A	90
B	120
C	160
D	90
E	1010
F	840
G	260
H	240
I	840
J	180
K	80
L	20
M	250
N	369(
O	728(
TOTAL AREA	14,710

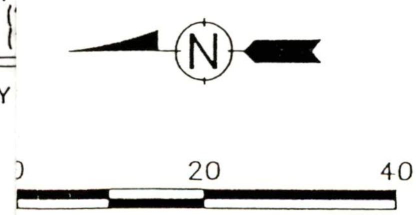


UNADJUSTED TOTAL VOLUME = TOTAL AF
= 14,710 SF
= 125,035 C
= 4,630 CY

LIMITS OF EXCAVATION

TOTAL VOLUME = 4,630 CY
- 700 CY (
+ 590 CY (

4,520 CY



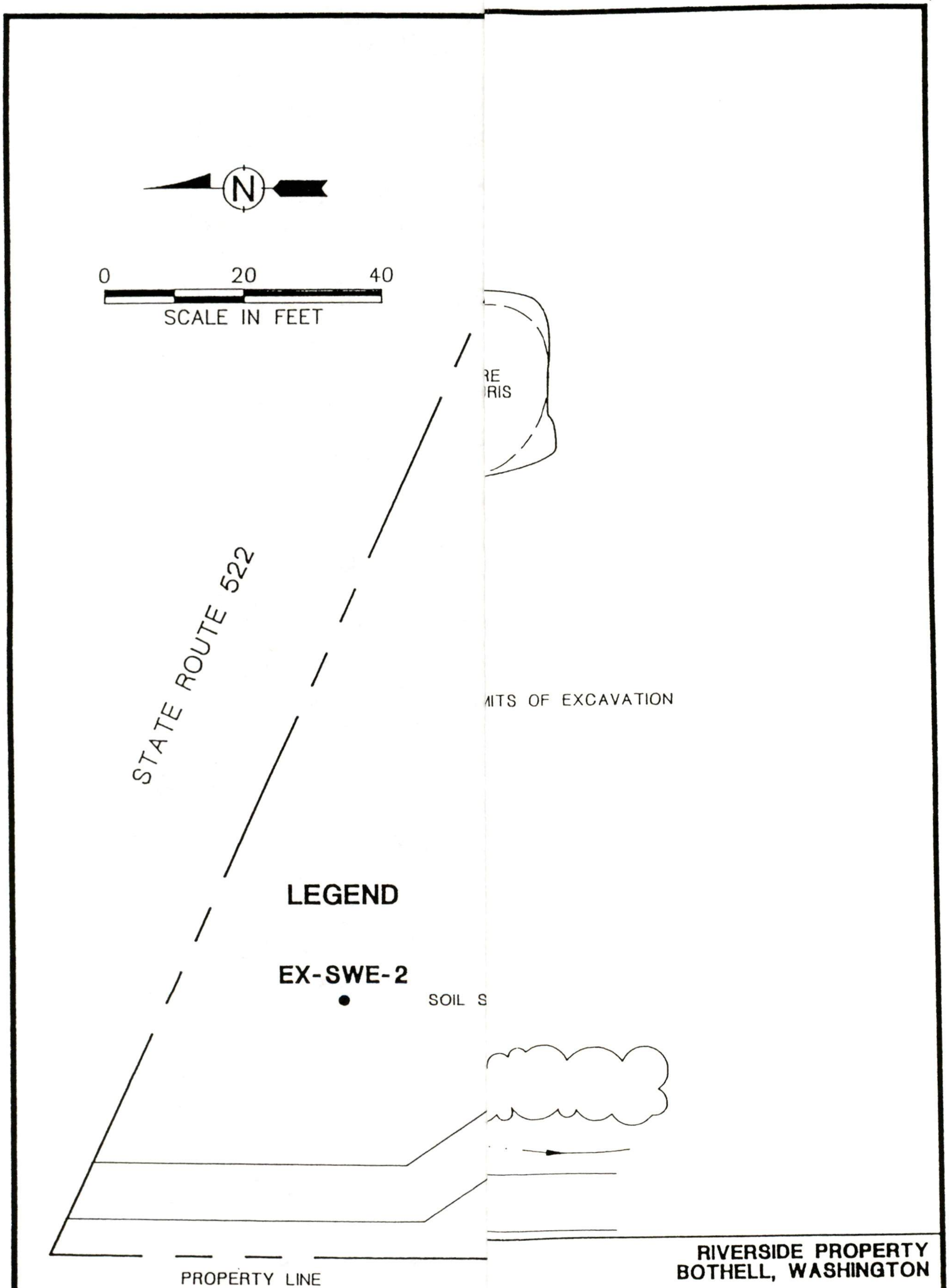
NOTE: AVERAGE DEPTH
IS APPROX. 8.5 F

RIVERSIDE PROPERTY
BOTHELL, WASHINGTON

CALCULATION OF EXCAVATION VOLUME

FIGURE 3

DRAWING NO. \8A\W-8043\VOLUME.DWG



RIVERSIDE PROPERTY
BOTHELL, WASHINGTON

SOIL SAMPLE LOCATIONS

FIGURE 4

DRAWING NO. \8A\W-8043\SS.DWG

TABLE 1: SOIL SAMPLE PARAMETERS
RIVERSIDE PROPERTY
BOTHELL, WASHINGTON
PROJECT NUMBER: W-8043

Sample Number	Location Sample was Collected	Depth of Sample (feet)	Comments
SP-NW-COM	Stockpile Composite (Northwest)	.5 - 1.0	Black soil Heavy petroleum odor
SP-SE-COM	Stockpile Composite (Southeast)	.5 - 1.0	Black, greasy soil Heavy petroleum odor
EX-NWE	North wall of excavation (East)	7.0 - 8.0	Slight odor
EX-NWW	North wall of excavation (West)	6.0 - 7.0	Very slight odor
EX-SWE	South wall of excavation (East)	7.0 - 8.0	Dark soil - Organic Odor
EX-SWW	South wall of excavation (West)	6.0 - 7.0	Some gray layers - No odor
EX-EWN	East wall of excavation (North)	7.0 - 8.0	Slight odor
EX-EWS	East wall of excavation (South)	6.0 - 7.0	Slight odor
EX-WWN	West wall of excavation (North)	6.0 - 7.0	Some gray layers - Slight odor
EX-WWS	West wall of excavation (South)	6.0 - 7.0	Some gray layers - No odor
EX-BNE	Bottom - Center of NE quadrant	8.0 - 9.0	Peat - Dark Brown, very dense
EX-BNW	Bottom - Center of NW quadrant	7.0 - 8.0	Peat - Dark Brown, very dense
EX-BSE	Bottom - Center of SE quadrant	8.0 - 9.0	Peat - Dark Brown, very dense
EX-BSW	Bottom - Center of SW quadrant	7.0 - 8.0	Peat - Dark Brown, very dense
TK-BC	Historical Tank Pit	7.0 - 8.0	Saturated gray sand Strong gasoline odor
SP-EW	Interim East wall - Waste Area	7.0 - 8.0	Black, greasy soil Heavy petroleum odor
EX-SWE-2	Re-sample South wall (East)	7.0 - 8.0	
EX-SWW-2	Re-sample South wall (West)	6.0 - 7.0	
EX-SWW-3	Re-sample South wall (West)	6.0 - 7.0	
EX-BSW-2	Re-sample SW quadrant of bottom	7.0 - 8.0	Peat - Dark Brown, very dense
EX-BSE-2	Re-sample SE quadrant of bottom	8.0 - 9.0	Peat - Dark Brown, very dense

TABLE 2: SUMMARY OF ANALYTICAL RESULTS - SOIL
RIVERSIDE PROPERTY
BOTHELL, WASHINGTON
PROJECT NUMBER: W-8043

Sample Number	Date Collected	TPH 418.1 (ppm)	TPH 8015[1] (ppm)	WTPH-G (ppm)	WTPH-D (ppm)	Benzene 8020 (ppm)	Toluene 8020 (ppm)	Ethyl-benzene 8020 (ppm)	Xylenes 8020 (ppm)	Lead 6010 (ppm)	PCBs[2] (ppm)	TCLP Benzene (ppm)
SP-NW-COM	8/25/91	860	<10	---	---	---	---	---	---	0.2	ND	.005
SP-SE-COM	8/25/91	9,300	2,400	---	---	---	---	---	---	0.5	ND	.008
EX-NWE/EX-NWW[3]	8/23/91	58	---	<1.0	<25	<.05	<.05	<.05	<.05	---	---	---
EX-SWE/EXSWW[3]	8/23/91	160	---	<1.0	<25	<.05	<.05	<.05	<.05	---	---	---
EX-EWN/EX-EWS[3]	8/23/91	96	---	<1.0	<25	<.05	<.05	<.05	<.05	---	---	---
EX-WWN/EX-WWS[3]	8/23/91	65	---	<1.0	<25	<.05	<.05	<.05	<.05	---	---	---
EX-BNE/EX-BNW[3]	8/23/91	87	---	5.6	65	.058	<.05	<.05	.063	---	---	---
EX-BSE/EX-BSW[3]	8/23/91	170	---	<1.0	66	<.05	<.05	<.05	<.05	---	---	---
TK-BC	8/23/91	2,200	870	---	---	0.27	1.4	7.1	18	---	---	---
SP-EW	8/23/91	2,700	>5,000	---	---	---	---	---	---	---	---	---
EX-SWE-2[4]	9/12/91	110	---	---	---	---	---	---	---	---	---	---
EX-SWW-3[4]	9/20/91	43	---	---	---	---	---	---	---	---	---	---
EX-BSW-2[4]	9/25/91	<10	---	---	---	---	---	---	---	---	---	---
EX-BSE-2[4]	9/25/91	<10	---	---	---	---	---	---	---	---	---	---

NOTES:
1. EPA Method 8015 - modified for gas and diesel
2. Polychlorinated Biphenols
3. Composite of the two sample numbers shown
4. Individual samples collected in areas where previous composite samples contained TPH in excess of State cleanup levels (see note below).

Samples which contain petroleum compounds at levels above the State cleanup levels. When two or more samples are composited Ecology requires that the analytical results be multiplied by the number of samples composited. The multiplier for the shaded samples is two.

--- Sample not tested for this analyte.

ND Sample did not contain this analyte at detectable concentrations, based on the laboratory detection limit.

TABLE 3: SUMMARY OF ANALYTICAL RESULTS - GROUNDWATER
RIVERSIDE PROPERTY
BOTHELL, WASHINGTON
PROJECT NUMBER: W-8043

Sample Number	Date Collected	TPH 418.1 (ppm)	Benzene (ppm)	Toluene (ppm)	Ethyl-benzene (ppm)	Xylenes (ppm)	Oregon HCID (ppm)		
							Gas	Diesel	Oil
W1	9/4/91	---	<.001	<.001	<.001	<.001	---	---	---
W5[1]	9/4/91	---	---	---	---	---	<20.0	<50.0	ND
W5[1]	9/12/91	235	---	---	---	---	---	---	---
PW1	9/20/91	13	---	---	---	---	---	---	---
W2	9/23/91	520	---	---	---	---	---	---	---
BL-N	10/21/91	ND	---	---	---	---	---	---	---
BL-S	10/21/91	ND	---	---	---	---	---	---	---

Notes: 1 These two samples were inadvertently given the same number. They are referred to in the text according to the date on which they were collected.

--- Sample was not tested for this analyte.

ND Sample did not contain this analyte at detectable concentrations, based on laboratory detection limits.

SOUND ANALYTICAL SERVICES, INC.

SPECIALIZING IN INDUSTRIAL & TOXIC WASTE ANALYSIS

4813 PACIFIC HIGHWAY EAST, TACOMA, WASHINGTON 98424 - TELEPHONE (206)922-2310 - FAX (206)922-5047

Report To: Rittenhouse-Zeman — Date: August 30, 1991

Report On: Analysis of Soil — Lab No.: 19517-1

IDENTIFICATION:
Sample received on 08-26-91
Project: W-7802
Client ID: RUSH SP-SE-COM

ANALYSIS:

Sample was extracted using Toxicity Characteristic Leaching Procedure (TCLP) in accordance with Federal Register, June 29, 1990. The leachate was analyzed in accordance with Test Methods for Evaluating Solid Waste, (SW-846), U.S.E.P.A., 1986 Method 8240 (Volatile Organics)

Compound	Concentration (mg/l)	PQL	Max. Conc. (mg/l)
Vinyl Chloride	ND	0.010	0.2
Chloroform	ND	0.005	6.0
1,2-Dichloroethane	ND	0.005	0.5
Carbon Tetrachloride	ND	0.005	0.5
Benzene	0.008	0.005	0.5
Chlorobenzene	ND	0.005	100
1,1-Dichloroethylene	ND	0.005	0.7
Methyl Ethyl Ketone	ND	0.100	200
Pyridine	ND	0.500	5.0
Tetrachloroethylene	ND	0.005	0.7
Trichloroethylene	ND	0.005	0.5

ND = Not detected.
PQL - Practical Quantitation Limit - These are the detection limits for this sample. This number is based on sample size, matrix and dilution required.

Volatile Surrogates

Surrogate	Percent Recovery	Control Limits
Toluene - D8	98	81 - 117
Bromofluorobenzene	86	74 - 121
1,2-Dichloroethane D4	101	70 - 121

Continued . . . . .

SOUND ANALYTICAL SERVICES, INC.

Client ID: RUSH SP-SE-COM

TCLP leachate was analyzed for metals in accordance with Test Methods for Evaluating Solid Waste, (SW-846), U.S.E.P.A., 1986 Method 6010 (ICP).

Contaminant	Concentration (mg/l)	Max Conc., (mg/l)
Lead	0.5	5.0

PCB in Soil:

	Concentration, mg/kg	Det. Limit
Aroclor 1016	ND	0.1
Aroclor 1221	ND	0.1
Aroclor 1232	ND	0.1
Aroclor 1242	ND	0.1
Aroclor 1248	ND	0.1
Aroclor 1254	ND	0.1
Aroclor 1260	ND	0.1

ND = Not Detected.

SURROGATE RECOVERY, %	
PCB-	
2,4,5,6-TCMX	115
Decachlorobiphenyl	120

Continued . . .

SOUND ANALYTICAL SERVICES, INC.

