FINAL

COMPLIANCE MONITORING PLAN

EQUILON SEATTLE SALES TERMINAL

SEATTLE, WASHINGTON

Submitted to

Washington State Department of Ecology

Submitted by

Equilon Enterprises LLC

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1 INTRODUCTION

The purpose of this compliance monitoring plan is to provide procedures to be followed to confirm that cleanup requirements have been achieved at the Equilon Seattle Sales Terminal on Harbor Island in Seattle, Washington. This compliance monitoring plan was prepared consistent with requirements of the Consent Decree between Equilon Enterprises LLC and the Washington State Department of Ecology (Ecology). This plan was also prepared in accordance with the Model Toxics Control Act regulation (WAC 173-340-410, -720, and -820).

This plan has been organized into seven sections as described below:

- **Introduction.** Overviews of the site hydrogeology, cleanup actions, monitoring objectives and rationale, types of monitoring, monitoring locations, and monitoring schedule are provided in this section.

- **Protection Monitoring.** This section discusses criteria for protection monitoring under WAC 173-340-400.

- **Performance Monitoring.** This section discusses performance criteria for product recovery and natural attenuation, product monitoring procedures, sampling and analysis, and schedules for performance monitoring of product and groundwater.

- **Confirmational Monitoring.** This section discusses compliance criteria, monitoring, sampling and analysis, and schedules for confirmational monitoring of groundwater and product.

- **Data Evaluation.** Data validation and evaluation procedures are discussed in this section.

- **Criteria for Meeting Performance and Compliance Standards.** This section discusses criteria to be used to determine if performance and compliance standards have been met. Changes in frequency of monitoring and changes in monitoring locations are also discussed.

- **Reporting.** This section discusses the types and frequency of reports to be submitted to Ecology.

- **Contingency Plan.** This section discusses the steps that will be implemented in the event the proposed cleanup actions are not effective.

1.1 Overview of Site Hydrogeology

Soil underlying the site consists of man-emplaced grade and dredge fill overlying native estuarine deposits (EMCON, 1997). The uppermost grade fill unit consists of coarse-grained fill varying from less than 1 to approximately 2 feet thick. The dredge fill unit originated from estuarine deposits near the site; therefore, delineation of the contact between the two units is difficult. The dredge fill appears to vary from approximately 8 to 20 feet thick at the site. It consists of fine- to medium-grained sand, with some gravel. Native estuarine deposits underlie the dredge fill at depths of approximately 9 to 20 feet. These deposits are composed primarily of fine- to medium-grained sand with thin silt interbeds.

Groundwater occurs as a thin lens of fresh water overlying brackish water at depth. The grade fill is permeable and was unsaturated during the remedial investigation. The water table occurs within the dredge fill 4 to 8 feet below the ground surface. Groundwater within the dredge fill unit occurs under unconfined conditions. The North Tank Farm and Main Terminal areas generally are unaffected by tides; at the Shoreline Manifold Area, groundwater quality and elevations within this unit are affected by surface water tidal fluctuations. The native estuarine deposits are fully saturated and unconfined. Water quality and water elevations within this unit are influenced by surrounding surface water bodies and associated tidal fluctuations. Groundwater within the shallower monitoring zone at the site is estimated to flow radially both to the north and to the south from a potentiometric high located within the Main Tank Farm area.

1.2 Summary of Cleanup Actions

Cleanup actions at the site include source removal and recycling/off-site disposal, monitoring, natural attenuation, and institutional controls. The specific cleanup actions are listed below:

- Continued active and passive product recovery at the Shoreline Manifold Area
- Aggressive passive product recovery at the North Tank Farm
- Groundwater treatment before disposal

- Excavation of accessible total petroleum hydrocarbons (TPH) subsurface soil hot spots above 10,000 milligrams per kilogram (mg/kg) to the extent practicable at the Shoreline Manifold Area
- Excavation of accessible TPH subsurface hot spots above 20,000 mg/kg to the extent practicable adjacent to Tank 31636 in the Main Tank Farm, and east of the warehouse
- Excavation or capping of lead-impacted surface soil above 1,000 mg/kg near the oil/water separator
- Excavation or capping of lead- and arsenic-impacted surface soil above 1,000 mg/kg lead and 32.6 mg/kg arsenic in the Main Tank Farm
- Natural attenuation of residual TPH in subsurface soil
- Product Monitoring
- Groundwater monitoring in point of compliance and property wells
- Institutional controls including a deed restriction
- Contingency plans

1.3 Monitoring Objectives and Rationale

The proposed cleanup actions at the site, as previously discussed in Section 1.2 of this plan, include product recovery, excavation of TPH soil hot spots, excavation or capping of lead- and arsenic-impacted surface soil, product monitoring, and groundwater monitoring. Cleanup areas (areas above cleanup action levels) were identified based on the soil and groundwater chemistry data collected during the remedial investigation (EMCON, 1996).

Types of monitoring, monitoring locations, and types of analyses were selected to monitor the effectiveness of the cleanup actions to meet the soil, product, and groundwater cleanup standards for the site. A brief discussion of site soil and groundwater chemistry data as it relates to monitoring well selection are presented in Sections 1.3.1 and 1.3.2.

1.3.1 Soil

TPH, arsenic, and lead concentrations were above levels requiring action at five locations at the site.

1. **TPH at the Shoreline Manifold Area.** Soil TPH concentrations were above the cleanup action levels (10,000 mg/kg) at the Shoreline Manifold Area.

2. **TPH at the North End of the Main Tank Farm.** Soil TPH concentrations were above the cleanup action levels (20,000 mg/kg inland) adjacent to Tank 31636 at the north end of the Main Tank Farm.

3. **TPH at the East Side of the Warehouse in the Main Terminal.** Soil TPH concentrations were above the cleanup action levels (20,000 mg/kg inland) on the east side of the warehouse.

4. **Arsenic and Lead in the Main Tank Farm.** Surface soil arsenic and lead were above the cleanup levels (32.6 and 1,000 mg/kg, respectively) in unpaved soil in the Main Tank Farm.

5. **Lead at the Oil/Water Separator in the Main Terminal.** Surface soil lead was above the cleanup level (1,000 mg/kg) in unpaved soil adjacent to the oil/water separator.

1.3.2 Groundwater

Groundwater will be monitored for benzene, toluene, ethylbenzene, TPH-G, TPH-D, TPH-O, carcinogenic polycyclic aromatic hydrocarbons (cPAHs), lead, and arsenic in specific areas of the site prior to and during the cleanup action. The selected analysis and monitoring locations correspond to the five soil cleanup actions areas identified in Section 1.3.1, areas of product recovery, and the water quality chemistry data for the site.

Areas Below Cleanup Levels

IHSs were not detected above the groundwater cleanup levels (Table 1-1) more than once in shallow monitoring wells MW-05, MW-102, MW-105, MW-106, MW-107, MW-109, MW-110, MW-112, TES-MW-1, and MW-201; and MW-213 and MW-214. These wells are located at the downgradient side of the North Tank Farm, at the northeast and northwest corners of the Main Tank Farm, across most of the Main Terminal, and at the Shoreline Manifold Area.

Wells Not Included in Compliance Monitoring Program. Monitoring wells MW-106, MW-107, MW-109, and MW-110 will not be included in the compliance monitoring program because of historical IHS detections below the cleanup levels.

Wells Included in Compliance Monitoring Program. Monitoring wells MW-05, MW-102, MW-105, MW-112, TES-MW-1, and MW-201 were also below cleanup levels. These wells will be included in the program due to their location adjacent to areas with soil cleanup actions or to provide a property boundary sentry well network. The fact that the water quality is already below cleanup levels before hot spot cleanup shows that the proposed cleanup is conservative. Monitoring in these wells will be focused on the IHSs (BTEX, TPH) to provide water quality data for baseline data and trend analysis. These wells will not be monitored for natural attenuation parameters since cleanup levels have been already met in these wells.