Client ID: RUSH SP-SE-COM

	Concentration, mg/kg
Total Petroleum Hydrocarbons by EPA Method 418.1	9,300
Total Petroleum Fuel Hydrocarbons by EPA SW-846 Modified Method 8015	2,400
TPH as	Gas/Diesel/Heavy Oil

SURROGATE RECOVERY, %

TPH by Mod 8015	
1-Chlorooctane	195*
Perylene	152*

* Surrogate recoveries invalid due to matrix interference.

SOUND ANALYTICAL SERVICES

DENNIS L. BEAN

SOUND ANALYTICAL SERVICES, INC.

SPECIALIZING IN INDUSTRIAL & TOXIC WASTE ANALYSIS
4813 PACIFIC HIGHWAY EAST, TACOMA, WASHINGTON 98424 - TELEPHONE (206)922-2310 - FAX (206)922-5047

Report To: Rittenhouse-Zeman   Date: August 30, 1991

Report On: Analysis of Soil   Lab No.: 19514

IDENTIFICATION:
Sample received on 08-26-91
Project: W-7802
Client ID: RUSH SP-NW-COM

ANALYSIS:

Sample was extracted using Toxicity Characteristic Leaching Procedure (TCLP) in accordance with Federal Register, June 29, 1990. The leachate was analyzed in accordance with Test Methods for Evaluating Solid Waste, (SW-846), U.S.E.P.A., 1986 Method 8240 (Volatile Organics)

Compound	Concentration (mg/l)	PQL	Max. Conc. (mg/l)
Vinyl Chloride	ND	0.010	0.2
Chloroform	ND	0.005	6.0
1,2-Dichloroethane	ND	0.005	0.5
Carbon Tetrachloride	ND	0.005	0.5
Benzene	0.005	0.005	0.5
Chlorobenzene	ND	0.005	100
1,1-Dichloroethylene	ND	0.005	0.7
Methyl Ethyl Ketone	ND	0.100	200
Pyridine	ND	0.500	5.0
Tetrachloroethylene	ND	0.005	0.7
Trichloroethylene	ND	0.005	0.5

ND = Not detected.
PQL - Practical Quantitation Limit - These are the detection limits for this sample. This number is based on sample size, matrix and dilution required.
* = Compound was detected but below PQL. Value shown is an estimated quantity.

Volatile Surrogates

Surrogate	Percent Recovery	Control Limits
Toluene - D8	95	81 - 117
Bromofluorobenzene	86	74 - 121
1,2-Dichloroethane D4	107	70 - 121

Continued . . . . .

SOUND ANALYTICAL SERVICES, INC.

Client ID: RUSH SP-NW-COM

TCLP leachate was analyzed for metals in accordance with Test Methods for Evaluating Solid Waste, (SW-846), U.S.E.P.A., 1986 Method 6010 (ICP).

Contaminant	Concentration (mg/l)	Max Conc., (mg/l)
Lead	0.2	5.0

PCB in Soil:

	Concentration, mg/kg	Det. Limit
Aroclor 1016	ND	0.1
Aroclor 1221	ND	0.1
Aroclor 1232	ND	0.1
Aroclor 1242	ND	0.1
Aroclor 1248	ND	0.1
Aroclor 1254	ND	0.1
Aroclor 1260	ND	0.1

ND = Not Detected.

Surrogate Recovery, %

2,4,5,6-TCMX	100
Decachlorobiphenyl	105

Continued . . .

SOUND ANALYTICAL SERVICES, INC.

Rittenhouse-Zeman

Lab No. 19514
Date

Client ID: RUSH SP-NW-COM

	Concentration, mg/kg
Total Petroleum Hydrocarbons by EPA Method 418.1	860
Total Petroleum Fuel Hydrocarbons by EPA SW-846 Modified Method 8015	< 10
TPH as	*Aged Gas/Diesel

SURROGATE RECOVERY, %

TPH by Mod 8015	
1-Chlorooctane	118
Perylene	86

*Aged Gas/Diesel detected, however, quantity was below PQL.
Heavy oil was also detected

SOUND ANALYTICAL SERVICES

DENNIS L. BEAN

SOUND ANALYTICAL SERVICES, INC.

SPECIALIZING IN INDUSTRIAL & TOXIC WASTE ANALYSIS

4813 PACIFIC HIGHWAY EAST, TACOMA, WASHINGTON 98424 - TELEPHONE (206) 922-2310 - FAX (206) 922-5047

QUALITY CONTROL REPORT

DUPLICATES

Lab No: 19514 (1)
Date: August 30, 1991
Client: Rittenhouse-Zeman

Client ID: RUSH SP-NW-COM
Matrix: Soil
Units: mg/kg

Parameter	Sample(S)	Duplicate(D)	RPD*
Total Petroleum Hydrocarbons	860	880	2.3
Total Petroleum Fuel Hydrocarbons	< 10	< 10	0.0
%Surrogate Recovery			
1-Chlorooctane	118	105	
Perylene	86	79	

*RPD = relative percent difference
= [(S - D) / ((S + D) / 2)] x 100

SOUND ANALYTICAL SERVICES, INC.

SPECIALIZING IN INDUSTRIAL & TOXIC WASTE ANALYSIS

4813 PACIFIC HIGHWAY EAST, TACOMA, WASHINGTON 98424 - TELEPHONE (206)922-2310 - FAX (206)922-5047

Report To: Rittenhouse-Zeman　　　　Date: August 30, 1991

Report On: Analysis of Method Blank　　Lab No.: 19514-MB

IDENTIFICATION:
Sample received on 08-26-91
Project: W-7802
Client ID: **METHOD BLANK**

ANALYSIS:

PCB in Soil:

	Concentration, mg/kg	Det. Limit
Aroclor 1016	ND	0.1
Aroclor 1221	ND	0.1
Aroclor 1232	ND	0.1
Aroclor 1242	ND	0.1
Aroclor 1248	ND	0.1
Aroclor 1254	ND	0.1
Aroclor 1260	ND	0.1

ND = Not Detected.

Surrogate Recovery, %

2,4,5,6-TCMX	100
Decachlorobiphenyl	105

Sound Analytical Services, Inc.

SPECIALIZING IN INDUSTRIAL & TOXIC WASTE ANALYSIS

4813 PACIFIC HIGHWAY EAST, TACOMA, WASHINGTON 98424 - TELEPHONE (206) 922-2310 - FAX (206) 922-5047

ANALYTICAL NARRATIVE

TPH 8015 CHECKLIST

Client: Rittenhouse-Zeman

Lab No.: 19514

Project Name: W-7802

Prepared by: Dawn Werner

Delivered by: Joe Palmquist of SAS

Analyzed by: Dean Strom

Lab Number	1				
Client ID	RUSH SP-NW-COM				
Date Sampled	8-25-91				
Date Received	8-26-91				
Date Extracted	8-26-91				
Date Analyzed	8-27-91				
Sample Matrix	Soil				
Duplicate RPD	0.0				
Surrogate Recovery 8015 Modified 1-Chlorooctane Perylene	 118 86				
Condition of samples on receipt: Sample received cold and in good condition with chain of custody in order.					
Notes and Discussion: Aged Gas/Diesel detected, however, quantity was below PQL. Heavy oil was also detected.					

SOUND ANALYTICAL SERVICES, INC.

SPECIALIZING IN INDUSTRIAL & TOXIC WASTE ANALYSIS

4813 PACIFIC HIGHWAY EAST, TACOMA, WASHINGTON 98424 - TELEPHONE (206)922-2310 - FAX (206)922-5047

Report To: Rittenhouse-Zeman Date: August 30, 1991

Report On: Analysis of Soil Lab No.: 19517-2

IDENTIFICATION:
Sample received on 08-26-91
Project: W-7802

ANALYSIS:

Lab Sample No.	2	3
Client Identification	TK-BC	SP-EW
Units	mg/kg	mg/kg
Benzene Toluene Ethyl Benzene Xylenes BTEX by EPA SW-846 Method 8020	0.27 1.4 7.1 18	NT NT NT NT
Total Petroleum Fuel Hydrocarbons by EPA SW-846 Modified Method 8015	870	> 5,000*
TPH as	Gas/Diesel	Heavy Oil Gas/Diesel
Total Petroleum Hydrocarbons by EPA Method 418.1	2,200	2,700

NT = Not Tested

SURROGATE RECOVERY, %

Lab Sample No.	2	3
BTEX-Trifluorotoluene	198**	NT
TPH by Mod 8015 1-Chlorooctane Perylene	 410** 134	 1,002** 100

* Concentration outside of calibration range.
** Surrogate recovery invalid due to matrix interference.

SOUND ANALYTICAL SERVICES

MARTY FRENCH

SOUND ANALYTICAL SERVICES, INC.

SPECIALIZING IN INDUSTRIAL & TOXIC WASTE ANALYSIS

4813 PACIFIC HIGHWAY EAST, TACOMA, WASHINGTON 98424 - TELEPHONE (206) 922-2310 - FAX (206) 922-5047

QUALITY CONTROL REPORT

Client: Rittenhouse-Zeman
Project: W-7802
Lab No: 19517-1
Date: August 30, 1991

METHOD BLANKS

PARAMETER	BLANK VALUE
Aroclor 1016	< 0.1
Aroclor 1221	< 0.1
Aroclor 1232	< 0.1
Aroclor 1242	< 0.1
Aroclor 1248	< 0.1
Aroclor 1254	< 0.1
Aroclor 1260	< 0.1

SOUND ANALYTICAL SERVICES, INC.

SPECIALIZING IN INDUSTRIAL & TOXIC WASTE ANALYSIS

4813 PACIFIC HIGHWAY EAST, TACOMA, WASHINGTON 98424 - TELEPHONE (206)922-2310 - FAX (206)922-5047

QUALITY CONTROL REPORT

DUPLICATES

Lab No: 19517-2 (2)
Date: August 30, 1991
Client: Rittenhouse-Zeman

Client ID: TK-BC
Matrix: Soil
Units: mg/kg

Compound	Sample(S)	Duplicate(D)	RPD
Benzene	0.27	0.21	25.0
Toluene	1.4	1.2	15.4
Ethyl Benzene	7.1	5.8	20.2
Xylenes	18	14	25.0
%Surrogate Recovery			
Trifluorotoluene	198*	180*	

* Surrogate recovery invalid due to matrix interference.

Lab No: 19517-2 (3)
Date: August 30, 1991
Client: Rittenhouse-Zeman

Client ID: SP-EW
Matrix: Soil
Units: mg/kg

Compound	Sample(S)	Duplicate(D)	RPD
Total Petroleum Fuel Hydrocarbons	> 5,000*	> 5,000*	0.0
%Surrogate Recovery			
1-Chlorooctane	1,002**	1,288**	
Perylene	100	172	

* Concentration outside of calibration range.
** Surrogate recovery invalid due to matrix interference.

RPD = relative percent difference
= [(S - D) / ((S + D) / 2)] x 100

SOUND ANALYTICAL SERVICES, INC.

SPECIALIZING IN INDUSTRIAL & TOXIC WASTE ANALYSIS
4813 PACIFIC HIGHWAY EAST, TACOMA, WASHINGTON 98424 - TELEPHONE (206) 922-2310 - FAX (206) 922-5047

ANALYTICAL NARRATIVE

TPH 8015 CHECKLIST

Client: Rittenhouse-Zeman

Lab No.: 19517

Project Name: W-7802

Prepared by: Dawn Werner

Delivered by: Joe Palmquist

Analyzed by: Marty French
Dean Strom

Lab Number	1	2	3		
Client ID	SP-SE-COM	TK-BC	SP-EW		
Date Sampled	8-23-91	8-23-91	8-23-91		
Date Received	8-26-91	8-26-91	8-26-91		
Date Extracted:					
BTEX		8-27-91			
TPH	8-27-91	8-27-91	8-27-91		
Date Analyzed:					
BTEX		8-29-91			
TPH	8-29-91	8-29-91	8-29-91		
Dilution Factor					
Sample Matrix	Soil	Soil	Soil		
Duplicate RPD:					
TPH			0.0		
Surrogate Recovery					
BTEX- Trifluorotoluene		198			
8015 Modified					
1-Chlorooctane	195*	410*	1,002*		
Perylene	152*	134	100		

Condition of samples on receipt:
Samples were received in good condition and cold. Chain of custody was in order.

Notes and Discussion:
* Surrogate recoveries invalid due to matrix interference.
Heavy oil detected in all samples. Concentrations estimated using diesel curve.

SOUND ANALYTICAL SERVICES, INC.

SPECIALIZING IN INDUSTRIAL & TOXIC WASTE ANALYSIS

4813 PACIFIC HIGHWAY EAST, TACOMA, WASHINGTON 98424 - TELEPHONE (206)922-2310 - FAX (206)922-5047

Report To: Rittenhouse-Zeman　　Date: August 30, 1991

Report On: Analysis of Soil　　Lab No.: 19517-2

IDENTIFICATION:
Sample received on 08-26-91
Project: W-7802

ANALYSIS:

Lab Sample No.	2	3
Client Identification	TK-BC	SP-EW
Units	mg/kg	mg/kg
Benzene Toluene Ethyl Benzene Xylenes BTEX by EPA SW-846 Method 8020	0.27 1.4 7.1 18	NT NT NT NT
Total Petroleum Fuel Hydrocarbons by EPA SW-846 Modified Method 8015	870	> 5,000*
TPH as	Gas/Diesel	Heavy Oil Gas/Diesel
Total Petroleum Hydrocarbons by EPA Method 418.1	2,200	2,700

NT = Not Tested

SURROGATE RECOVERY, %

Lab Sample No.	2	3
BTEX-Trifluorotoluene	198**	NT
TPH by Mod 8015 1-Chlorooctane Perylene	 410** 134	 1,002** 100

* Concentration outside of calibration range.
** Surrogate recovery invalid due to matrix interference.

SOUND ANALYTICAL SERVICES

MARTY FRENCH

SOUND ANALYTICAL SERVICES, INC.

SPECIALIZING IN INDUSTRIAL & TOXIC WASTE ANALYSIS

4813 PACIFIC HIGHWAY EAST, TACOMA, WASHINGTON 98424 - TELEPHONE (206) 922-2310 - FAX (206) 922-5047

QUALITY CONTROL REPORT

Client: Rittenhouse-Zeman
Project: W-7802
Lab No: 19517-1
Date: August 30, 1991

METHOD BLANKS

PARAMETER	BLANK VALUE
Aroclor 1016	< 0.1
Aroclor 1221	< 0.1
Aroclor 1232	< 0.1
Aroclor 1242	< 0.1
Aroclor 1248	< 0.1
Aroclor 1254	< 0.1
Aroclor 1260	< 0.1

SOUND ANALYTICAL SERVICES, INC.

SPECIALIZING IN INDUSTRIAL & TOXIC WASTE ANALYSIS

4813 PACIFIC HIGHWAY EAST, TACOMA, WASHINGTON 98424 - TELEPHONE (206)922-2310 - FAX (206)922-5047

QUALITY CONTROL REPORT

DUPLICATES

Lab No: 19517-2 (2)
Date: August 30, 1991
Client: Rittenhouse-Zeman

Client ID: TK-BC
Matrix: Soil
Units: mg/kg

Compound	Sample(S)	Duplicate(D)	RPD
Benzene	0.27	0.21	25.0
Toluene	1.4	1.2	15.4
Ethyl Benzene	7.1	5.8	20.2
Xylenes	18	14	25.0
%Surrogate Recovery			
Trifluorotoluene	198*	180*	

* Surrogate recovery invalid due to matrix interference.

Lab No: 19517-2 (3)
Date: August 30, 1991
Client: Rittenhouse-Zeman

Client ID: SP-EW
Matrix: Soil
Units: mg/kg

Compound	Sample(S)	Duplicate(D)	RPD
Total Petroleum Fuel Hydrocarbons	> 5,000*	> 5,000*	0.0
%Surrogate Recovery			
1-Chlorooctane	1,002**	1,288**	
Perylene	100	172	

* Concentration outside of calibration range.
** Surrogate recovery invalid due to matrix interference.

RPD = relative percent difference
= [(S - D) / ((S + D) / 2)] x 100

SOUND ANALYTICAL SERVICES, INC.

SPECIALIZING IN INDUSTRIAL & TOXIC WASTE ANALYSIS

4813 PACIFIC HIGHWAY EAST, TACOMA, WASHINGTON 98424 - TELEPHONE (206) 922-2310 - FAX (206) 922-5047

ANALYTICAL NARRATIVE

TPH 8015 CHECKLIST

Client: Rittenhouse-Zeman

Lab No.: 19517

Project Name: W-7802

Prepared by: Dawn Werner

Delivered by: Joe Palmquist

Analyzed by: Marty French
Dean Strom

Lab Number	1	2	3		
Client ID	SP-SE-COM	TK-BC	SP-EW		
Date Sampled	8-23-91	8-23-91	8-23-91		
Date Received	8-26-91	8-26-91	8-26-91		
Date Extracted: BTEX TPH	 8-27-91	 8-27-91 8-27-91	 8-27-91		
Date Analyzed: BTEX TPH	 8-29-91	 8-29-91 8-29-91	 8-29-91		
Dilution Factor					
Sample Matrix	Soil	Soil	Soil		
Duplicate RPD: TPH			 0.0		
Surrogate Recovery BTEX- Trifluorotoluene 8015 Modified 1-Chlorooctane Perylene	 195* 152*	 198 410* 134	 1,002* 100		

Condition of samples on receipt:
Samples were received in good condition and cold. Chain of custody was in order.

Notes and Discussion:
* Surrogate recoveries invalid due to matrix interference.
Heavy oil detected in all samples. Concentrations estimated using diesel curve.

RZA

RITTENHOUSE-ZEMAN & ASSOCIATES, INC.
ENVIRONMENTAL CONSULTANTS

1400 140th AVENUE NE
BELLEVUE, WASHINGTON 98005
(206)746-8020 FAX#(206)746-6364

CHAIN OF CUSTODY RECORD / LABORATORY ANALYSES REQUEST

JOB #: W-7802

PROJECT NAME:

RZA CONTACT: Carol Hutley

PHONE #: 820-4669

ANALYSIS REQUESTED: (Circle, Check Box, or Write Preferred Method in Box) OTHER: (Write in)

SAMPLE ID #	DATE	TIME	PRESERV.	MATRIX	BTEX	Total Petrol. Hydrocarbons EPA 418.1	Fuel Scan/TPH by GC EPA 8015-mod.	Halogenated Volatiles EPA 601 EPA 8010	Aromatics EPA 602 EPA 8020	PolyNuclear Aromatics EPA 610 8310	Total Halogens (TOX) EPA 9076	Total Metals ICP AA	TCLP Metals EPA 1311	Purgeable Organics GC/MS: EPA 8240 624	Base/Neut/Acid/Organics GC/MS: EPA 625 8270	(PCB) EPA 608 8080	Ignitability (Flash) EPA 1010	TCLP VOLATILES (SOLVENTS)	8015 COMBINED GAS/DIESEL	TCLP ORG. LEAD			Hold for Future Analysis	# of Containers	Detection Limits Desired
RUSH 1 SP-SE-COM	8/25	9:30	None	Soil		X										X		X	X	X				1	
RUSH 2 SP-NW-COM	8/25	9:20	None	Soil		X										X		X	X	X				1	
3 TK-BC	8/23		None	Soil	X	X													X					1	
4 SP-EW	8/23		None	Soil		X													X					1	
5																									
6																									
7																									
8																									
9																									
10																									
11																									
12																									

RELINQUISHED BY RZA:	RELINQUISHED BY:	RELINQUISHED BY:
Signature: Carol Hutley	Signature: Mike Bekey	Signature: J Palmquist
Printed Name: CAROL HUTLEY	Printed Name: Michael Bekey	Printed Name: PALMQUIST
Firm: RZA	Firm: RZA	Firm: SAS
Date/Time: 9:12	Date/Time: 8/26 10:30	Date/Time: 8/26 12:25

RECEIVED BY:	RECEIVED BY:	RECEIVED BY:
Signature: Mike Bekey	Signature: J Palmquist	Signature: Mary Curtiss
Printed Name: Michael Bekey	Printed Name: PALMQUIST	Printed Name: Mary Curtiss
Firm: RZA	Firm: SAS	Firm: SAS
Date/Time: 8-26 9:13 AM	Date/Time: 8/26 11:35A	Date/Time: 8/26/91 12:25

LABORATORY: Sound Analytical

Shipping I.D. #:

Carrier:

DOT Designation:

SAMPLE RECEIPT:

Total # Containers:

Condition of Containers?

Condition of Seals?

SPECIAL INSTRUCTIONS/COMMENTS:

Need these results by 5 p.m. Friday Please. Be aware that some of these samples may contain peat.

DISTRIBUTION: WHITE-return to originator; YELLOW-lab; PINK-retained by originator.

SOUND ANALYTICAL SERVICES, INC.

SPECIALIZING IN INDUSTRIAL & TOXIC WASTE ANALYSIS

4813 PACIFIC HIGHWAY EAST, TACOMA, WASHINGTON 98424 - TELEPHONE (206)922-2310 - FAX (206)922-5047

Report To: Rittenhouse-Zeman

Date: September 9, 1991

Report On: Analysis of Soil

Lab No: 19516

IDENTIFICATION:

Samples received on 08-26-91
Project: W-7802

ANALYSIS:

Lab Sample No.	1	2	3	4
Client ID	Comp. EX-NWE & NWW	Comp. EX-SWE & SWW	Comp. EX-EWN & EWS	Comp. EX-WWN & WWS
Units	mg/kg	mg/kg	mg/kg	mg/kg
Total Petroleum Hydrocarbons by EPA Method 418.1	58	160	96	65
WTPH-G				
Gasoline (C7 - C12)	< 1.0	< 1.0	< 1.0	< 1.0
BTEX by 8020				
Benzene	< 0.05	< 0.05	< 0.05	< 0.05
Toluene	< 0.05	< 0.05	< 0.05	< 0.05
Ethyl Benzene	< 0.05	< 0.05	< 0.05	< 0.05
Xylenes	< 0.05	< 0.05	< 0.05	< 0.05
WTPH-D				
Diesel (> C12 - C24)	< 25	< 25	< 25	< 25
SURROGATE RECOVERIES				
WTPH-G Trifluorotoluene %	112	103	89	113
BTEX- Trifluorotoluene %	114	110	86	107
WTPH-D Perylene %	90	83	89	105

Results are reported on a dry weight basis.

Continued . . .

SOUND ANALYTICAL SERVICES, INC.

Rittenhouse-Zeman
Project: W-7802

Lab No. 19516
September 9, 1991

Lab Sample No.	5	6
Client ID	Comp. Ex. BNE & BNW	Comp. Ex BSE & BSW
Units	mg/kg	mg/kg
Total Petroleum Hydrocarbons by EPA Method 418.1	87	170
WTPH-G		
Gasoline (C7 - C12)	5.6	< 1.0
BTEX by 8020		
Benzene	0.058	< 0.05
Toluene	< 0.05	< 0.05
Ethyl Benzene	< 0.05	< 0.05
Xylenes	0.063	< 0.05
WTPH-D		
Diesel (> C12 - C24)	65	66
SURROGATE RECOVERIES		
WTPH-G Trifluorotoluene %	114	124
BTEX- Trifluorotoluene %	114	97
WTPH-D Perylene %	78	138

Results are reported on a dry weight basis.

SOUND ANALYTICAL SERVICES

MARTY FRENCH

NORTH CREEK ANALYTICAL

18939 120th Avenue N.E., Suite 101 • Bothell, WA 98011-2569
Phone (206) 481-9200 • FAX (206) 485-2992

Rittenhouse Zeman & Associates	Client Project ID: City of Bothell 7802	Analyst :	J. Kimball
11335 NE 122nd Way, #100	Method : EPA 418.1 mod.		
Kirkland, WA 98034	Sample Matrix : Water		
Attention: Randy Adams	Units : mg/L	Analyzed:	Oct 23, 1991
	QC Sample #: BLK102391	Reported:	Oct 23, 1991

QUALITY CONTROL DATA REPORT

ANALYTE	Petroleum Oil
Sample Conc.:	N.D.
Spike Conc. Added:	15
Conc. Matrix Spike:	14.5
Matrix Spike % Recovery:	97
Conc. Matrix Spike Dup.:	14.3
Matrix Spike Duplicate % Recovery:	95
Relative % Difference:	1.4

NORTH CREEK ANALYTICAL

Scot Cocanour
Laboratory Director

% Recovery: $\frac{\text{Conc. of M.S. - Conc. of Sample}}{\text{Spike Conc. Added}} \times 100$

Relative % Difference: $\frac{\text{Conc. of M.S. - Conc. of M.S.D.}}{\text{(Conc. of M.S. + Conc. of M.S.D.) / 2}} \times 100$

SOUND ANALYTICAL SERVICES, INC.

SPECIALIZING IN INDUSTRIAL & TOXIC WASTE ANALYSIS
4813 PACIFIC HIGHWAY EAST, TACOMA, WASHINGTON 98424 - TELEPHONE (206)922-2310 - FAX (206)922-5047

QUALITY CONTROL REPORT

DUPLICATES

Lab No: 19516 (6)
Date: September 9, 1991
Client: Rittenhouse-Zeman

Client ID: Ex BSE & BSW
Matrix: Soil
Units: mg/kg

Compound	Sample(S)	Duplicate(D)	RPD*
WTPH-D			
Diesel (C11)-(C24)	66	53	21.8
WTPH-418.1 MODIFIED			
Heavy Petroleum Oils	170	170	0.0
SURROGATE RECOVERY, %			
WTPH-D- Trifluorotoluene	138	93	

*RPD = relative percent difference
= [(S - D) / ((S + D) / 2)] x 100

SOUND ANALYTICAL SERVICES, INC.

SPECIALIZING IN INDUSTRIAL & TOXIC WASTE ANALYSIS

4813 PACIFIC HIGHWAY EAST, TACOMA, WASHINGTON 98424 - TELEPHONE (206) 922-2310 - FAX (206) 922-5047

ANALYTICAL NARRATIVE CHECKLIST

Client: Rittenhouse-Zeman

Lab No.: 19516

Project Name: W-7802

Prepared by: Joe Palmquist

Delivered by: Joe Palmquist

Analyzed by: Marty French

Lab Number	1	2	3	4	5
Client ID	EX-NWE & NWW	EX-SWE & SWW	EX-EWN EWS	EX-WWN & WWS	Ex. BNE & BNW
Date Sampled	8-23-91	8-23-91	8-23-91	8-23-91	8-23-91
Date Received	8-26-91	8-26-91	8-26-91	8-26-91	8-26-91
Date Extracted:					
418.1	8-29-91	8-29-91	8-29-91	8-29-91	8-29-91
WTPH-D	8-29-91	8-29-91	8-29-91	8-29-91	8-29-91
WTPH-G	8-29-91	8-29-91	8-29-91	8-29-91	8-29-91
BTEX	8-29-91	8-29-91	8-29-91	8-29-91	8-29-91
Date Analyzed:					
418.1	8-30-91	8-30-91	8-30-91	8-30-91	8-30-91
WTPH-D	9-3-91	9-3-91	9-3-91	9-3-91	9-3-91
WTPH-G	8-31-91	8-31-91	8-31-91	8-31-91	8-31-91
BTEX	8-31-91	8-31-91	8-31-91	8-31-91	8-31-91
Sample Matrix	Soil	Soil	Soil	Soil	Soil
Surrogate Recovery					
WTPH-D perylene %	90	83	89	105	78
WTPH-G Trifluorotoluene	112	103	89	113	114
BTEX- Trifluorotoluene	114	110	86	107	114

Condition of samples on receipt:
Samples were received in good condition and cold. Chain of custody was in order.

Notes and Discussion:

SOUND ANALYTICAL SERVICES, INC.

SPECIALIZING IN INDUSTRIAL & TOXIC WASTE ANALYSIS
4813 PACIFIC HIGHWAY EAST, TACOMA, WASHINGTON 98424 - TELEPHONE (206) 922-2310 - FAX (206) 922-5047

ANALYTICAL NARRATIVE CHECKLIST

Client: Rittenhouse-Zeman

Lab No.: 19516

Project Name: W-7802

Prepared by: Joe Palmquist

Delivered by: Joe Palmquist

Analyzed by: Marty French

Lab Number	6				
Client ID	Ex BSE & BSW				
Date Sampled	8-23-91				
Date Received	8-26-91				
Date Extracted: 418.1 WTPH-D WTPH-G BTEX	 8-29-91 8-29-91 8-29-91 8-29-91				
Date Analyzed: 418.1 WTPH-D WTPH-G BTEX	 8-30-91 9-3-91 8-31-91 8-31-91				
Duplicate RPD: 418.1 WTPH-D Sample Matrix	 0.0 21.7 Soil				
Surrogate Recovery WTPH-D perylene % WTPH-G Trifluorotoluene BTEX- Trifluorotoluene	 138 124 97				

Condition of samples on receipt:
Samples were received in good condition and cold. Chain of custody was in order.