MW-213 and MW-214 are two conditional point of compliance wells located at the Shoreline Manifold Area. The two wells are located as close as possible to the area of concern and screened at the bottom of the bulkhead to monitor water quality concentrations at the groundwater/surface water interface or the quality of water entering the Bay. Data collected to date in the well have been below cleanup levels and below the laboratory detection limit, indicating that the interim actions at the Shoreline Manifold Area have been effective. MW-213 and MW-214 will be included in the compliance monitoring program and monitored for BTEX, TPH, and cPAHs.

Areas Above Cleanup Levels

BTEX and TPH Areas. Shallow monitoring wells with periodic or consistent detections of BTEX constituents or TPH above the cleanup levels include MW-101, MW-104, MW-111, TX-03, TX-04, TX-06, MW-202, and MW-203. These wells are located in or around the Main Tank Farm (MW-101, TX-03, TX-04, and TX-06), in the North Tank Farm (MW-202 and MW-203), and in two isolated locations in the Main Terminal (MW-104 and MW-111). Due to the historic detections of petroleum-hydrocarbon-related IHSs above the cleanup levels, these monitoring wells will be included in the compliance monitoring program.

Lead Areas. Dissolved lead was detected periodically above the cleanup level only in MW-104; lead will be included in the analysis of MW-104. Lead will be included in the compliance monitoring program in MW-05, MW-101, MW-104, MW-105, TX-03, TX-04, and TX-06 to monitor the surface soil cleanup action in the Main Tank Farm.

Arsenic Areas. Dissolved arsenic was detected at about two times the cleanup level in TX-06. Arsenic will be included in the compliance monitoring program in MW-05,

MW-101, MW-104, MW-105, TX-03, TX-04, and TX-06 to monitor the surface soil cleanup action in the Main Tank Farm.

Areas In or Around Free Product. Shallow wells located in or around a free product plume at the Shoreline Manifold Area include MW-208, MW-210, MW-211, and MW-212. In addition, there are well points WP-1 through WP-8 to monitor product along the bulkhead. Product in these well points have been reduced to a sheen. Trace amounts of free product have also been measured in MW-204 in the North Tank Farm. Product performance and confirmational monitoring will be performed in these wells. The product performance standard is a "measurable product thickness", and the product cleanup standard is "no visible sheen." After the performance standard has been met, MW-204 will be sampled for BTEX and TPH.

Off-site Wells Southeast of the Main Terminal. Benzene, toluene, ethylbenzene, and/or TPH-G were detected above the cleanup levels in two off-site wells, A-28 and SH-04, located southeast of the Main Terminal. Dissolved lead was detected in SH-04. Well A-28 is located downgradient of an off-site free-product plume, and the detections above the cleanup levels in this well, therefore, represent contaminant migration toward the terminal from an off-site source. Well A-28 will not be monitored as part of the Equilon compliance monitoring program but will be observed by Ecology for its potential adverse impact to the Equilon Terminal cleanup. Well SH-04 will be monitored for one year and the results reviewed with Ecology to determine if SH-04 should be included in Equilon's compliance monitoring program.

Background

MW-206 is located upgradient to the North Tank Farm and will serve as the site background monitoring well.

1.4 Monitoring Types, Locations, and Schedule

Types of Monitoring. Compliance monitoring will consist of product monitoring, groundwater level monitoring, and groundwater sampling.

- Product monitoring will consist of measuring product levels in areas of the site with floating product on the water table
- Groundwater level monitoring will be performed during product monitoring events and during groundwater sampling events

- Groundwater samples will be collected from compliance monitoring wells and property (sentry) wells on the Equilon site and one off-site well

Monitoring Locations. Figure 1-1 shows the locations of all wells in which product will be monitored, groundwater levels will be measured, and groundwater samples will be collected as part of the site compliance monitoring program. Table 1-2 provides a list of compliance monitoring wells, identifying the well location, monitoring objective, and well use. The monitoring objectives have been categorized as confirmational, performance, and sentry.

- Performance monitoring is to confirm that the cleanup action has attained performance of cleanup standards

- Confirmational monitoring is to confirm the long-term effectiveness of the cleanup action once performance and cleanup standards have been met.

- Sentry monitoring is to provide early warning of off-site contaminant migration.

Table 1-3 provides a summary of the compliance monitoring analytical parameters.

Monitoring Schedule. Groundwater sampling will begin in April 1999 and will continue for five years to March 2004. Sampling will occur quarterly for the first year. Ecology and Equilon will review the data after one year. If trends are declining, the sampling frequency and number of parameters may be reduced.

2 PROTECTION MONITORING

The objective of protection monitoring is to confirm that human health and the environment are adequately protected during all phases of the cleanup action (WAC 173-340-410(1)(a). Protection monitoring will be addressed in the health and safety plan prepared in conjunction with the engineering design report, construction plans and specifications, and operation and maintenance plan (WAC 173-340-400).

3 PERFORMANCE MONITORING

The objective of performance monitoring is to confirm that the cleanup action has attained performance and cleanup standards (WAC 173-340-410(1)(b). Performance monitoring will consist of product monitoring during product recovery activities and groundwater sampling to evaluate the effectiveness of natural attenuation.

3.1 Performance Criteria

The site-specific performance criteria for the respective cleanup options are:

Product Recovery. The performance criterion will be a lack of measurable product thickness in product monitoring wells.

Natural Attenuation. The performance criterion will be periodic demonstrations that natural attenuation is reducing contaminant concentrations at the site (USEPA, 1997). Natural attenuation processes include a variety of physical, chemical, or biological processes that can act to reduce the mass, toxicity, mobility, volume, or concentration of constituents in groundwater. These in-situ processes include biodegradation, dispersion, dilution, sorption, volatilization, and chemical or biological stabilization, transformation, or destruction of contaminants (USEPA, 1997). Monitoring the effectiveness of natural attenuation requires the collection of constituent plume data (i.e., BTEX and TPH) and a variety of other indicators. Following is the rationale for the selection of the natural attenuation monitoring parameters (from USEPA, 1994c).

Constituent Plume Characteristics

In the absence of natural attenuation mechanisms, constituent concentrations would remain relatively constant within the plume and then decrease rapidly at the edge of the plume. If natural attenuation is occurring, constituent concentrations will decrease with distance from the source along the flow path of the plume as a result of dispersion. If other natural attenuation mechanisms are occurring, the rate at which concentrations of constituents are reduced will be accelerated.

Monitoring of constituent concentrations in the groundwater over time will give the best indication of whether natural attenuation is occurring. If natural attenuation is occurring, the contaminant plume will migrate more slowly than expected based on the average groundwater velocity. Receding plumes typically occur when the source has been

eliminated. Natural attenuation may also be occurring in plumes that are expanding, but at a slower than expected rate. For example, in sandy soils [similar to Harbor Island] with relatively low organic carbon content (about 0.1 percent), BTEX constituents are expected to migrate at one-third to two-thirds of the average groundwater speed velocity (McAllister, 1994). Higher organic carbon content would further retard constituent migration. If constituents are migrating more slowly than expected based on groundwater flow rates and retardation factors, then other natural attenuation mechanisms (primarily biodegradation) are likely reducing constituent concentrations. For stable plumes, the rate at which contaminants are being added to the system at the source is equal to the rate of attenuation. A plume may be stable for a long period of time before it begins to recede, and in some cases, if the source is not eliminated, the plume may not recede.

Occurrence of biodegradation might also be deduced by comparison of the relative migration of individual constituents. The relative migration rates of BTEX constituents, based on the chemical properties, are expected to be in the following order:

benzene > toluene, o-xylene > ethylbenzene, m-xylene, p-xylene

If the actual migration rates do not follow this pattern, biodegradation may be responsible.

Dissolved Oxygen Indicators

The rate of biodegradation will depend, in part, on the supply of oxygen to the contaminated area. At levels of dissolved oxygen (D.O.) below 1 to 2 mg/L in the groundwater, aerobic biodegradation rates are very slow. If background D.O. levels (upgradient of the contaminant source) equal or exceed 1 to 2 mg/L, the flow of groundwater will supply D.O. to the contaminated area, and aerobic degradation is possible.