RZA

RITTENHOUSE-ZEMAN & ASSOCIATES, INC.
ENVIRONMENTAL CONSULTANTS

1400 140th AVENUE NE
BELLEVUE, WASHINGTON 98005
(206)746-8020 FAX#(206)746-6364

CHAIN OF CUSTODY RECORD / LABORATORY ANALYSES REQUEST

JOB #: W-7802

PROJECT NAME:

RZA CONTACT: Carol Hutley

PHONE #:

SAMPLE ID #	DATE	TIME	PRESERV.	MATRIX
1 EX-NWE	8/23		None	Soil
2 EX-NWW	8/23		None	Soil
3 EX-SWE	8/23		None	Soil
4 EX-SWW	8/23		None	Soil
5 EX-EWN	8/23		None	Soil
6 EX-EWS	8/23		None	Soil
7 EX-WWN	8/23		None	Soil
8 EX-WWS	8/23		None	Soil
9 EX-BNE	8/23		None	Soil
10 EX-BNW	8/23		None	Soil
11. EX-BSE	8/23		None	Soil
12 EX-BSW	8/23		None	Soil

ANALYSIS REQUESTED: (Circle, Check Box, or Write Preferred Method in Box) OTHER: (Write in)

SAMPLE ID #	BTEX	Total Petrol. Hydrocarbons EPA 418.1	Fuel Scan/TPH by GC EPA 8015-mod.	Halogenated Volatiles EPA 601 EPA 8010	Aromatics EPA 602 EPA 8020	PolyNuclear Aromatics EPA 610 8310	Total Halogens (TOX) EPA 9076	Total Metals ICP AA	TCLP Metals EPA 1311	Purgeable Organics GC/MS: EPA 8240 624	Base/Neut/Acid/Organics GC/MS: EPA 625 8270	PCB EPA 608 8080	Ignitability (Flash) EPA 1010	WTPH G	WTPH D	TOTAL LEAD			Hold for Future Analysis	# of Containers	Detection Limits Desired
1	X	X												X	X						
2																					
3	X	X												X	X						
4																					
5	X	X												X	X						
6																					
7	X	X												X	X						
8																					
9	X	X												X	X						
10																					
11	X	X												X	X						
12																					

RELINQUISHED BY RZA:	RELINQUISHED BY:	RELINQUISHED BY:
Signature: Carol Hutley	Signature: [signature]	Signature: [signature]
Printed Name: CAROL HURLEY	Printed Name: Michael Bekey	Printed Name: PALMQUIST
Firm: RZA	Firm: RZA	Firm: SAS
Date/Time: 9:12	Date/Time: 8/26 1135	Date/Time: 8/26 12:25P

RECEIVED BY:	RECEIVED BY:	RECEIVED BY:
Signature: [signature]	Signature: [signature]	Signature: Mary Curtiss
Printed Name: Michael Bekey	Printed Name: PALMQUIST	Printed Name: Mary Curtiss
Firm: RZA	Firm: SDS	Firm: SAS
Date/Time: 8-26 9:13 AM	Date/Time: 8/26 11:35A	Date/Time: 8/26/91 12:25

LABORATORY: Sound Analytical

Shipping I.D. #:

Carrier:

DOT Designation:

SAMPLE RECEIPT:

Total # Containers:

Condition of Containers?

Condition of Seals?

SPECIAL INSTRUCTIONS/COMMENTS:

Standard turnaround
Be aware that many of these samples may contain peat.
Composite samples per markings (C)

DISTRIBUTION: WHITE-return to originator; YELLOW-lab; PINK-retained by originator.

SOUND ANALYTICAL SERVICES, INC.

SPECIALIZING IN INDUSTRIAL & TOXIC WASTE ANALYSIS

4813 PACIFIC HIGHWAY EAST, TACOMA, WASHINGTON 98424 - TELEPHONE (206)922-2310 - FAX (206)922-5047

Report To: Rittenhouse-Zeman

Date: September 12, 1991

Report On: Analysis of Water

Lab No.: 19784

<u>IDENTIFICATION:</u>
Samples received on 09-06-91
Project: W-7802

<u>ANALYSIS:</u>

Lab Sample No.	1
Client Identification	W5
Units	mg/l
OREGON-HCID Gasoline (C7 - C12) Diesel (> C12 - C24) Heavy Petroleum Oils (C24+)	 < 20 < 50 ND
SURROGATE RECOVERIES WTPH-HCID 1-Chlorooctane % Perylene %	 111 132

ND = None detected
< = less than
> = greater than

Results are reported on a dry weight basis.

Continued . . .

SOUND ANALYTICAL SERVICES, INC.

Rittenhouse-Zeman
Project: W-7802

Lab No. 19784
September 12, 1991

Lab Sample No.	2
Client ID	W1
Units	mg/l
BTEX by 8020	
Benzene	< 0.001
Toluene	< 0.001
Ethyl Benzene	< 0.001
Xylenes	< 0.001
SURROGATE RECOVERIES	
BTEX-Trifluorotoluene %	67

Results are reported on a dry weight basis.

SOUND ANALYTICAL SERVICES

MARTY FRENCH

Sound Analytical Services, Inc.

SPECIALIZING IN INDUSTRIAL & TOXIC WASTE ANALYSIS

4813 PACIFIC HIGHWAY EAST, TACOMA, WASHINGTON 98424 · TELEPHONE (206) 922-2310 · FAX (206) 922-5047

ANALYTICAL NARRATIVE

Client: Rittenhouse - Zeman

Lab No.: 19784

Project Name: W-7802

Prepared by: Felix Zboralski

Delivered by: Joe Palmquist of SAS

Analyzed by: Dean Strom (HCID)
Marty French (BTEX)

Lab Number	1	2			
Client ID	W5	W1			
Date Sampled	9-4-91	9-4-91			
Date Received	9-6-91	9-6-91			
Date Extracted	9-10-91	9-10-91			
Date Analyzed	9-11-91	9-10-91			
Sample Matrix	Water	Water			
%Surrogate Recovery BTEX- Trifluorotoluene	NT	67			
Surrogate Recovery HCID: 1-Chlorooctane % Perylene %	111 132	NT NT			

Condition of samples on receipt: Samples received cold and in good condition with chain of custody in order.

Notes and Discussion: NT = Not Tested.

RZA
RITTENHOUSE-ZEMAN & ASSOCIATES, INC.
ENVIRONMENTAL CONSULTANTS

1400 140th AVENUE NE
BELLEVUE, WASHINGTON 98005
(206)746-8020 FAX#(206)746-6364

CHAIN OF CUSTODY RECORD / LABORATORY ANALYSES REQUEST 9-5-91

JOB #: 7802

PROJECT NAME:

RZA CONTACT: Carol Hutley

PHONE #: 820-4669

ANALYSIS REQUESTED: (Circle, Check Box, or Write Preferred Method in Box) OTHER: (Write in)

SAMPLE ID #	DATE	TIME	PRESERV.	MATRIX	BTEX	Total Petrol. Hydrocarbons EPA 418.1	Fuel Scan/TPH by GC EPA 8015-mod.	Halogenated Volatiles EPA 601 EPA 8010	Aromatics EPA 602 EPA 8020	PolyNuclear Aromatics EPA 610 8310	Total Halogens (TOX) EPA 9076	Total Metals ICP AA	TCLP Metals EPA 1311	Purgeable Organics GC/MS: EPA 8240 624	Base/Neut/Acid/Organics GC/MS: EPA 625 8270	PCB EPA 608 8080	Ignitability (Flash) EPA 1010	HCID OREGON METHOD					Hold for Future Analysis	# of Containers	Detection Limits Desired
1 W5	9/4		None	H_2O														✓						1 liter	
2 W1	9/4		None	H_2O	✓																			1 VOA	
3																									
4																									
5																									
6																									
7																									
8																									
9																									
10																									
11																									
12																									

RELINQUISHED BY RZA:	RELINQUISHED BY:	RELINQUISHED BY:
Signature: Carol Hutley	Signature: [signature]	Signature: [signature]
Printed Name: CAROL HUTLEY	Printed Name: Michael Bekey	Printed Name: PALMQUIST
Firm: RZA-AGRA	Firm: RZA	Firm: SAS
Date/Time: 9-5-91 4:15	Date/Time: 9/6 11:10	Date/Time: 9/6/91 2:03

RECEIVED BY:	RECEIVED BY:	RECEIVED BY:
Signature: [signature]	Signature: [signature]	Signature: Mary Curtiss
Printed Name: Michael Bekey	Printed Name: PALMQUIST	Printed Name: Mary Curtiss
Firm: RZA AGRA	Firm: SAS	Firm: SAS
Date/Time: 9-5-91 4:15	Date/Time: 9/6/91 11:10A	Date/Time: 9/6/91 2:03

LABORATORY:

Shipping I.D. #:

Carrier:

DOT Designation:

SAMPLE RECEIPT:

Total # Containers:

Condition of Containers?

Condition of Seals?

SPECIAL INSTRUCTIONS/COMMENTS:

DISTRIBUTION: WHITE-return to originator; YELLOW-lab; PINK-retained by originator.

SOUND ANALYTICAL SERVICES, INC.

SPECIALIZING IN INDUSTRIAL & TOXIC WASTE ANALYSIS

4813 PACIFIC HIGHWAY EAST, TACOMA, WASHINGTON 98424 - TELEPHONE (206)922-2310 - FAX (206)922-5047

Report To: Rittenhouse - Zeman   Date: September 13, 1991

Report On: Analysis of Soil & Water   Lab No.: 19918

IDENTIFICATION:
Sample received on 09-12-91
Project: W-7802

ANALYSIS:

Lab Sample No.	Client ID	Total Petroleum Hydrocarbons, by EPA Method 418.1
RUSH 1	EX-SWW-2 (soil)	1,300 mg/kg
RUSH 2	EX-SWE-2 (soil)	110 mg/kg
RUSH 3	W-5 (water)	235 mg/l

Note - Soil results reported on a dry weight basis.

SOUND ANALYTICAL SERVICES

MARTY FRENCH

SOUND ANALYTICAL SERVICES, INC.

SPECIALIZING IN INDUSTRIAL & TOXIC WASTE ANALYSIS

4813 PACIFIC HIGHWAY EAST, TACOMA, WASHINGTON 98424 - TELEPHONE (206) 922-2310 - FAX (206) 922-5047

QUALITY CONTROL REPORT

DUPLICATES

Lab No: 19918 (1)
Date: September 13, 1991
Client: Rittenhouse - Zeman

Client ID: EX-SWW-2
Matrix: Soil
Units: mg/kg

Parameter	Sample(S)	Duplicate(D)	RPD*
Total Petroleum Hydrocarbons	1,300	1,600	20

*RPD = relative percent difference
$= [(S - D) / ((S + D) / 2)] \times 100$

RZA

RITTENHOUSE-ZEMAN & ASSOCIATES, INC.
ENVIRONMENTAL CONSULTANTS

1400 140th AVENUE NE
BELLEVUE, WASHINGTON 98005
(206)746-8020 FAX#(206)746-6364

CHAIN OF CUSTODY RECORD / LABORATORY ANALYSES REQUEST

JOB #: 7802

PROJECT NAME:

RZA CONTACT: Carol Hutley

PHONE #: 820-4669

ANALYSIS REQUESTED: (Circle, Check Box, or Write Preferred Method in Box) OTHER: (Write in)

SAMPLE ID #	DATE	TIME	PRESERV.	MATRIX	BTEX	Total Petrol. Hydrocarbons EPA 418.1	Fuel Scan/TPH by GC EPA 8015-mod.	Halogenated Volatiles EPA 601 EPA 8010	Aromatics EPA 602 EPA 8020	PolyNuclear Aromatics EPA 610 8310	Total Halogens (TOX) EPA 9076	Total Metals ICP AA	TCLP Metals EPA 1311	Purgeable Organics GC/MS: EPA 8240 624	Base/Neut/Acid/Organics GC/MS: EPA 625 8270	PCB EPA 608 8080	Ignitability (Flash) EPA 1010						Hold for Future Analysis	# of Containers	Detection Limits Desired
1 EX-SWW-2	9/12		None	Soil		✓																		1	
2 EX-SWE-2	9/12		None	Soil		✓																		1	
3 W-5	9/12		None	H_2O		✓																		1 liter	
4																									
5																									
6																									
7																									
8																									
9																									
10																									
11																									
12																									

RELINQUISHED BY RZA:	RELINQUISHED BY:	RELINQUISHED BY:
Signature: Carol Hutley	Signature: [signature]	Signature: [signature]
Printed Name: Carol Hutley	Printed Name: Michael Bekey	Printed Name: Palmquist
Firm: RZA	Firm: RZA	Firm: SAS
Date/Time: 9/12/91 10:30	Date/Time: 9/12/91 11:10	Date/Time: 9/12/91 12:15

RECEIVED BY:	RECEIVED BY:	RECEIVED BY:
Signature: [signature]	Signature: [signature]	Signature: S Giang
Printed Name: Michael Bekey	Printed Name: PALMQUIST	Printed Name: S Giang
Firm: RZA	Firm: SAS	Firm: SAS
Date/Time: 9/12/91 10:30	Date/Time: 9/12/91 11:10	Date/Time: 9/12/91 12:15

LABORATORY:

Shipping I.D. #:

Carrier:

DOT Designation:

SAMPLE RECEIPT:

Total # Containers:

Condition of Containers?

Condition of Seals?

SPECIAL INSTRUCTIONS/COMMENTS:

24 hrs on turn around

Please be sure to get a representative sample of the soil. It is layered in the jar.

DISTRIBUTION: WHITE-return to originator; YELLOW-lab; PINK-retained by originator.

PAGE ___ OF ___

Sound Analytical Services, Inc.