Where aerobic biodegradation is occurring, an inverse relationship between D.O. concentration and constituent concentrations can be expected (i.e., D.O. levels increase as constituent levels decrease). Thus, if D.O. is significantly below background within the plume, aerobic biodegradation is probably occurring at the perimeter of the plume.

Geochemical Indicators

Certain geochemical characteristics can also serve as indicators that natural attenuation, particularly biodegradation, is occurring. Aerobic biodegradation of petroleum products produces carbon dioxide and organic acids, both of which tend to cause a region of lower pH and increased alkalinity within the constituent plume.

Anaerobic biodegradation may result in different geochemical changes, such as increased pH. Under anaerobic conditions, biodegradation of aromatic hydrocarbons typically causes reduction of Fe^{3+} (insoluble) to Fe^{2+} (soluble), because iron is commonly used as an electron acceptor under anaerobic conditions. Thus, soluble iron concentrations in the groundwater tend to increase immediately downgradient of a petroleum source as the D.O. is depleted, and conditions change to be come anaerobic (i.e., reduced). The concentration of methane increases, another indication that anaerobic biodegradation is occurring.

Oxidation/Reduction Potential

> The oxidation/reduction (redox) potential of groundwater is a measure of electron activity and is an indicator of the relative tendency of a solution to accept or transfer electrons. Because redox reactions in groundwater are biologically mediated, the rates of biodegradation both influence and depend on redox potential. Many biological processes operate only within a prescribed range of redox conditions. Redox potential also can be used as an indicator of certain geochemical activities (e.g., reduction of sulfate, nitrate, or iron). The redox potential of groundwater generally ranges from 800 millivolts to about -400 millivolts... The lower the redox potential, the more reducing and anaerobic the environment.
>
> Measurement of redox potential of groundwater also allows for approximate delineation of the extent of the contaminant plume. Redox potential values taken from within the contaminant plume will be lower than background (upgradient) redox values and values from outside the plume. This is due in part to the anaerobic conditions that typically exist within the core of the dissolved hydrocarbon plume.

Based on this discussion (USEPA, 1994c), groundwater samples collected for natural attenuation evaluation will be analyzed for plume characterization parameters (BTEX, TPH-G, TPH-D, and TPH-O), dissolved oxygen, geochemical indicators (alkalinity, carbon dioxide, total iron (from which ferric iron [Fe^{3+}] can be calculated), ferrous iron (Fe^{2+}), hardness, methane, pH, and sulfate), and oxidation/reduction potential.

3.2 Monitoring and Schedule

Product Recovery. Monitoring wells MW-204, MW-208, MW-210, MW-211, and MW-212, and well points WP-1 through WP-8 will be monitored for the presence of floating product and for potential indicators of product such as odor and sheen. Floating product is defined as a measurable thickness of product (greater than or equal to 0.01 feet thick). Sheen is defined as a visible display of iridescent colors on equipment or water removed from a monitoring well.

An oil-water interface probe will be used to measure product thickness and depth to groundwater. The probe and the water surface in the well will be observed for sheen. If measurable floating product is present, a peristaltic pump or disposable polyethylene bailer will be used to skim floating product from the well.

Product monitoring will be conducted at an interval long enough to allow product to flow into wells in product plumes but no less frequently than once a month. The frequency of product monitoring will depend on the amount and type of product removed from the monitoring wells, the season, and the type of product recovery activity. Product monitoring has historically occurred every two to four weeks, and it is anticipated that this frequency will likely continue.

Natural Attenuation. Groundwater samples will be collected from six monitoring wells at the north end of the Main Tank Farm and in the North Tank Farm for this evaluation. Wells TES-MW-1 and MW-201 will represent groundwater quality upgradient and downgradient, respectively, of a plume of TPH-G and BTEX. Monitoring wells MW-101, TX-03, MW-202, and MW-203 will represent wells in the plume.

Ongoing monitoring will be conducted to confirm the effectiveness of natural attenuation and to estimate the rate. Starting in April 1999, monitoring for natural attenuation will be conducted quarterly for the first year and annually thereafter (USEPA, 1994c).

4 CONFIRMATIONAL AND SENTRY MONITORING

The objective of confirmational monitoring is to confirm the long-term effectiveness of the cleanup action once performance and cleanup standards have been met (WAC 173-340-410(1)(c). Confirmational monitoring will consist of product monitoring and groundwater sampling. In addition, sentry monitoring wells located at the property boundary will be monitored to provide early warning of off-site contaminant migration.

4.1 Product

4.1.1 Compliance Criteria

The compliance criterion for product will be a lack of visible sheen on the water surface in product monitoring wells.

4.1.2 Monitoring and Schedule

Monitoring Wells. Monitoring wells MW-204, MW-208, MW-210, MW-211, and MW-212, and well points WP-1 through WP-8 will be monitored for the presence of floating product and for potential indicators of product such as odor and sheen. Floating product is defined as a measurable thickness of product (greater than or equal to 0.01 feet thick). Sheen is defined as a visible display of iridescent colors on equipment or water removed from a monitoring well.

An oil-water interface probe will be used to measure product thickness and depth to groundwater. The probe and the water surface in the well will be observed for sheen. If measurable floating product is present, a peristaltic pump or disposable polyethylene bailer will be used to skim floating product from the well.

Schedule. Confirmation product monitoring will be conducted once per month for a period of one year after cessation of product recovery activities. The schedule will be reevaluated at that time as discussed in Section 5.2.1.

4.2 Groundwater

4.2.1 Compliance Levels

Groundwater cleanup levels on Harbor Island are based on protection of aquatic organisms and humans ingesting such organisms (Lovely Consulting, Inc., and EMCON, 1997). Accordingly, these cleanup levels are applicable at the groundwater/surface water interface. Table 1-1 presents the groundwater cleanup levels.

4.2.2 Sampling, Analysis, and Schedule

Sample Collection. Groundwater samples will be collected from background monitoring well MW-206, confirmational monitoring wells MW-213 and MW-214, and sentry monitoring wells MW-05, MW-101, MW-102, MW-104, MW-105, MW-111, MW-112, MW-201, MW-202, MW-203, TX-03, TX-04, and TX-06 using low flow sampling techniques. After the performance standard has been met, MW-204 will be added to the list of wells to be sampled. Each well will be purged at a low flow rate using the peristaltic pump fitted with disposable polyethylene tubing. Purging will continue until field parameters have stabilized. Groundwater samples will then be collected from the discharge line of the peristaltic pump. A round of groundwater levels will be measured in all available network wells and piezometers before each sampling event.

Sample Analysis. Groundwater samples collected from all wells during confirmational and sentry monitoring will be submitted to a laboratory for analysis of the site petroleum-related IHSs (BTEX, TPH-G, TPH-D, and TPH-O). Additionally, samples collected from wells MW-05, MW-101, MW-104, MW-105, TX-03, TX-04, and TX-06 will be analyzed for total and dissolved arsenic and lead to monitor the surface soil cleanup action in the Main Tank Farm. The samples collected from MW-213 and MW-214 will also be submitted for analysis of cPAHs, which were periodically detected in shallow groundwater at the Shoreline Manifold Area.

Sampling and Analysis Procedures. Detailed procedures for sampling, sampling handling, residuals management, well abandonment, sample analysis, and quality assurance are presented in Appendix A.

Schedule. Confirmational and sentry monitoring will begin in April 1999 and will continue for five years after completion of the cleanup (estimated to be March 2004 based on construction schedules). Sampling will occur quarterly for the first year. Ecology and Equilon will review the data after one year. If trends are declining, the sampling frequency and number of parameters may be reduced.