SPECIALIZING IN INDUSTRIAL & TOXIC WASTE ANALYSIS

4813 PACIFIC HIGHWAY EAST, TACOMA, WASHINGTON 98424 - TELEPHONE (206) 922-2310 - FAX (206) 922-5047

QUALITY CONTROL REPORT

DUPLICATES

Lab No: 20144 (2)
Date: September 26, 1991
Client: Rittenhouse-Zeman

Client ID: EX-SWW-3
Matrix: Soil
Units: mg/kg

Parameter	Sample(S)	Duplicate(D)	RPD*
Total Petroleum Hydrocarbons	43	39	9.7

*RPD = relative percent difference
= [(S - D) / ((S + D) / 2)] x 100

RZA
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1400 140th AVENUE NE
BELLEVUE, WASHINGTON 98005
(206)746-8020 FAX#(206)746-6364

CHAIN OF CUSTODY RECORD / LABORATORY ANALYSES REQUEST

JOB #: 7802

PROJECT NAME:

RZA CONTACT: Carol Hutley

PHONE #: 820-4669

ANALYSIS REQUESTED: (Circle, Check Box, or Write Preferred Method in Box) OTHER: (Write in)

SAMPLE ID #	DATE	TIME	PRESERV.	MATRIX	BTEX	Total Petrol. Hydrocarbons EPA 418.1	Fuel Scan/TPH by GC EPA 8015-mod.	Halogenated Volatiles EPA 601 EPA 8010	Aromatics EPA 602 EPA 8020	PolyNuclear Aromatics EPA 610 8310	Total Halogens (TOX) EPA 9076	Total Metals ICP AA	TCLP Metals EPA 1311	Purgeable Organics GC/MS: EPA 8240 624	Base/Neut/Acid/Organics GC/MS: EPA 625 8270	PCB EPA 608 8080	Ignitability (Flash) EPA 1010						Hold for Future Analysis	# of Containers	Detection Limits Desired
1 W-2	9/20		None	H_2O		✓																		2	
2 EX-SWW-3	9/20		None	Soil		✓																		1	
3																									
4																									
5																									
6																									
7																									
8																									
9																									
10																									
11																									
12																									

RELINQUISHED BY RZA:	RELINQUISHED BY:	RELINQUISHED BY:
Signature: Carol Hutley	Signature: [signature]	Signature: [signature]
Printed Name: CAROL HUTLEY	Printed Name: Michael Bailey	Printed Name: PALMQUIST
Firm: RZA	Firm: RZA	Firm: SAS
Date/Time: 10:22 9/23/91	Date/Time: 9/23/91 10:45	Date/Time: 9/23 11:30A
RECEIVED BY:	**RECEIVED BY:**	**RECEIVED BY:**
Signature: [signature]	Signature: [signature]	Signature: Mary Curtiss
Printed Name: Michael Bailey	Printed Name: PALMQUIST	Printed Name: Mary Curtiss
Firm: RZA AGRA	Firm: SAS	Firm: SAS
Date/Time: 10:22 9/23/91	Date/Time: 9/23 10:45A	Date/Time: 9/23/91 11:30

LABORATORY: Sound Analytical

Shipping I.D. #:

Carrier:

DOT Designation:

SAMPLE RECEIPT:

Total # Containers:

Condition of Containers?

Condition of Seals?

SPECIAL INSTRUCTIONS/COMMENTS:

Attn: Stan

DISTRIBUTION: WHITE-return to originator; YELLOW-lab; PINK-retained by originator.

SOUND ANALYTICAL SERVICES, INC.

SPECIALIZING IN INDUSTRIAL & TOXIC WASTE ANALYSIS
4813 PACIFIC HIGHWAY EAST, TACOMA, WASHINGTON 98424 - TELEPHONE (206)922-2310 - FAX (206)922-5047

Report To: Rittenhouse-Zeman — Date: September 27, 1991

Report On: Analysis of Water — Lab No.: 20104

IDENTIFICATION:
Sample received on 09-20-91
Project: W-7802 City of Bothell
Client ID: PW1

ANALYSIS:

Total Petroleum Hydrocarbons, mg/l by EPA Method 418.1	13

SOUND ANALYTICAL SERVICES
[signature]
STAN P. PALMQUIST

SOUND ANALYTICAL SERVICES, INC.

SPECIALIZING IN INDUSTRIAL & TOXIC WASTE ANALYSIS

4813 PACIFIC HIGHWAY EAST, TACOMA, WASHINGTON 98424 - TELEPHONE (206) 922-2310 - FAX (206) 922-5047

QUALITY CONTROL REPORT

DUPLICATES

Lab No: 20104 (1)
Date: September 27, 1991
Client: Rittenhouse-Zeman

Client ID: PW1
Matrix: Water
Units: mg/l

Parameter	Sample(S)	Duplicate(D)	RPD*
Total Petroleum Hydrocarbons	13	13	0.0

*RPD = relative percent difference
= [(S - D) / ((S + D) / 2)] x 100

RZA

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ENVIRONMENTAL CONSULTANTS

1400 140th AVENUE NE
BELLEVUE, WASHINGTON 98005
(206)746-8020 FAX#(206)746-6364

CHAIN OF CUSTODY RECORD / LABORATORY ANALYSES REQUEST

JOB #: 7802

PROJECT NAME: City of Bothel

RZA CONTACT: Carol Hutley

PHONE #: 870-4669

ANALYSIS REQUESTED: (Circle, Check Box, or Write Preferred Method in Box) OTHER: (Write in)

SAMPLE ID #	DATE	TIME	PRESERV.	MATRIX	BTEX	Total Petrol. Hydrocarbons EPA 418.1	Fuel Scan/TPH by GC EPA 8015-mod.	Halogenated Volatiles EPA 601 EPA 8010	Aromatics EPA 602 EPA 8020	PolyNuclear Aromatics EPA 610 8310	Total Halogens (TOX) EPA 9076	Total Metals ICP AA	TCLP Metals EPA 1311	Purgeable Organics GC/MS: EPA 8240 624	Base/Neut/Acid/Organics GC/MS: EPA 625 8270	PCB EPA 608 8080	Ignitability (Flash) EPA 1010						Hold for Future Analysis	# of Containers	Detection Limits Desired
1 PW1	4/16	12PM		H2O		X																	+		
2																									
3																									
4																									
5																									
6																									
7																									
8																									
9																									
10																									
11																									
12																									

RELINQUISHED BY RZA:	RELINQUISHED BY:	RELINQUISHED BY:
Signature: Randy Adams	Signature: [signature]	Signature: S Palmquist
Printed Name: Randy Adams	Printed Name: Michael Belegg	Printed Name: PALMQUIST
Firm: RZA	Firm: RZA AGRA	Firm: SAS
Date/Time: 9/20/91 930	Date/Time: 9/20/91 1130	Date/Time: 9/20/91 12:30P
RECEIVED BY:	**RECEIVED BY:**	**RECEIVED BY:**
Signature: [signature]	Signature: S Palmquist	Signature: S Giang
Printed Name: Michael Belegg	Printed Name: PALMQUIST	Printed Name: S Giang
Firm: R-ZA AGRA	Firm: SAS	Firm: SAS
Date/Time: 9/20/91 930AM	Date/Time: 9/20 11:30A	Date/Time: 9/20/91 12:30PM

LABORATORY:	SAMPLE RECEIPT:
Shipping I.D. #:	Total # Containers:
Carrier:	Condition of Containers?
DOT Designation:	Condition of Seals?

SPECIAL INSTRUCTIONS/COMMENTS:

DISTRIBUTION: WHITE-return to originator; YELLOW-lab; PINK-retained by originator.

SOUND ANALYTICAL SERVICES, INC.

SPECIALIZING IN INDUSTRIAL & TOXIC WASTE ANALYSIS
4813 PACIFIC HIGHWAY EAST, TACOMA, WASHINGTON 98424 - TELEPHONE (206)922-2310 - FAX (206)922-5047

Report To: Rittenhouse-Zeman   Date: October 1, 1991

Report On: Analysis of Soil   Lab No.: 20225

IDENTIFICATION:
Samples received on 09-26-91
Project: W-7802

ANALYSIS:

Lab Sample No.	Client ID	Total Petroleum Hydrocarbons, mg/kg by EPA Method 418.1
1	EX-BSW-2	< 10
2	EX-BSE-2	< 10

Results are reported on a dry weight basis.

SOUND ANALYTICAL SERVICES
STAN P. PALMQUIST

Sound Analytical Services, Inc.

SPECIALIZING IN INDUSTRIAL & TOXIC WASTE ANALYSIS

4813 PACIFIC HIGHWAY EAST, TACOMA, WASHINGTON 98424 - TELEPHONE (206) 922-2310 - FAX (206) 922-5047

QUALITY CONTROL REPORT

DUPLICATES

Lab No: 20225 (1)
Date: October 1, 1991
Client: Rittenhouse-Zeman

Client ID: EX-BSW-2
Matrix: Soil
Units: mg/kg

Parameter	Sample(S)	Duplicate(D)	RPD*
Total Petroleum Hydrocarbons	< 10	< 10	0.0

*RPD = relative percent difference
= [(S - D) / ((S + D) / 2)] x 100

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1400 140th AVENUE NE
BELLEVUE, WASHINGTON 98005
(206)746-8020 FAX#(206)746-6364

CHAIN OF CUSTODY RECORD / LABORATORY ANALYSES REQUEST

JOB #: 7802

PROJECT NAME:

RZA CONTACT: Carol Hutley

PHONE #: 820-4669

ANALYSIS REQUESTED: (Circle, Check Box, or Write Preferred Method in Box) OTHER: (Write in)

SAMPLE ID #	DATE	TIME	PRESERV.	MATRIX	BTEX	Total Petrol. Hydrocarbons EPA 418.1	Fuel Scan/TPH by GC EPA 8015-mod.	Halogenated Volatiles EPA 601 EPA 8010	Aromatics EPA 602 EPA 8020	PolyNuclear Aromatics EPA 610 8310	Total Halogens (TOX) EPA 9076	Total Metals ICP AA	TCLP Metals EPA 1311	Purgeable Organics GC/MS: EPA 8240 624	Base/Neut/Acid/Organics GC/MS: EPA 625 8270	PCB EPA 608 8080	Ignitability (Flash) EPA 1010						Hold for Future Analysis	# of Containers	Detection Limits Desired
1 EX-BSW-2	9/25	11:00	None	Soil		✓																	✓	1	
2 EX-BSE-2	9/25	11:00	None	"		✓																	✓	1	
3																									
4																									
5																									
6																									
7																									
8																									
9																									
10																									
11.																									
12																									

RELINQUISHED BY RZA:	RELINQUISHED BY:	RELINQUISHED BY:
Signature: Carol Hutley	Signature: [signature]	Signature: [signature]
Printed Name: CAROL HUTLEY	Printed Name: Steve Gisselberg	Printed Name: Michael Pelkey
Firm: RZA	Firm: RZA	Firm: RZA-AGRA
Date/Time: 8:45 9/25	Date/Time: 9-26-91 9:45	Date/Time: 9/26/91 1210

RECEIVED BY:	RECEIVED BY:	RECEIVED BY:
Signature: [signature]	Signature: [signature]	Signature: [signature]
Printed Name: Steve Gisselberg	Printed Name: Michael Pelkey	Printed Name: PALMQUIST
Firm: RZA	Firm: RZA AGRA	Firm: SAS
Date/Time: 858 9-26-91	Date/Time: 9/26/91 945	Date/Time: 9/26/91 1110

LABORATORY: Sound Analytical

Shipping I.D. #:

Carrier:

DOT Designation:

SAMPLE RECEIPT:

Total # Containers:

Condition of Containers?

Condition of Seals?

SPECIAL INSTRUCTIONS/COMMENTS:

These samples contain peat. They will need extra attention during cleanup. See Stan, please.

Attn: Stan

DISTRIBUTION: WHITE-return to originator; YELLOW-lab; PINK-retained by originator.

NORTH CREEK ANALYTICAL

18939 120th Avenue N.E., Suite 101 • Bothell, WA 98011-2569
Phone (206) 481-9200 • FAX (206) 485-2992

Rittenhouse Zeman & Associates	Client Project ID:	City of Bothell 7802	Sampled:	Oct 21, 1991
11335 NE 122nd Way, #100	Matrix Descript:	Water	Received:	Oct 22, 1991
Kirkland, WA 98034	Analysis Method:	EPA 418.1 (I.R. with clean-up)	Extracted:	Oct 23, 1991
Attention: Randy Adams	First Sample #:	110-0844	Analyzed:	Oct 23, 1991
			Reported:	Oct 23, 1991

TOTAL RECOVERABLE PETROLEUM HYDROCARBONS

Sample Number	Sample Description	Petroleum Oil mg/L (ppm)
110-0844	BL-N	N.D.
110-0845	BL-S	N.D.
BLK102391	Method Blank	N.D.

Detection Limits:	1.0

Analytes reported as N.D. were not present above the stated limit of detection.

NORTH CREEK ANALYTICAL

Scot Cocanour
Laboratory Director

NORTH CREEK ANALYTICAL

18939 120th Avenue N.E., Suite 101 • Bothell, WA 98011-2569
Phone (206) 481-9200 • FAX (206) 485-2992

Rittenhouse Zeman & Associates	Client Project ID: City of Bothell 7802	Analyst :	J. Kimball
11335 NE 122nd Way, #100	Method : EPA 418.1 mod.		
Kirkland, WA 98034	Sample Matrix : Water		
Attention: Randy Adams	Units : mg/L	Analyzed:	Oct 23, 1991
	QC Sample #: BLK102391	Reported:	Oct 23, 1991

QUALITY CONTROL DATA REPORT

ANALYTE	Petroleum Oil
Sample Conc.:	N.D.
Spike Conc. Added:	15
Conc. Matrix Spike:	14.5
Matrix Spike % Recovery:	97
Conc. Matrix Spike Dup.:	14.3
Matrix Spike Duplicate % Recovery:	95
Relative % Difference:	1.4

NORTH CREEK ANALYTICAL

Scot Cocanour
Laboratory Director

% Recovery: $\frac{\text{Conc. of M.S. - Conc. of Sample}}{\text{Spike Conc. Added}}$ x 100

Relative % Difference: $\frac{\text{Conc. of M.S. - Conc. of M.S.D.}}{\text{(Conc. of M.S. + Conc. of M.S.D.) / 2}}$ x 100

NORTH CREEK ANALYTICAL
18939 120th Avenue N.E., Suite 101 • Bothell, WA 98011-2569
Phone (206) 481-9200 • FAX (206) 485-2992

Rittenhouse Zeman & Associates	Client Project ID:	City of Bothell 7802		Sampled:	Oct 21, 1991
11335 NE 122nd Way, #100	Matrix Descript:	Water		Received:	Oct 22, 1991
Kirkland, WA 98034	Analysis Method:	EPA 418.1 (I.R. with clean-up)		Extracted:	Oct 23, 1991
Attention: Randy Adams	First Sample #:	110-0844		Analyzed:	Oct 23, 1991
				Reported:	Oct 23, 1991

TOTAL RECOVERABLE PETROLEUM HYDROCARBONS

Sample Number	Sample Description	Petroleum Oil mg/L (ppm)
110-0844	BL-N	N.D.
110-0845	BL-S	N.D.
BLK102391	Method Blank	N.D.