4.2.3 Well Abandonment

Monitoring wells MW-106 and MW-207 will be abandoned because they are redundant and because no constituents have been detected in these wells above the groundwater cleanup levels. MW-106 is located in the same area as MW-107, MW-108, MW-109, and a series of piezometers. MW-207 is located off site near MW-206.

5 DATA EVALUATION

5.1 Data Validation

All chemistry data will be validated according to United States Environmental Protection Agency (USEPA) data validation guidelines (USEPA, 1994a and 1994b). Data validation will include evaluation of holding times, method blank results, surrogate recovery results, field and laboratory duplicate results, completeness, detection limits, laboratory control sample results, and chain-of-custody forms. A detailed description of the data validation procedures is provided in the sampling and analysis plan (Appendix A). After the data has been validated, it will be entered into the project database with any assigned data qualifiers.

5.2 Data Evaluation

5.2.1 Practical Quantitation Limits

Practical Quantitation Limits (PQLs) will be established for each analyzed constituent to determine whether any are above the corresponding cleanup level. Per WAC 173-340-707(2), if the PQL for any constituent is above the corresponding cleanup level, the cleanup level will be considered to be attained if the constituent is undetected at the PQL or detected below the PQL. The PQL will be determined by multiplying the lowest method detection limit (MDL) obtained by the laboratory for Terminal groundwater samples by a factor of ten (Ecology, 1993). It is anticipated that PQLs will be used as cleanup levels only for the cPAHs.

5.2.2 Product Monitoring Data

Product monitoring data will be reviewed as it is generated to determine the need for product recovery system alterations or to determine changes in product monitoring frequency. Groundwater and product level data will be entered in spreadsheets.

5.2.3 Groundwater Chemistry Data Review

Natural Attenuation Monitoring Data. Natural attenuation monitoring data will be reviewed to see if the data are providing the information needed to evaluate natural attenuation at the site. If the data are not sufficient for the evaluation, Equilon may propose to Ecology adding parameters (Wiedemeier and others, 1995) to the natural attenuation analyte list.

Confirmational and Sentry Monitoring Data. Groundwater chemistry data will be reviewed after it is validated. The data will be compared to the groundwater cleanup levels. If a sample result is above a groundwater cleanup level and also above the historic high concentration in that well, the well will be resampled to verify the result. Resampling will occur within one month of receiving the laboratory data. Groundwater elevation data will be entered into the project database for use in the five year review.

5.2.4 One Year Site Review

Groundwater elevation and chemistry data will be evaluated after the first year of sampling (in 2000). Natural attenuation monitoring well data will be evaluated as discussed in USEPA (1994c; see Section 3.2 above) and Wiedemeier and others (1995). Spatial and temporal changes in plume characterization parameters, dissolved oxygen, geochemical indicators, and oxidation/reduction potential will be evaluated to determine the effectiveness and rate of natural attenuation at the site.

Groundwater TPH and BTEX data will be evaluated using time-trend plots and data comparison to cleanup levels. Time-trend plots will be prepared for each constituent detected above the PQL; trends will be identified by visual observation. The time-trend plots will be used to evaluate long-term trends in the compliance wells and to put the comparisons to cleanup levels in context. A groundwater contour map will be prepared to verify that the groundwater flow directions at the Terminal have not significantly changed.

Ecology and Equilon will review the evaluation. After the first year review, if the sentry wells at the property boundary exceed cleanup standards, Ecology, Equilon, and the adjacent property owner will evaluate groundwater conditions prior to considering contingency plans. If trends are declining, the sampling frequency and number of parameters may be reduced.

5.2.5 Five Year Site Review

Groundwater elevation and chemistry data will be evaluated after five years of sampling (in 2004). Groundwater contour maps will be prepared to verify that the groundwater flow directions at the Terminal have not significantly changed.

Natural Attenuation Monitoring Data. Natural attenuation monitoring well data will be evaluated as described in Section 5.2.4. The evaluation will be documented for presentation in the five-year review report.

Sentry Well Data. Groundwater TPH and BTEX data will be evaluated using time-trend plots and data comparison to cleanup levels. Time-trend plots will be prepared for each constituent detected above the PQL; trends will be identified by visual observation.

Confirmational Well Data. Groundwater TPH, BTEX, and cPAH data will be evaluated using time-trend plots, data comparison to cleanup levels, and, if appropriate, statistical analysis. Time-trend plots will be prepared for each constituent detected above the PQL; trends will be identified by visual observation. The time-trend plots will be used to evaluate long-term trends in the compliance wells and to put the comparisons to cleanup levels, and statistical analyses if performed, in context. If none of the results for an analyte are above the cleanup level, the data for that analyte will not be analyzed using statistics. If at least one result for an analyte is above the cleanup level, statistical analysis per WAC 173-340-720(8) and Ecology (1992, 1993, and 1995) will be conducted.

6 CRITERIA FOR MEETING PERFORMANCE AND COMPLIANCE STANDARDS

6.1 Performance Monitoring

Changes to the product monitoring schedule and wells will be made based on product monitoring data review. Changes may be made in the frequency of product monitoring to maximize product removal or system efficiency, depending on the amount and type of product removed from the monitoring wells, the season, and the type of product recovery activity. Other changes in performance monitoring will be made as follows (Figure 6-1):

- Additional product recovery activities and monitoring will be initiated immediately if a product sheen emanating from the shoreline manifold area is observed on the Elliott Bay water surface.

- An additional well or well point will be installed and monitored if floating product is found for the first time in a downgradient or crossgradient well. The need for additional product recovery activities will also be reviewed.

- Performance monitoring will continue as long as floating product is found in the area being monitored.

- Performance monitoring will end and confirmational monitoring will begin when floating product has not been found in any well in the area being monitored for a period of six months.

6.2 Confirmational Monitoring

6.2.1 Product

Product confirmational monitoring will continue until one of the follow occurs (Figure 6-2):

- Product recovery activities and performance monitoring will resume immediately if a product sheen emanating from the shoreline manifold area is observed on the Elliott Bay water surface
- Product recovery activities and performance monitoring will resume if measurable floating product is found in any well in an area being monitored
- Confirmational monitoring will end and the area considered without floating product when no sheen has not been found in any well in the area being monitored for a period of one year

6.2.2 Groundwater

Changes to the groundwater monitoring program will be based on groundwater quality data review. The review of groundwater quality data will be focused at evaluating groundwater quality trends and not a single event or exceedance in a single well. Changes in sampling will be made as follows (Figure 6-3):

- A well will be resampled if the analyte in the well is above the cleanup level and historic high concentrations

Groundwater quality data will be tabulated and trend plots prepared as part of the one-year site review and five-year site review. If the chemistry results are all below cleanup levels for four consecutive quarters, then Equilon will petition Ecology for site delisting review. Statistical analysis of the data will be performed if there are analytical results above cleanup levels. Alternatively, if the cleanup standards are met for 95 percent of the wells for four consecutive quarters, Equilon will petition Ecology for site delisting review. In addition to reviewing chemistry data for the indicator hazardous substances, natural attenuation parameters will also be evaluated to determine the effectiveness of natural attenuation at the site. The contingency plan (summarized in Section 8 of this Plan) will be initiated if an increasing trend is identified in the five-year review as follows (Figure 6-4):

- The contingency plan will be initiated if there is an increasing trend in the sentry well groundwater quality data and the data exceeds the cleanup level.

- The contingency plan will be initiated if any analyte is consistently above the cleanup level or statistically above the cleanup level with an increasing trend and with no evidence of natural attenuation.

7 REPORTING

Compliance monitoring data will be submitted to Ecology throughout the monitoring program. Ecology will also be notified immediately if product sheen emanating from the shoreline manifold area is observed on the Elliott Bay water surface. Data will be submitted in the following reports:

- **Quarterly Data Reports.** Laboratory data reports will be submitted to Ecology after each round of laboratory data has been received.

- **Annual Data Reports.** An annual data report will be prepared. The data report will include a data validation memo, updated groundwater chemistry tables (including any well resampling results), and product recovery data for the previous year. Any changes in the product recovery system will also be discussed.