Detection Limits:	1.0

Analytes reported as N.D. were not present above the stated limit of detection.

NORTH CREEK ANALYTICAL

Scot Cocanour
Laboratory Director

RZA

RITTENHOUSE-ZEMAN & ASSOCIATES, INC.
ENVIRONMENTAL CONSULTANTS

1400 140th AVENUE NE
BELLEVUE, WASHINGTON 98005
(206)746-8020 FAX#(206)746-6364

CHAIN OF CUSTODY RECORD / LABORATORY ANALYSES REQUEST

JOB #:

PROJECT NAME:

RZA CONTACT:

PHONE #:

ANALYSIS REQUESTED: (Circle, Check Box, or Write Preferred Method in Box) OTHER: (Write in)

SAMPLE ID #	DATE	TIME	PRESERV.	MATRIX	BTEX	Total Petrol. Hydrocarbons EPA 418.1	Fuel Scan/TPH by GC EPA 8015-mod.	Halogenated Volatiles EPA 601 EPA 8010	Aromatics EPA 602 EPA 8020	PolyNuclear Aromatics EPA 610 8310	Total Halogens (TOX) EPA 9076	Total Metals ICP AA	TCLP Metals EPA 1311	Purgeable Organics GC/MS: EPA 8240 624	Base/Neul/Acid/Organics GC/MS: EPA 625 8270	PCB EPA 608 8080	Ignitability (Flash) EPA 1010						Hold for Future Analysis	# of Containers	Detection Limits Desired
1																									
2																									
3																									
4																									
5																									
6																									
7																									
8																									
9																									
10																									
11.																									
12																									

RELINQUISHED BY RZA:	RELINQUISHED BY:	RELINQUISHED BY:	LABORATORY:	SAMPLE RECEIPT:
Signature:	Signature:	Signature:		
Printed Name:	Printed Name:	Printed Name:	Shipping I.D. #:	Total # Containers:
Firm:	Firm:	Firm:	Carrier:	Condition of Containers?
Date/Time:	Date/Time:	Date/Time:	DOT Designation:	Condition of Seals?

RECEIVED BY:	RECEIVED BY:	RECEIVED BY:	SPECIAL INSTRUCTIONS/COMMENTS:
Signature:	Signature:	Signature:	24 hr RUSH
Printed Name:	Printed Name:	Printed Name:	
Firm:	Firm:	Firm:	
Date/Time:	Date/Time:	Date/Time:	

DISTRIBUTION: WHITE-return to originator; YELLOW-lab; PINK-retained by originator.

Groundwater Technology, Inc.

APPENDIX D

STANDARD OPERATING PROCEDURES

7.0 EXCAVATION AND TRENCH SOIL SAMPLING

7.1 Purpose

Underground Storage Tank (UST) decommissioning requires documentation of soil conditions. If tank closure is accomplished by excavation, removal and destruction of the tanks and lines, collection of representative samples for subsequent analysis is imperative. Utilizing the following procedures enables Groundwater Technology to secure the best possible retrieval of observations and samples.

7.2 Equipment

- Field Book, standard Surveyor's, waterproof, 5" x 7"
- Pencils
- Clipboard
- 6' folding ruler
- 50' cloth or fiberglass tape with weight
- Interface probe
- PID or other organic vapor screening device
- Sampling jars with air-tight Teflon lids, brass liners, 2" dia. x 6" long
- Aluminum foil or Teflon tape
- Bailer
- Rags probe wipers
- Alconox solution, distilled water, and H_2O
- Contract Documents, site plan, site sampling plan (QAPP), Site Safety Plan
- Lumber crayon or waterproof marking pen
- Safety equipment such as hard hat, appropriate footwear, respirator, goggles, ear plugs, gloves
- Copies of maps such as topographic or site vicinity
- Pocket knife
- Camera

7.3 Procedure

There are a number of preparations to be made by the Geologist/ Environmental Scientist before a site investigation begins. Attending to these preparations can increase the efficiency and quality of the work to be accomplished.

Before going into the field, each Geologist/Environmental Scientist should be completely familiar with the long and short term project objectives. He or she should review all of the available information about a site including site geology and the nature of the project. He or she should be familiar with all installation and sampling procedures that will be required.

It is the responsibility of the Project Manager to clearly describe the nature of each project and the amount of and type of work to be performed at a site. It is the responsibility of the Geologist/Environmental Scientist to make certain they understand what they are being asked to find out or do and, if they do not understand, then to ASK QUESTIONS.

The importance of communication <u>and</u> documentation cannot be stressed enough. What is not written down is often lost. What is written down and not pointed out may be inadvertently overlooked.

7.3.1 The principle reason for requiring excavation supervision is to acquire reliable information.

7.3.2 While supervising a tank or piping excavation, the Geologist should always make certain that accurate depth measurements are made by ruler and not by visually "eyeballing" the measurements.

7.3.3 Discrepancies between the excavator's statements of depth and the Geologist's should be immediately clarified by remeasurement so that the operator and the Geologist are in agreement.

7.3.4 Note strata changes that occur during excavation. Strata changes can be estimated by observing changes in color, soil-type, or the ease of excavation.

7.3.5 Photographic records of site conditions are an important tool for filling in narrative discussion. Do not hesitate to take pictures of all site activities before, during, and after. Label and record each photograph in your field notes according to procedures similar to section 7.4.1 (b).

7.4 Sample Collection Methods

7.4.1 The following information must be kept during the sampling events:

(a) A sketch of the site must be made which clearly shows all of the sample locations and identifies each location with a unique sample identification code.

(b) Each soil and water sample must be clearly labeled with its sample identification code. A written record must be maintained which includes, but is not limited to: the date, time and location of the sample collection; the name of the person collecting the sample; how the sample was collected; and any unusual or unexpected problems encountered during the sample collection which may have affected the sample integrity.

(c) Formal chain-of-custody records must be maintained for each sample.

7.4.2 If soil samples cannot be safely collected from the excavation, a backhoe may be used to remove a bucket of native soil from each of the sample areas. The soil is to be brought rapidly to the surface where samples are to be immediately taken from the soil in the bucket.

7.4.3 The following procedures must be used for the collection of soil samples from open pits or trenches:

(a) Just prior to collecting each soil sample, approximately three inches of soil must be rapidly scraped away from the surface of the sample location.

(b) To minimize the loss of volatile materials, it is recommended that samples be taken using a driven-tube type sampler. A clean brass or stainless steel tube of at least one inch in diameter and three inches in length may be used for this purpose. The tube should be driven into the soil with a suitable instrument such as a wooden mallet or hammer.

(c) The ends of the sample-filled tube must be immediately covered with clean aluminum foil or Teflon® tape. The foil must be held in place by plastic end caps which are then sealed onto the tube with a suitable tape.

(d) Alternatively, samples may be taken with a minimum amount of disturbance and packed in a clean wide-mouth glass jar leaving as little headspace as possible. The jar must then be immediately sealed with a teflon-lined screw cap.

(e) After the samples are properly sealed, they are to be immediately placed on ice and maintained at a temperature of no greater than 4°C (39°F) until being prepared for analysis by the laboratory. All samples must be analyzed within 14 days of collection.

1.0 DRILLING

1.1 The principle reason for requiring on-site drilling supervision is to acquire reliable information.

1.2 While supervising a test boring or well installation, the geologist should always make certain that the driller is making accurate depth measurements by ruler and not by visually "eyeballing" the measurements (five foot auger lengths or drill rods may vary in length by +/- .75 feet.

1.3 Discrepancies between the driller's statements of depth and the geologist's should be immediately clarified by remeasurement so that the driller and geologist are in agreement.

1.4 Note lithologic changes that occur between sampling depths. Lithologic changes can be estimated by: noting changes in the rate of penetration of the drilling tools; noting color and/or soil-type changes in the drill cuttings; and, noting the soil on the auger flights.

1.5 Samples obtained by split-spoon sampler should follow the standard penetration test procedure (see Section 2.0).

1.6 For each soil sample taken, the following information must be recorded on the well/boring log:

- sample depth
- sample number
- sampling method: split-spoon (SS), wash sample, auger flight sample, drill cutting sample.
- blow counts for every 6 inches penetration of the split-spoon sampler
- sample description should follow the Unified Soil Classification System.

1.7 The sample brass tubes must be labeled with the following information

- job number
- date and time
- well/boring number
- sample number
- sample depth
- name of sampler

1.8 Insure that samples are sealed in brass tubes as nearly intact and undisturbed as possible. Soil structure can be an important feature in interpreting the subsurface geology.

1.9 Seal the ends of the brass tubes with aluminum foil or teflon tape prior to placing on the air tight cap. Place the sealed and labeled tube on ice in a cooler for shipment to the lab along with a chain-of-custody.

1.10 Seal the contents of a second brass tube in a plastic sample bag for vapor level measurements.

1.11 Measure vapor levels with a photoionization detector (PID) when the samples reach room temperature (70 degrees F). Otherwise keep the samples cool until an instrument is available. Bring the samples to room temperature prior to measuring the vapor levels.

1.12 Attempt to determine the depth to groundwater as drilling progresses. After a well has been installed, measure the initial groundwater level. If no well has been installed, measure the water level in the boring prior to removing all of the auger flights or casing and backfilling the borehole.

1.13 When drilling in soils such as loose sands and silts, which tend to run up into the borehole, whether it is stabilized with casing or augers or not, the driller should maintain a positive head of water in the borehole (that is above the water table) at ALL times.

1.14 All pertinent data concerning drilling method, groundwater, penetration resistance, soil description, etc. should be entered onto the well/boring log.

1.15 Locate each well/boring location by taping the distances to at least three permanent physical features at the site. These may include any feature that is shown on the site plan provided, such as building corners, pump island, light standards, fences, planters, etc. DO NOT measure to another well/boring as one of the three measurements unless it is absolutely necessary. DO include measurements between well/borings as additional location information. This information, entered onto the well/boring log, will be used in conjunction with survey data to complete the site map and to generate groundwater contour and petroleum distribution maps.

1.16 At the completion of drilling, arrange to survey the well/boring locations and elevations.

1.17 Groundwater Technology does not assume the responsibility of directing the operations of independent contractors or insuring the safety of their workmen. Inform the contractor of the project requirements. Do not drive contractor trucks or operate or borrow his equipment.

1.18 Comply with all applicable articles of the Occupational Safety and Health Act of 1970, (OSHA).

2.0 STANDARD PENETRATION TEST

2.1 The standard split-spoon sampler consists of a 2-inch O.D. by 1-3/8-inch I.D., 18-inch minimum length, heat treated, case hardened, steel head, split-spoon and shoe assembly.

2.2 The head is vented to prevent pressure buildup during sampling and must be kept clean. A ball check valve is located in the head to prevent downward water pressure during sampling and sample retrieval. Removal of the water check valve often results in sample loss.

2.3 The drive rods which connect the split-spoon must have a stiffness equal or greater than an A-rod. In order to reduce rod deflection, especially in deep holes, it may be preferable to use larger diameter rods. The size of the drive rods must be consistent throughout a specific exploration as the energy absorbed will vary with the size and the weight of the rods used. The type of drive rod should be noted on the well/boring log.

2.4 The drive head consists of a guide rod to give the drop hammer a free fall in order to strike the anvil attached to the lower end of the assembly. The rod must be a minimum of 3-1/2 feet in length to insure the correct 30-inch hammer drop.

2.5 The drop hammer must weigh 140 pounds and have a 2-1/2-inch diameter hole through the center for the passage of the drive head rod.

2.6 The hammer is raised with a rope activated by the drill rig cathead. No more than two turns of rope should be allowed on the cathead.

2.7 A 30-inch free hammer drop is mandatory and extreme care should be exercised to insure consistent results.

2.8 Automatic trip hammers are available which insure a 30-inch, free-fall drop. These are recommended when retaining soil-structure data is critical, such as in liquefaction studies.

2.9 Attach the split-spoon sampler to the drill rods and lower the assembly to the bottom of the hole. Measure the drill rod stickup to determine if the bottom of the sampler is resting on the bottom of the hole. If the sampler is not on the bottom (ex. blow-up of the stratum being sampled), remove the assembly and clean out the hole to the appropriate sampling depth.

2.10 Note any penetration of the sampler/rod assembly due to the weight of the rods. Do not drop the assembly to the bottom of the hole.

2.11 Raise the 140-pound hammer 30 inches above the drivehead anvil and then allow it to drop, free-fall, and strike the anvil. This procedure is repeated until the sampler has been driven 18 inches into the stratum at the bottom of the hole (a 24-inch sampler may be driven 24 inches).

2.12 The number of blows of the hammer required for each 6 inches of penetration of the sampler is counted and recorded.

2.13 A penetration rate of 100 blows per foot is normally considered refusal; however, this criterion may be varied depending on the nature of the project and the desired information.

2.14 The penetration resistance, density, is calculated by adding together the second and the third resistance blowcounts. (Ex: for blow counts 2-6-6, density = 12.)

2.15 The sampler is then withdrawn form the borehole, preferably by pulling the rope rather than by bumping it out using the cathead and hammer in reverse.

2.16 Keeping the casing/augers/borehole full of water when removing the sampler will enhance sample recovery. however, this practice may not be appropriate when drilling at contamination sites.

2.17 When sampling soils where recovery is poor, lining the sampler with a flexible material such as plastic wrap or placing a sand catch in the shoe will often increase sample recovery.

2.18 Careful measurement of all drilling tools, samplers, casing, etc. must be exercised throughout all phases of the test boring operation.

2.19 Carefully open the sampler and describe the contents, noting soil structure, color, characteristics, etc. following the Unified Soils Classification System.

2.20 All pertinent data concerning sampling activities including sampling, interval, blow counts and sample recovery should be entered on the well/boring log.

11.0 MONITORING WELL INSTALLATION

11.1 Purpose

Monitoring wells provide both the immediate and long-term sampling points necessary to assess the type, level, and extent of groundwater contamination at a site. The effectiveness of remedial measures taken at a site cannot be determined without the accurate data obtained from properly installed and maintained wells. The design an installation f monitoring wells is determined by the specific conditions encountered at a site. In general, there are four typical types of installations: 1) water table aquifers where the water table is extremely shallow; 2) water table aquifers where the water table is several feet below the ground surface; 3) confined aquifers; and 4) bedrock aquifers. Design and construction materials will vary depending on the type of contamination and the surface chemical environment.

11.2 References

Driscoll, Fletcher G., Ph.D., 1986, "Groundwater and Wells", Johnson Division, St. Paul, Minnesota.

Hvorslev, M.J., 1949, "Subsurface Exploration and Sampling of Soils for Civil Engineering Purposes", U.S. Army Engineer Waterways Experiment Station, Vicksburg.

U.S. EPA, 1979, "Procedures Manual for Ground Water Monitoring at Solid Waste Disposal Facilities".

11.3 Equipment

- 50' tape with weight
- 6' folding ruler
- Photoionization Detector (PID such as a HNU) or Flame Ionization Detector
- Sampling jars with air tight lids
- Aluminum foil
- Interface probe
- Bailer
- Hydrometer
- Rags, probe wipers
- Alconox solution and distilled water
- Tools for cutting the well casing
- Well/boring logs
- Clipboard
- Lumber crayon

11.4 Procedure

11.4.1 Well Construction Materials - The materials that are used in construction of a monitoring well and that come in contact with the water sample should not alter the chemical quality of the sample for the constituents being examined using the appropriate sampling protocols. Furthermore, the riser, will screen, and annular sealant injection equipment should be steam or high pressure water cleaned (if appropriate for the selected riser material) immediately prior to well installation. Samples of the cleaning water, filter pack, annular seal, and mixed grout should be retained to serve a quality control until the completion of at least one round of groundwater quality sampling and analysis.

11.4.2 Water - Water used in the drilling process, to prepare grout mixtures and to decontaminate the well screen, riser, and annular sealant injection equipment, should be obtained from a source of known chemistry that does not contain constituents that could compromise the integrity of the well installation.

11.4.3 Primary Filter Pack - The primary filter pack (gravel Pack) consists of a granular material of known chemistry and selected grain size and graduation that is installed in the annulus between the screen and the borehole wall. The filter pack is usually selected to have a 30% finer (d-30) grain size that is about 4 to 10 times greater than the 30% finer (d-30) grain size of the hydrologic unit being filtered. Usually, the filter is selected to have a low (i.e., less than 2.5) uniformity coefficient. The grain size and gradation of the filter are selected to stabilize the hydrologic unit adjacent to the screen and permit only the finest soil grains to enter the screen during development. Thus, after development, a correctly filtered monitoring well is relatively turbid-free.

NOTE: When installing a monitoring well in Karst or highly fractured bedrock, the borehole configuration is often unknown. Therefore, the installation of a filter pack becomes difficult and may not be possible.

- Gradation - The filter pack should be uniformly graded and comprised of hard durable silicous particles washed and screened with a particle size distribution derived by multiplying the d-30 size of the finest-grained screened stratum by a factor between 4 and 10. Use a number between four and six as the multiplier if the stratum is fine and uniform; use a factor between six and ten where the material has highly nonuniform gradation and includes silt-sized particles. The grain-size distribution of the filter pack is then plotted using the d-30 size as the control point on the graph. The selected filter pack should have a uniformity coefficient of approximately 2.5 or less.

  NOTE: Because the well screen slots have uniform opening, the filter pack should be composed of particles that are as uniform in size as is practical. Ideally, the uniformity coefficient (the quotient of the 60% passing, D-60 size divided by the 10% passing D-10 size (effective size) of the filter pack should be 1.0 (i.e., the D-60 percent and the D-10 percent sizes should be identical). However, a more practical and consistently achievable uniformity coefficient for all ranges of filter pack sizes is 2.5. This value of 2.5 should represent a maximum value not an ideal.

  NOTE: Although not recommended as standard practice, often a project requires drilling and installing the well in one phase of work. Therefore, the filter pack materials must be ordered and delivered to the drill site before soil samples can be collected.

11.4.4 Well screen - The well screen should be new, machine-slotted or continuous wrapped wire-wound and composed of materials most suited for the monitoring environment and site characterization findings. The screen should be plugged at the bottom. The plug should be of the same material as the well screen. This assembly must have the capability to withstand installation and development stresses without becoming dislodged or damaged. The length of the slotted area should reflect the interval to be monitored. Immediately prior to installation, the well screen should be steam or high pressure water cleaned (if appropriate for the selected well screen materials) with water from a source of known chemistry.

NOTE: Well screens are most commonly composed of PVC, stainless steel, fiberglass, or fluoropolymer materials.

- Diameter - The minimum nominal internal diameter of the well screen should be chosen based on the particular application. However, in most instances, a minimum of 2 in. (5.0 cm) is needed to allow for the introduction and withdrawal of sampling devices.

- Slot Size - The slot size of the well screen should be determined relative to the grain size analysis of the stratum interval to be monitored and the gradation of the filter pack material. In granular noncohesive strata that will fall in easily around the screen, filter packs are not necessary. In these cases, the slot size of the well screen is to be determined using the grain size of the materials in the surrounding strata. The slot size and arrangement should retain at least 90% and preferable 99% of the filter pack. The method for determining the correct gradation of filter pack material is described in Section 11.4.8 - Cement.

  NOTE: When formation grain size is unknown or if conditions warrant the use of different materials, monitoring wells will be constructed of threaded PVC casing and threaded PVC (0.010 or 0.020 slot size) well screen with a minimum I.D. diameter of 2 inches. 0.020 well screen is recommended due to the tendency of PVC to swell slightly in the presence of hydrocarbons.

11.4.5 Riser - The riser should be new and composed of materials that will not alter the quality of water samples for the constituents of concern and that are appropriate for the monitoring environment. The riser should have adequate wall thickness and coupling strength to withstand installation and development stresses. Each section of riser should be steam or high pressure water cleaned (if appropriate for the selected material) using water from a source of known chemistry immediately prior to installation.

NOTE: Risers are generally constructed of PVC, stainless steel, fiberglass, or fluoropolymer materials.

- Diameter - The minimum nominal internal diameter of the riser should be chosen based on the particular application. However, in most instances, a minimum of 2 in. (5.0 cm) is needed to accommodate sampling devices.

- Joints (Couplings) - Threaded joints are recommended. Glued or solvent welded joints of any type are <u>not</u> recommended since glues and solvents may alter the chemistry of the water samples. In most cases, threaded joints should be PTFE taped to prevent leakage of water into the riser. alternatively, 0-rings composed of materials that would not impact the water sample for the constituents of concern may be selected for use on flush joint threads.

11.4.6 Casing - Where conditions warrant, the use of permanent casing installed to prevent communication between water-bearing zones is encouraged. The following subsections address both temporary and permanent casings.

- Materials - The material type and minimum wall thickness of the casing should be adequate to withstand the forces of installation. All casing that is to remain as permanent part of the installation (i.e., multi-cased walls) should be new and cleaned to be free of interior an exterior protective coatings.

  NOTE: The exterior casing (temporary or permanent) is generally composed of steel, although other appropriate materials may be used.

- Diameter - Several different casing sizes may be required depending on the subsurface geologic conditions penetrated. The diameter of the casing should be selected so that a minimum annular space of 2 in. (5.0 cm) is maintained between the casing and riser. In addition, the diameter of the casings in multi-cased wells should be selected so that a minimum annular space of 2 in. is maintained between the casing and the borehole (i.e., a 2 in. diameter screen will require first setting a 6 in. (15.2 cm) diameter casing in a 10 in. (25.4 cm) diameter boring).

- Joints (Couplings) - The ends of each casing section should be either flush-threaded or bevelled for welding.

11.4.7 Protective Casing - Protective casings may be made of aluminum, steel, stainless steed, cast iron, or a structural plastic depending on potential loading (traffic). The protective casing should have a lid capable of being locked shut by a locking device.

- Diameter - The inside dimensions of the protective casing should be a minimum of 2 in. (5.0 cm) and preferably 4 in. (10.1 cm) larger than the outside diameter of the riser to facilitate the installation and operation of sampling equipment.

11.4.8 Annular Sealants - The materials used to seal the annulus may be prepared as a slurry or used un-mixed in a dry pellet, granular, or chip form. Sealants should be selected to be compatible with ambient geologic, hydrogeologic, and climatic conditions and any man-induced conditions anticipated to occur during the life of the well.

- Bentonite - Bentonite should be powdered, granular, pelletized, or chipped sodium montmorillonite furnished in sacks or buckets from a commercial source and free of impurities which adversely impact the water quality i the well. Pellets consist of roughly spherical or disk shaped units of compressed bentonite powder. Chips are large, irregularly shaped, and coarse granular units of bentonite free of additives. The diameter of pellets or chips selected for monitoring well construction should be less than one-fifth the width of the annular space into which they are placed to reduce the potential for bridging. Granules consist of coarse particles of unaltered bentonite, typically smaller than 0.2 in. (5.0 cm).

- Cement - Each type of cement has slightly different characteristics that may be appropriate under various physical and chemical conditions. Cement should be one of the five Portland cement types that are specified in ASTM C 150. **The use of quick-setting cements containing additives is not recommended for use in monitoring well installation**. Additives may leach from the cement and influence the chemistry of the water sample.

- Grout - The grout backfill that is placed above the bentonite annular seal and secondary filters is ordinarily a liquid slurry consisting of either a bentonite (powder and/or granules) base and water, or a Portland cement base and water. Often, bentonite-based grounds are used when it is desired that the grout remain flexible (i.e., to accommodate freeze-thaw) during the life of the installation. Cement-based grouts are often used when the filling in of cracks in the surrounding geologic material, adherence to rock units, or a rigid setting is desired.

  a) Mixing - The mixing (and placing) of a grout backfill should be performed with precisely recorded weights and volumes of materials, and according to procedures stipulated by the manufacturer that often include the order of component mixing. The grout should be thoroughly mixed with a paddle type mechanical mixer or by recirculating the mix through a pump until all lumps are disintegrated. Lumpy grout should not be used in the construction of a monitoring well to prevent bridging within the tremie.

  NOTE: Lumps do not include lost circulation materials that may be added to the grout if excessive grout losses occur.

  b) Typical Bentonite Base Grout - When a bentonite base grout is used, bentonite, usually unaltered, must be the first additive placed in the water. A typical bentonite base grout consists of about 1 lb to 1.25 lb (0.5 kg) of unaltered bentonite to each 1 gal (3.7 L) of water. After the bentonite is mixed and allowed to "yield", up to 2 lb (1.0 kg) of Type I Portland cement (per gallon of water) is often added to stiffen the mix. Bentonite grouts should not be used in the vadose zone of arid regions because of their propensity to desiccate. This could result in non-representative waters affecting the target monitoring zone.

  NOTE: Other bentonite-based grouts may contain granular bentonite to increase the solids content and other additives to either stiffen or retard stiffening of the mix. All Additives to grouts should be evaluated for their effects on subsequent water samples.

  c) Typical Cement Base Grout - When a cement-based grout is used, cement is usually the first additive placed in the water. A typical cement-based grout consists of about 6.0 gal to 7.0 gal (21 L to 30 L) of water per 94 lb (42.8 kg) bag of Type I Portland cement. From 0 to 10% (by weight) of unaltered bentonite powder is often added after the initial mixing of cement and water to retard shrinkage and provide plasticity. The bentonite is added "dry" to the cement-water slurry without first mixing it with water.

11.4.9 Annular Seal Equipment - The equipment used to inject the annular seals and filter pack should be steam or high pressure water cleaned (if appropriate for the selected material) using water from a source or known quality prior to use. This procedure is performed to prevent the introduction of materials that may ultimately alter the water sample quality.

11.4.10 Drilling Method Selection - The type of equipment required to create the stable, open, vertical borehole for installation of a monitoring well depends upon the site geology, hydrology, and the intended use of the data. Engineering and geological judgment is required for the selection of the drilling methods utilized for drilling the exploratory boreholes and monitoring wells. Whenever possible, drilling procedures should be utilized that do not require the introduction of water or liquid fluids into the borehole, and that optimize cuttings control at the ground surface. Where the use of drilling fluid is unavoidable, the selected fluid should have as little impact as possible on the water samples for the constituents of interest. In addition, care should be taken to remove a much drilling fluid as possible from the well and aquifer during development.

11.4.11 Procedure - General

- The top of the well casing will be capped with a tightly fitting cap to prevent surface water and/or debris from entering the monitoring well.

- In water table aquifers contaminated with petroleum products, well screens will extend 10-15 feet below the water table. Deeper and multi-level wells should be considered on sites where the contaminants are Dense Non Aqueous Phase Liquid (DNAPL's) than water.

- In order to accommodate seasonal groundwater fluctuations and to detect free-phase hydrocarbons, when present, well screens will extend a minimum of 5 feet above the water table, where possible.

- When petroleum products are encountered in a well, every effort should be made to obtain enough of the product to measure the specific gravity of the liquid with a hydrometer.

- All monitoring wells should be developed after installation (see Well Development - Section 15).

- All monitoring wells should be clearly labeled with spray paint or other indelible method in the field.

11.5 Cautions

11.5.1 In a situation where two separate aquifers are encountered in a boring, in order to avoid possible cross contamination between the upper and lower aquifers, always backfill the hole from the bottom with an impermeable material such as a cement or cement/bentonite grout or a tamped bentonite pellet seal to the top of the separating or confining layer.

11.5.2 In order to avoid the vertical migration of contaminants from one strata to another and to reduce the possibility of dilution by the seepage of clean water from one strata to another, the sand/gravel pack should not extend into an overlying strata.

11.5.3 Impermeable seals should be placed between well screen sections when a well is screened at more than one depth, or install two separate wells.

11.5.4 <u>Measure accurately</u>.

11.5.5 Follow appropriate health and safety protective measures.

11.5.6 As monitoring wells age, periodic maintenance may be required. This may include, but is not necessarily limited to: repair of the surface seal. redevelopment, treatment for biological fouling.

11.6 Shallow Water Table Aquifer Monitoring Well

11.6.1 See Monitoring Well Schematic: Shallow Water table.

11.6.2 A shallow water table aquifer is one where the water table is so shallow that in order to have sufficient well screen above the water table to accommodate seasonal groundwater fluctuations and to detect free-phase hydrocarbons, when present, the well must be screened to the surface. Because the well is screened to the surface, a seal is placed at the ground surface.