- **Five-year Review Report.** A report will be submitted to Ecology summarizing the five-year review of the compliance monitoring data. The report will include an updated groundwater elevation table, a representative groundwater contour map, time-trend plots for analytes detected above the PQL, a comparison of the data to cleanup levels, and a discussion of natural attenuation.

8 CONTINGENCY PLAN

A contingency plan is a cleanup technology that serves as a "backup" remediation technology in the event that the preferred option fails or proves ineffective in a timely manner (five years after implementation of the preferred option). A contingency plan will be triggered and implemented within 30 days of meeting any of the following criteria:

- The results of the groundwater monitoring program indicate elevated contaminant concentrations over the specified restoration time frame of five years after implementing the preferred corrective options
- Contaminants are identified in point of compliance wells located outside of the original plume boundary, indicating renewed contaminant migration
- Contaminant migration is not decreasing at a sufficient rate to ensure that the primary and secondary concerns identified for the site are being met

The following actions will be initiated if the above criteria are triggered:

- Identify the source(s) causing the criteria to be triggered. For example, at the Shoreline Manifold Area, an increasing trend could indicate a new release. The highest priority in the compliance plan would be to identify and control the source.
- Remove the source (e.g., impacted soil) or implement appropriate treatment (e.g., adding oxygen releasing compounds), as needed, to the extent practicable. For example, additional hot-spot soil at the Shoreline Manifold Area will be excavated to the extent practicable when the underground pipelines are relocated above ground. Sources will be removed as long as removal does not impact the integrity of existing structures or create a greater environmental hazard.
- If residual product is identified beyond the capture zone of the existing product recovery network, the network will be evaluated and expanded to ensure removal of free product from the water table.
- If the results (increasing trend in surface water quality in point of compliance wells and a significant new product release at the Shoreline Manifold Area)

indicate there has been potential environmental impacts to aquatic organisms in Elliott Bay, then sediment and bioassay sampling will be implemented in accordance with the procedures outlined in the State of Washington Sediment Management Standards.

LIMITATIONS

The services described in this report were performed consistent with generally accepted professional consulting principles and practices. No other warranty, express or implied, is made. These services were performed consistent with our agreement with our client. This report is solely for the use and information of our client unless otherwise noted. Any reliance on this report by a third party is at such party's sole risk.

Opinions and recommendations contained in this report apply to conditions existing when services were performed and are intended only for the client, purposes, locations, time frames, and project parameters indicated. We are not responsible for the impacts of any changes in environmental standards, practices, or regulations subsequent to performance of services. We do not warrant the accuracy of information supplied by others, nor the use of segregated portions of this report.

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TABLES

Table 1-1

Groundwater Cleanup Levels
Equilon Seattle Sales Terminal
Seattle, Washington

Constituent	Cleanup Level (mg/L)
Benzene	0.071
Benzo(a)anthracene	0.000031
Benzo(a)pyrene	0.000031
Benzo(b)fluoranthene	0.000031
Benzo(k)fluoranthene	0.000031
Chrysene	0.000031
Ethylbenzene	0.43
Indeno(1,2,3-cd)pyrene	0.000031
Lead	0.0058
TPH-G	1
TPH-D	10
TPH-O	10
Toluene	5.0

Table 1-2

Compliance Monitoring Wells
Equilon Seattle Sales Terminal
Seattle, Washington

Well	Location	Monitoring Objective	Use
MW-05	Main Terminal	Sentry Well	Water Sampling
MW-101	Main Tank Farm	Performance Monitoring Well	Water Sampling
MW-102	NW of Main Tank Farm	Sentry Well	Water Sampling
MW-104	Main Terminal	Sentry Well	Water Sampling
MW-107	Main Terminal	Sentry Well	Water Sampling
MW-111	Main Terminal	Sentry Well	Water Sampling
MW-112	Main Terminal	Sentry Well	Water Sampling
SH-04	Main Terminal, Off Site	Off-site Impact Study Well	Water Sampling
TES-MW-1	Main Tank Farm	Performance Monitoring Well	Water Sampling
TX-03	Main Tank Farm, Off Site	Sentry, Performance Monitoring Well	Water Sampling
TX-04	Main Tank Farm, Off Site	Sentry Well	Water Sampling
TX-06	Main Tank Farm, Off Site	Sentry Well	Water Sampling
MW-201	North Tank Farm	Sentry, Performance Monitoring Well	Water Sampling
MW-202	North Tank Farm	Performance Monitoring Well	Water Sampling
MW-204	North Tank Farm	Performance Monitoring Well	Product Monitoring/Recovery
MW-206	North Tank Farm	Background Monitoring Well	Water Sampling
MW-208	Shoreline Manifold Area	Performance Monitoring Well	Product Monitoring/Recovery
MW-210	Shoreline Manifold Area	Performance Monitoring Well	Product Monitoring/Recovery
MW-211	Shoreline Manifold Area	Performance Monitoring Well	Product Monitoring/Recovery
MW-212	Shoreline Manifold Area	Performance Monitoring Well	Product Monitoring/Recovery
MW-213	Shoreline Manifold Area	Confirmational Monitoring Well	Water Sampling
MW-214	Shoreline Manifold Area	Confirmational Monitoring Well	Water Sampling
WP-1	Shoreline Manifold Area	Performance Monitoring Well	Product Monitoring/Recovery
WP-2	Shoreline Manifold Area	Performance Monitoring Well	Product Monitoring/Recovery
WP-3	Shoreline Manifold Area	Performance Monitoring Well	Product Monitoring/Recovery
WP-4	Shoreline Manifold Area	Performance Monitoring Well	Product Monitoring/Recovery
WP-5	Shoreline Manifold Area	Performance Monitoring Well	Product Monitoring/Recovery
WP-6	Shoreline Manifold Area	Performance Monitoring Well	Product Monitoring/Recovery
WP-7	Shoreline Manifold Area	Performance Monitoring Well	Product Monitoring/Recovery
WP-8	Shoreline Manifold Area	Performance Monitoring Well	Product Monitoring/Recovery

Table 1-3

Compliance Monitoring Analytical Parameters
Equilon Seattle Sales Terminal
Seattle, Washington

Well	First Year Sampling Frequency	Analytical Parameters								
		BTEX	TPH-G	TPH-D	TPH-O	cPAHs	Arsenic	Lead	Natural Attenuation[a]	Field[b]
MW-05	Quarterly[a]	X	X	X	X	—	X	X	—	X
MW-101	Quarterly[a]	X	X	X	X	—	X	X	X	X
MW-102	Quarterly[a]	X	X	X	X	—	X	X	—	X
MW-104	Quarterly[a]	X	X	X	X	—	X	X	—	X
MW-105	Quarterly[a]	X	X	X	X	—	X	X	—	X
MW-111	Quarterly[a]	X	X	X	X	—	—	—	—	X
MW-112	Quarterly[a]	X	X	X	X	—	—	—	—	X
SH-04	Quarterly[a]	X	X	X	X	—	—	—	—	X
TES-MW-1	Quarterly[a]	X	X	X	X	—	X	X	X	X
TX-03	Quarterly[a]	X	X	X	X	—	X	X	X	X
TX-04	Quarterly[a]	X	X	X	X	—	X	X	—	X
TX-06	Quarterly[a]	X	X	X	X	—	—	—	—	X
MW-201	Quarterly[a]	X	X	X	X	—	—	—	X	X
MW-202	Quarterly[a]	X	X	X	X	—	—	—	X	X
MW-203	Quarterly[a]	X	X	X	X	—	—	—	X	X
MW-206	Quarterly[a]	X	X	X	X	—	—	—	—	X
MW-213	Quarterly[a]	X	X	X	X	X	—	—	—	X
MW-214	Quarterly[a]	X	X	X	X	X	—	—	—	X