11.6.3 Complete the borehole to the required depth.

11.6.4 If necessary, backfill with clean common backfill and tamp hole to a depth approximately 1 foot below the final depth of the well screen.

11.6.5 Backfill the hole with 1 foot of sand/gravel pack.

11.6.6 Lower the well screen to the required depth making certain that the well screen and casing remain plumb in the hole.

11.6.7 Install sand/gravel pack in the annular space between the well screen and the side of the borehole to within 3-4 inches of the top of the well screen.

11.6.8 Install protective casing. Be sure that the casing does not extend below the anticipated water table or water/hydrocarbon interface.

11.6.9 Carefully seal the area around the exterior of the protective casing with mortar. When possible, place the protective casing slightly above the ground surface and slope the mortar away from the casing to encourage drainage away from the well.

11.7 Water Table Aquifer Monitoring Well

11.7.1 See Monitoring Well Schematic: Water Table Aquifer

11.7.2 Complete the borehole to the required depth.

11.7.3 If necessary, backfill the hole with clean common backfill and tamp hole to a depth approximately 1 foot below the final bottom of the well.

11.7.4 Backfill the hole with 1 foot of sand/gravel pack.

11.7.5 Assemble the well screen and casing and lower the assembled well screen and casing to the required depth making certain to keep the well screen and casing plumb in the hole.

11.7.6 Install sand/gravel pack in the annular space between the well screen and casing and the side of the borehole to a depth of approximately 2 feet above the top of the well screen.

11.7.7 Place a 1 foot bentonite/cement seal between the sank/gravel pack and he remainder of the backfill used to fill the annular space in the well.

11.7.8 Fill the remaining annular space in the borehole with clean backfill (less than 10 ppm on a PID) or bentonite/cement grout to a depth of approximately 4 feet below the ground surface (see specific state guidelines for local protocol).

11.7.9 Wells will then be sealed from surface contamination by a 1-2 foot bentonite/cement seal.

11.7.10 The top of the seal will be a minimum of 6" below the bottom of the roadway box or protective casing. This allows water to freely drain out of the roadway box.

11.7.11 Backfill the remainder of the borehole with sand/gravel pack to a depth approximately 3-4 inches below the top of the well casing.

11.7.12 Install the protective casing.

11.7.13 Carefully seal the area around the protective casing with mortar to permanently secure the casing and to prevent surface water from entering the well.

11.8 Confined Aquifer Monitoring Well

11.8.1 See Monitoring Well Schematic: Artesian Aquifer.

11.8.2 Complete the borehole to the required depth. Accurately determine the location of the top and bottom of the confining layer.

11.8.3 If necessary, backfill with clean common backfill and tamp hole to a depth approximately 1 foot below the final bottom of the well screen.

11.8.4 Backfill the hole with 1 foot of sand/gravel pack.

11.8.5 Determine the amount of well casing required so that the joint between the casing and the well screen, when installed in the borehole, will be approximately at the interface between the aquifer formation and the bottom of the confining layer.

11.8.6 Assemble the well screen and casing and lower the assembled well screen and casing to the required depth.

11.8.7 Install sand/gravel pack in the annular space between the well screen and the side of the borehole. Tamping of the sand/gravel pack may be required to ensure that the well screen is uniformly surrounded by sand/gravel pack. The top of the sand/gravel pack should not extend past the bottom of the confining layer.

11.8.8 Fill the remaining annular space in the borehole with bentonite/cement grout to a depth approximately 6 inches below the bottom of the protective casing.

11.8.9 Backfill the remainder of the borehole with sand/gravel pack or grout to a depth of 3-4 inches below the top of the well casing.

11.8.10 Install the protective casing.

11.8.11 Carefully seal the area around the protective casing with mortar to permanently secure the casing and to prevent surface water from entering the well.

11.8.12 Caution: If dual aquifers are present, take precautions to prevent cross-contamination of the aquifers. Consult with the Project Manager prior to proceeding.

3.0 WATER QUALITY SAMPLING

3.1 Water samples should not be taken from the stagnant water in the well.

3.2 Water samples should be taken in triplicate.

3.3 Remove 3 to 5 volumes of water in the well prior to sampling. The water may be removed by bailing, submersible pump, or purge system. Wells with a slow recovery period should be bailed dry and then sampled within 1 hour or when recovered to 80%. Monitor pH, temperature and specific conductivity with each well volume to insure water quality stabilization has occurred. However, this is not necessary at every well or in all circumstances.

3.4 Use only Teflon, stainless steel, or glass bailers to obtain the sample. Use Teflon only for sampling water containing chlorinated compounds and also for bacteriological samples. PVC bailers can be used for one-time sampling for other than EPA 624 analysis. Using a bailer for a one-time sampling reduces the possibility for cross-contamination.

3.5 When sampling, avoid stirring up any sediments in the well and agitating the water to reduce volitization of any dissolved compounds that may be present.

3.6 All sampling equipment must be cleaned following the appropriate procedure to avoid cross contamination from site to site and sample to sample. The sampling equipment should be cleaned before each well sampling, between each sampling, and at the end of each sampling round.

3.7 Monitoring wells should be gauged prior to sampling.

3.8 If possible, the monitoring wells should be sampled starting with the cleanest well and ending with the most contaminated well.

3.9 Wells containing free-phase contaminants should not be sampled.

3.10 When filling out the chain of custody form:

- enter the samples in the order in which they were collected;
- make a note as to the cleaning fluid used to clean the sampling equipment;
- attempt to identify which samples are the most contaminated;
- complete all other requested information.

3.11 The laboratory sample identification label should be filled out with a waterproof pen and firmly affixed to each sample container. Typically, identification labels require that the following information be supplied:

- job name
- job number
- sampler's name
- sample identification
- date sampled and time
- analysis requested

3.12 Acidification is required for samples that will be analyzed by the EPA 624 method. (see Acidification Procedure in this section)

3.13 Acidification is recommended for EPA method 601 and 602 samples to preserve them and increase their holding life. (see Acidification Procedure in this section)

3.14 Field blanks should be taken as part of each sampling round. A field blank consists of a sample of distilled water which has been collected by putting the distilled water into a sampling bailer after the bailer has been cleaned following the procedure used to clean that bailer during the sampling round. The field blank is stored with the samples. It is not analyzed unless requested by the Project Manager. The field blank should not be identified as such to the laboratory.

3.15 Handling of decontaminated equipment:

- Always use "pristine" gloves (latex, solvex, etc.).
- Place decontaminated bailers on clean surface (plastic).
- Do not wipe down bailer with paper towels or cloth. Follow decontamination procedure.

3.16 Sample accuracy can be adversely affected by the entrainment of sediment in wells which have not been properly developed. Contaminants adhering to the sediments can be released when samples are acidified for preservation. Therefore, if sediments are present, field filtering of the samples is recommended.

3.17 Chemical changes can take place because the sample was oxidized during sampling. It is critical to avoid oxidation of samples when sampling for volatile organic compounds (VOC). Therefore, take care to insure minimal agitation occurs during sampling.

3.18 All samples should be properly and promptly preserved.

3.19 All samples should be analyzed quickly; arrangements should be made with the testing laboratory to insure prompt analysis is performed within the allowable times for the specific analyses to be done.

3.20 Bailer strings that have contacted water or contaminants should be replaced between each well to avoid contamination from a bailer string which has absorbed contamination. A good practice is to replace the string between wells. Caution: some bailer strings are treated with a fungicide which may be detected in priority pollutant analysis.

3.21 Notify laboratory that samples are being shipped in advance of sampling to insure proper delivery and turnaround.

3.22 On the chain of custody, note what type of decontamination or preservation fluids, chemicals were used.

4.0 ACIDIFICATION PROCEDURE (EPA Methods 601,602, and 624)

4.1 At the start of each sampling round, the amount of acid required to lower a sampling container of water to be sampled to a pH of less than 2 should be determined.

4.2 After removing 3 to 5 well volumes from the first well to be sampled, put 5-10 drops of 50% HCL into a 40 ml sample vial (larger sampling container will require more acid) and fill the vial with water form the well; determine the pH of water in the vial with pH paper; if the pH is too high, repeat the procedure using 15-20 drops of acid in the vial; repeat until the pH of the water in the sample vial is a pH of less than 2 on the pH paper. Note the amount of acid required to lower the pH of the volume of water in the sampling vial. (pH paper should not be placed into sampling container. Pour sample onto pH paper to check for proper pH.)

4.3 Discard the practice acidified sample.

4.4 Once the amount of acid required to reach a pH of <2 is known, the acid can be routinely added to each sample container directly; the water to be analyzed is added to vial or container containing the appropriate amount of acid.

4.5 Note that the amount of acid required is site specific and should be noted on the Chain of Custody form.

4.6 The procedure should be repeated for each site at the start of each sampling round.

4.7 Equipment
- Bailer or other means to remove 3 to 5 well volumes
- Sampling bailer
- Polyethylene squirt bottle of 50% hydrochloric (HCL) acid
- Narrow range pH paper (1.0 - 2.5 pH range)
- Paper towels
- Waterproof pen
- Laboratory sample identification labels
- Cooler with ice
- Chain of custody forms
- Sample containers (usually 40 ml glass vials with teflon faced septums)
- Alconox solution and/or methanol
- Distilled water
- Safety equipment (gloves, etc.)
- Dissolved oxygen meter (sometimes used in limited biorec projects in conjunction with bacteriological testing)

5.0 SURVEYING

5.1 Equipment Handling

- The level/transit is a sensitive, expensive instrument, handle it accordingly. Keep it dry and clean as possible. Never carry the instrument in the back of the truck.

- Never leave the instrument on the tripod without securely attaching it.

- Make sure that the tripod is stable at all times.

- Always setup the tripod and instrument so that it is easily seen.

- Never leave a tripod and instrument unattended when surveying in an area with vehicular traffic. Place protective cones around the survey station.

- Keep an eye on the equipment at all times.

- Keep the survey rod free of dirt and grit.

5.2 Leveling the Instrument

- Center the level and screw it into the tripod.

- Firmly plant the tripod legs.

- Use foot screw to level the instrument. The bubble must be within the setting circle in order for the instrument the be level.

- Rotate the level 360 degrees, checking to be sure that the bubble remains inside the circle at every point.

5.3 Focusing the Cross Hairs and Siting

- To focus the cross hairs, look through the instrument and turn the ring around the eyepiece until the hairs come into focus.

- Relax your eye while looking through the eyepiece.

- Use a sun shade.

5.4 Rod

- Be careful when using a rod around overhead power and utility lines.

- The rod is graduated into hundredths of a foot. The bottom of each black line is an odd hundredth; the top of each black line is an even hundredth.

- When surveying to the rod, the rod should be slowly rocked forward and back to determine the lowest, and most accurate, reading.

5.5 Stadia Surveys

- Readings should be taken at the intersection of the vertical cross hair with the three horizontal cross hairs. (A level survey requires reading only the center cross hair.)

- Distance (D) calculation:

  D = (High Stadia - Low Stadia) x 100

  ex:
  High Stadia = 8.87   D = (8.87 - 8.29) x 100
  Low Stadia = 8.29   D = 58.0

- Check the accuracy of your readings as you survey. An acceptable error is .01 feet difference between calculations per siting.

- Check Readings: high - mid = mid - low

5.6 Bench Marks

- Clearly note the location and type of the bench mark used for each survey. The location should be marked permanently in the field so that it may be reused.

- If an existing bench mark with a known elevation is within a reasonable distance of the site, the surveyors should attempt to use it as the bench mark for the survey. possible existing bench marks are sewer manhole rims, storm drains, USGS (from topo map)

- If there is no known bench mark in the area, a bench mark must be created arbitrarily.

- Use the following guidelines for establishing an arbitrary bench mark:

  a) use permanent physical features such as the corner of a pump island, a cement floor slab, manhole or sewer rim.
  b) assign an elevation to the bench mark; if the nearest 10-foot contour is known, use it as the BM elevation; if the contour elevation is not known, assign an arbitrary elevation.
  c) clearly note the location and elevation of the BM in the field and on all site plans.
  d) DO NOT USE MONITORING OR RECOVERY WELLS AS BENCH MARKS.

5.7 Level Surveys

- When surveying wells, make certain to choose a survey point that can be used when gauging the well; if the top of the PVC casing is greater than 6 inches below the ground surface, do not use it as the survey point, instead use the lip or rim of the protective casing. Clearly note the survey point of each well in the survey notes.

- Obtain the following for each monitoring well survey location:

  a) the elevation of the top of the well casing (T.O.C.);
  b) the elevation of the lip or rim of the protective casing (T.O.R.)

- Permanently mark the survey point with paint or permanent marker.

- Place the rod on the survey point and hold it vertical; move it backwards and forwards to determine the most accurate reading.

- Calculate the elevation from the middle cross hair reading.

- Limit the number of times the instrument must be moved.

- After completing level readings at each set up, shoot back to two or more wells to close the level run.

- In a multiple-station survey, always shoot at least two known points for each station.

- Where there is a significant topographic change across a site, additional survey information will be required in order to document the ground surface elevation differences; this information is critical when drawing cross-sections and in planning trenching and infiltration gallery installations.

- Calculate elevations before moving instrument to determine if there are any irregularities or errors.

5.8 Turning Points

- A TP (turning point) is used when all of the survey points cannot be seen form one instrument position and the instrument must be moved.

- The TP essentially establishes a new bench mark from which a new height of instrument is calculated.

- A TP can be a permanent structure, a PK, the original BM or a well. (A PK is a surveyor's nail driven into the ground/asphalt to create a hub for the rod to rest upon.)

- Complete the following steps to create a TP:

a) take a FS (foresight) on the TP and record the measurement under the FS column in the field book;
b) the FS is subtracted from the HI (height of instrument) for the current instrument location to determine the elevation of the TP;
c) the instrument is then moved to a new location and leveled;
d) a BS (backsight) reading is taken to the TP and entered in the BS column in the field book;
e) the BS is added to the TP to determine the new HI elevation;
f) NOTE: the TP entry in the survey data in the field book will always have 4 entries: BS, FS, HI, and elevation.

5.9 Taping locations

- Use a tape to verify distances that were surveyed with the instrument.

- Obtain three measurements for each location.

- Pull the tape tightly between points being measured.

- Measure dimensions of buildings on site to confirm base maps.