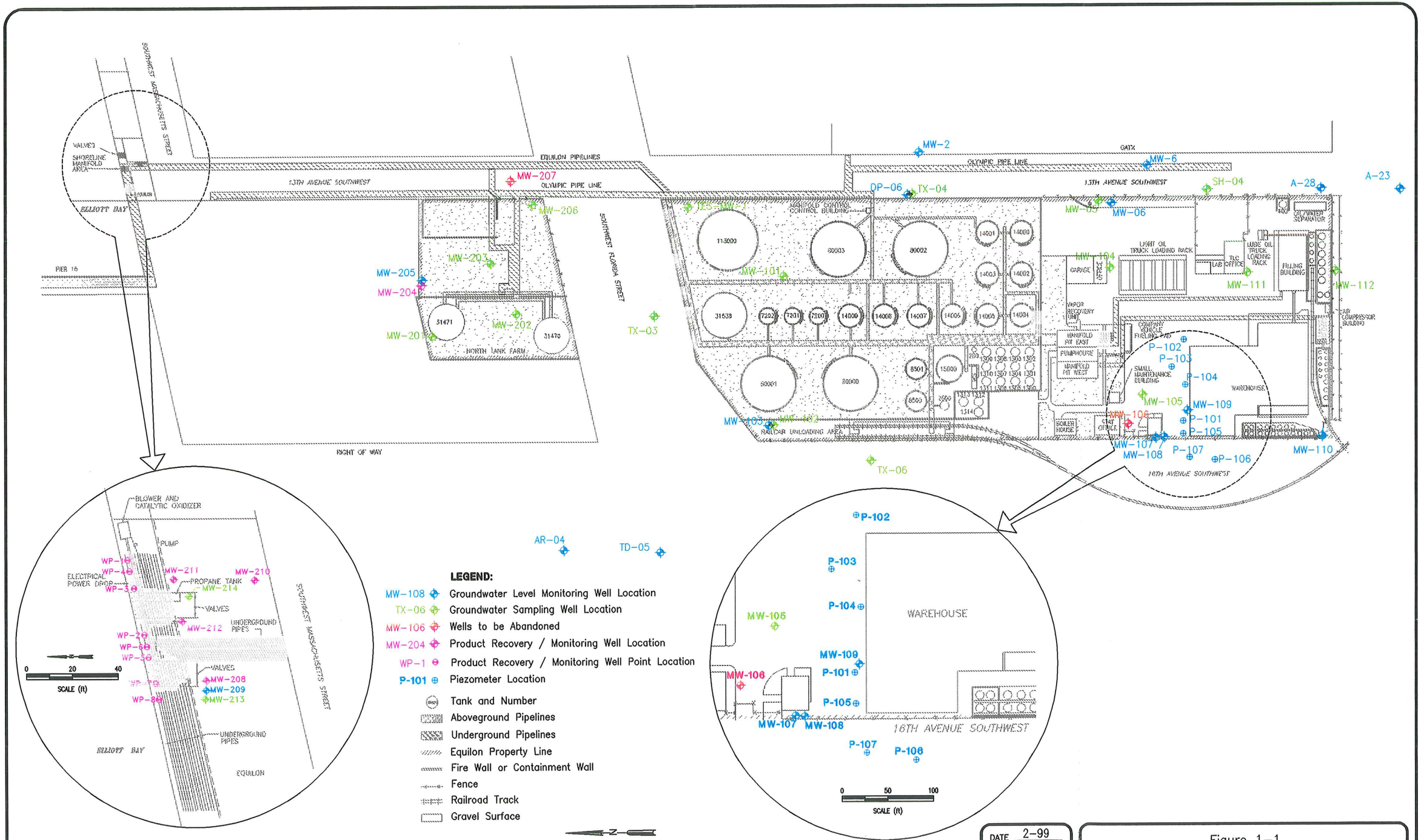
NOTE: See Appendix A for analytical methods.

[a] Sampling will occur April 1999 through March 2004; Ecology and Equilon will review the data after one year; if trends are declining, sampling frequency and parameters may be reduced; natural attenuation parameters will be analyzed annually after the first year; well SH-04 will be monitored for one year and the results reviewed with Ecology to determine if SH-04 should be included in Equilon's compliance monitoring program.

[b] Natural attenuation parameters include alkalinity, carbon dioxide, dissolved oxygen, total iron, ferrous iron, hardness, methane, oxidation/reduction potential, pH, and sulfate.

[c] Field parameters include dissolved oxygen, pH, specific conductance, temperature, and turbidity.

FIGURES



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PROJECT NO.	41236-001.001

Figure 1-1
EQUILON SEATTLE SALES TERMINAL
SEATTLE, WASHINGTON

MONITORING WELL LOCATIONS

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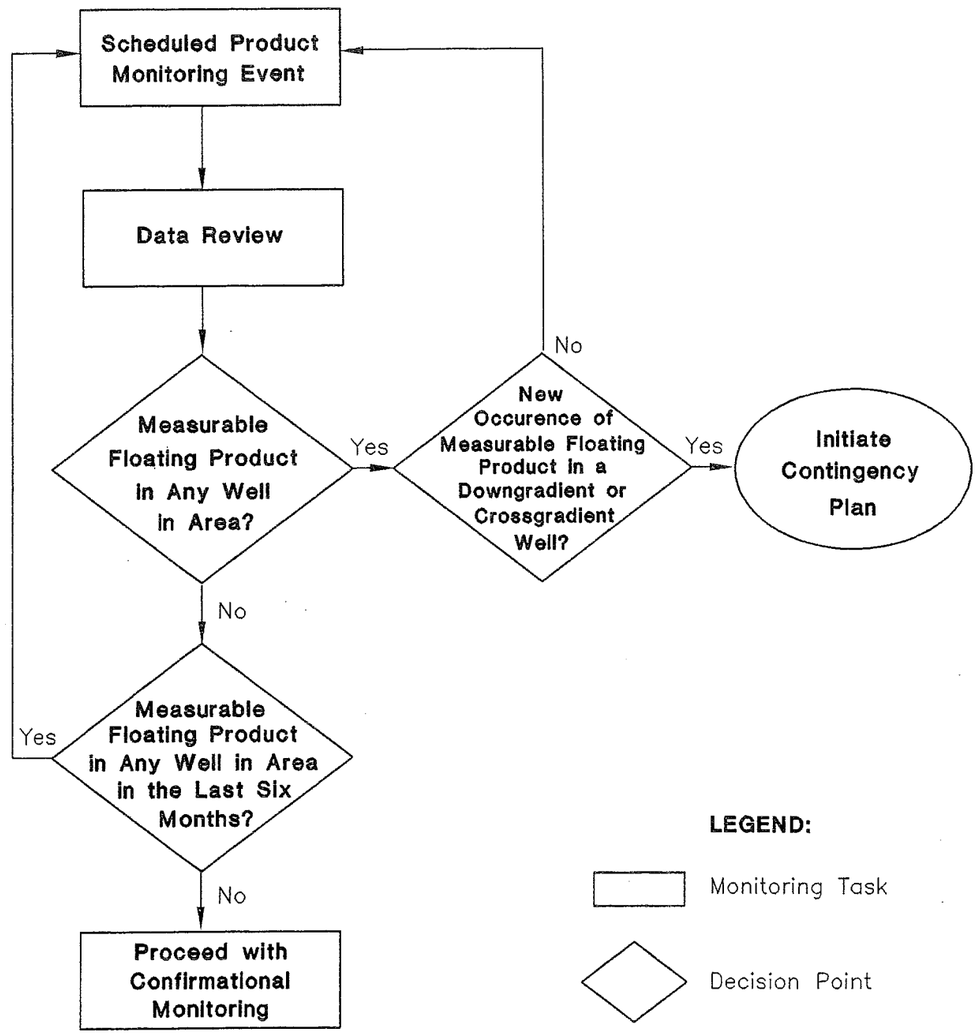

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PROJECT NO. 41236-001.001

FIGURE 6-1
EQUILON SEATTLE SALES TERMINAL
SEATTLE, WASHINGTON

PERFORMANCE MONITORING FLOW CHART

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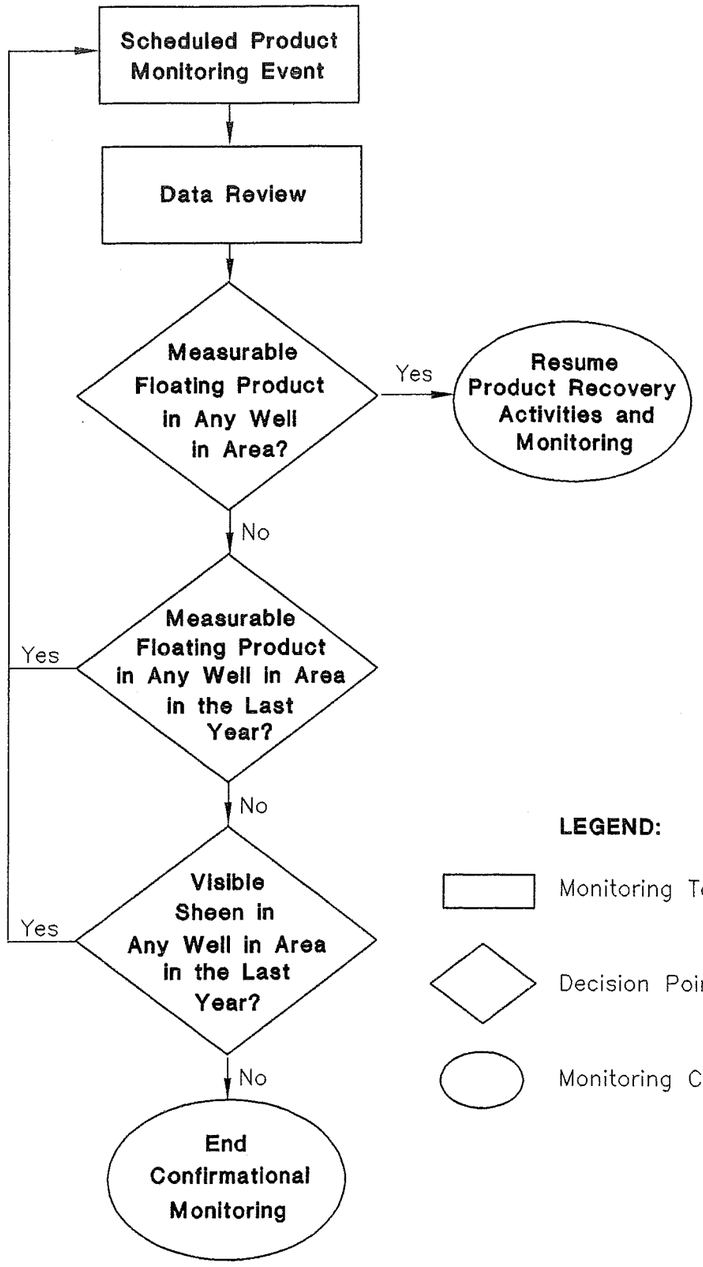

LEGEND:

- Monitoring Task
- Decision Point
- Monitoring Change

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FIGURE 6-2
EQUILON SEATTLE SALES TERMINAL
SEATTLE, WASHINGTON

PRODUCT CONFIRMATIONAL MONITORING FLOW CHART

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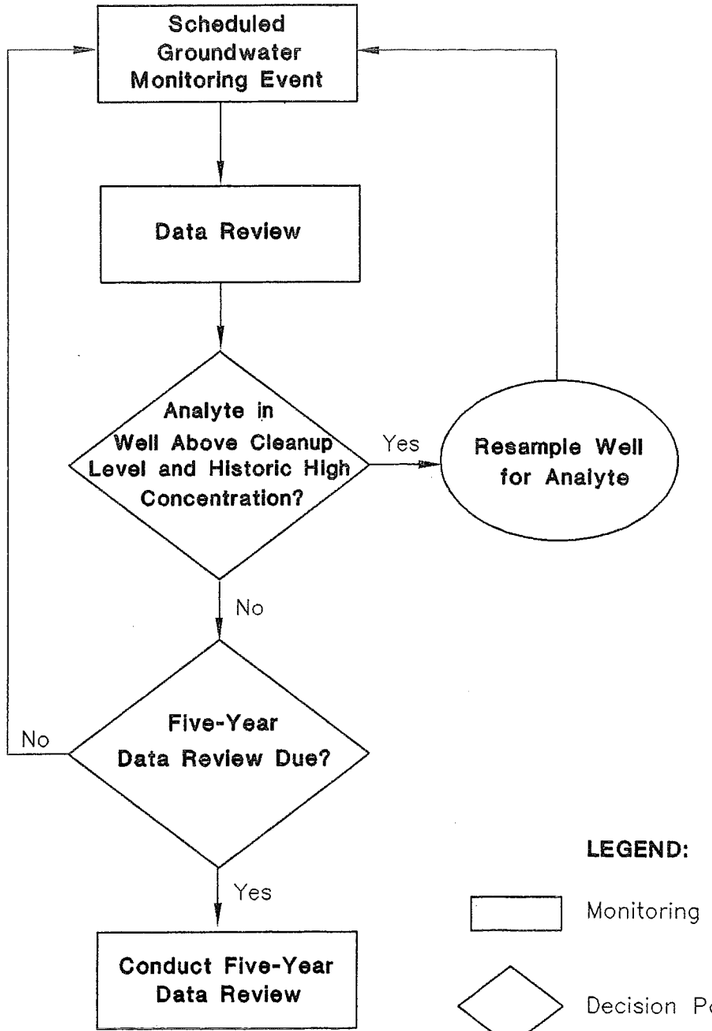

LEGEND:

- Monitoring Task
- Decision Point
- Monitoring Change

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DATE 8/98
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FIGURE 6-3
EQUILON SEATTLE SALES TERMINAL
SEATTLE, WASHINGTON

GROUNDWATER CONFIRMATIONAL MONITORING FLOW CHART

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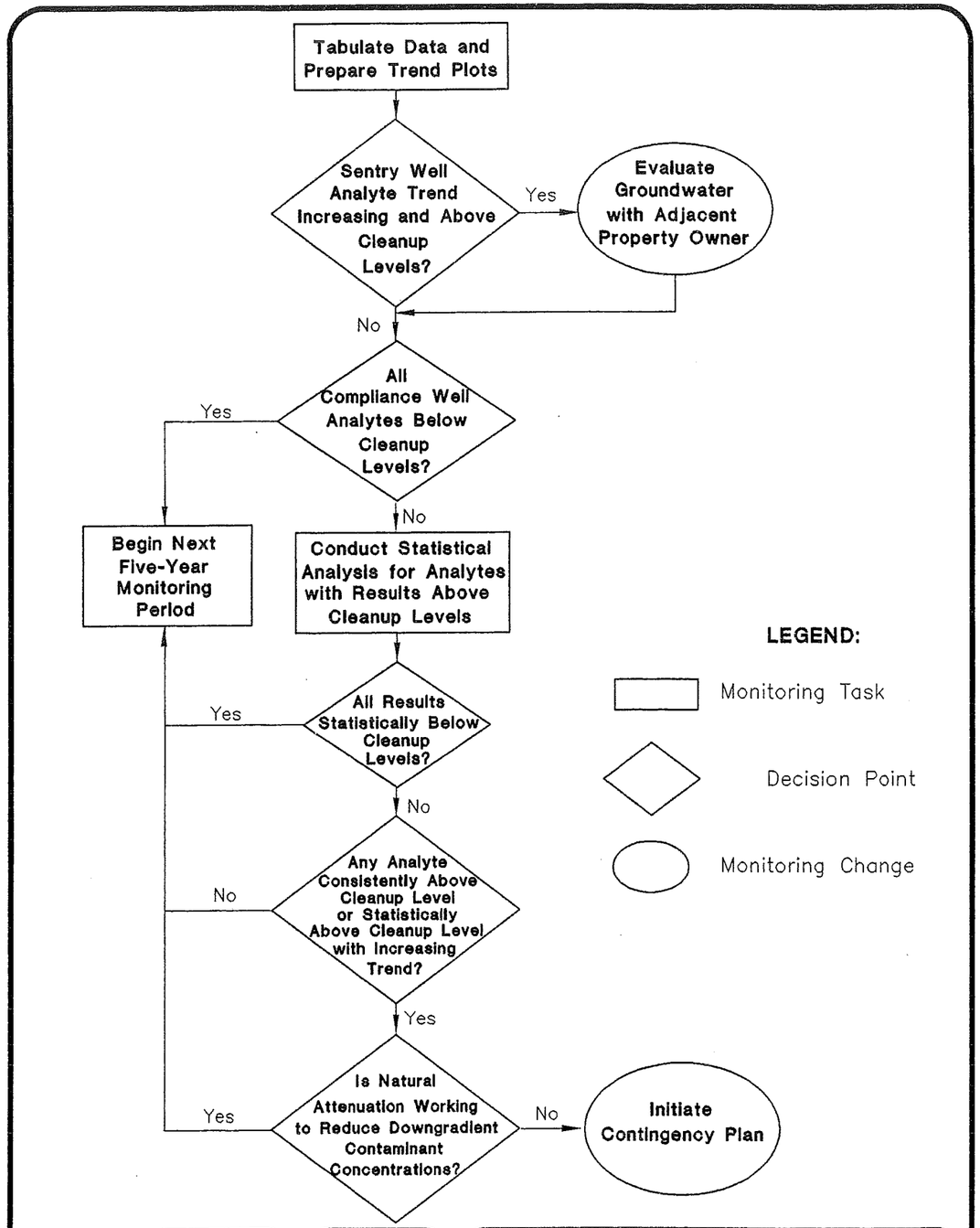

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FIGURE 6-4
EQUILON SEATTLE SALES TERMINAL
SEATTLE, WASHINGTON

FIVE-YEAR DATA REVIEW FLOW CHART

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APPENDIX A

COMPLIANCE SAMPLING AND ANALYSIS PLAN

COMPLIANCE SAMPLING AND ANALYSIS PLAN

EQUILON SEATTLE SALES TERMINAL

SEATTLE, WASHINGTON

Submitted to

Washington State Department of Ecology

Submitted by

Equilon Enterprises LLC

October 8, 1998

Revised February 25, 1999

Prepared by

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Project 41236-001.001(2)

CONTENTS

TABLES AND ILLUSTRATIONS

At end of report

Tables

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1 INTRODUCTION

The purposes of this sampling and analysis plan are to (1) specify procedures for field sampling and monitoring activities described in the Compliance Monitoring Plan for the Equilon Seattle Sales Terminal on Harbor Island in Seattle, Washington, (2) identify quality assurance (QA) procedures to be implemented during sampling activities and laboratory analyses, and (3) meet the requirements of the Model Toxics Control Act (MTCA) for sampling and analysis plans (WAC 173-340-820).

The sampling and analysis plan is organized into four sections:

- **Introduction.** This section provides an overview of the sampling and analysis plan.
- **Field Sampling Plan.** Procedures to be used during field sampling and monitoring activities are provided in this section.
- **Quality Assurance Project Plan.** This section identifies the QA procedures for field activities and laboratory analyses.
- **Field Forms.** Forms and an equipment list to be used during field activities are provided in this section.

2 FIELD SAMPLING PLAN

2.1 Overview

The objectives of the field compliance monitoring activities will be to provide data of sufficient quality and quantity to determine if the cleanup requirements have been achieved at the site. Field compliance monitoring activities will include measuring free product thicknesses and groundwater levels, and collecting groundwater samples.

2.2 Product Monitoring

2.2.1 Locations and Frequency

Wells with product and shallow wells adjacent to wells with product will be monitored for the presence of floating product, sheen, and odor. These wells currently include:

- **North Tank Farm:** MW-204
- **Shoreline Manifold Area:** MW-208, MW-210, MW-211, MW-212, WP-1, WP-2, WP-3, WP-4, WP-5, WP-6, WP-7, and WP-8

Figure 2-1 provides the well locations, and Table 2-1 summarizes the well completion details. Until product recovery is complete, the frequency of product monitoring will depend on the amount of product removed from the monitoring wells, the season, and the type of product recovery activity. Product monitoring has historically occurred every two to four weeks and will occur no less frequently than monthly. Product monitoring will continue as outlined in Section 6 of the Compliance Monitoring Plan.

2.2.2 Monitoring Procedures

Product monitoring will involve monitoring for the presence of floating product and for potential indicators of product such as odor and sheen. Floating product is defined as a measurable thickness of product (greater than or equal to 0.01 feet thick). Sheen is defined as a visible display of iridescent colors on equipment or water removed from a

monitoring well. To monitor wells for floating product, the following procedures will be followed:

- An oil-water interface probe will be used to measure the product thickness and depth to groundwater.
- Depth to product (if present) and depth to water will be measured to the nearest 0.01 foot from the top of each well. Product and groundwater depths, product thickness, and field observations, including indications of sheen or a product film on the probe and hydrocarbon-like odor, will be recorded in a field book or on a Field Sampling Data Form (Section 4). The field notes will include date and time.
- If measurable floating product is present, a peristaltic pump fitted with silicon and polyethylene tubing or a disposable polyethylene bailer will be used to skim floating product from the well. The approximate volume of product will be recorded in a field book or on a Field Sampling Data Form.

2.3 Groundwater Sampling

2.3.1 Locations and Frequency

Groundwater samples will be collected from 17 monitoring wells located around the Main Terminal, North Tank Farm, and Shoreline Manifold Area. Samples will be collected quarterly for the first year, at which time Ecology and Equilon will review the data. If trends are declining, the sampling frequency and number of parameters may be reduced. The wells to be sampled include one background monitoring well (MW-206), two confirmational monitoring wells (MW-213 and MW-214), 13 sentry monitoring wells (MW-05, MW-101, MW-102, MW-104, MW-105, MW-111, MW-112, TX-03, TX-04, TX-06, MW-201, MW-202, and MW-203), and one off-site well (SH-04). Figure 2-1 provides the well locations, and Tables 2-1 and 2-2 summarize the well completion details.

Groundwater samples will also be collected from six performance monitoring wells at the north end of the Main Tank Farm and in the North Tank Farm for the analysis of natural attenuation parameters. These wells (MW-101, TES-MW-1, TX-03, MW-201, MW-202, and MW-203) will be sampled quarterly for the first year and annually thereafter.

2.3.2 Analyses

Groundwater samples collected from background monitoring well MW-206, confirmational monitoring wells MW-213 and MW-214, sentry monitoring wells MW-05, MW-101, MW-102, MW-104, MW-105, MW-111, MW-112, TX-03, TX-04, TX-06, MW-201, MW-202, and MW-203, and off-site well SH-04 will be submitted to the analytical laboratory for analysis of benzene, toluene, ethylbenzene, and total xylenes (BTEX) and total petroleum hydrocarbons (TPH). Additionally, the samples collected from MW-213 and MW-214 will be submitted for analysis of carcinogenic polycyclic aromatic hydrocarbons (cPAHs), and the samples from MW-05, MW-101, MW-104, MW-105, TX-03, TX-04, and TX-06 will be analyzed for total and dissolved lead and arsenic. The samples will be analyzed for BTEX by USEPA Method 8021 (USEPA, 1996), TPH as gasoline (TPH-G) by Ecology Method WTPH-G (Ecology, 1992), TPH as diesel and oil (TPH-D and TPH-O) by Ecology Method WTPH-D (extended; Ecology, 1992), cPAHs by USEPA Method 8310 (USEPA, 1986), and total and dissolved arsenic and lead by USEPA Method 200.9.

Groundwater samples collected from the performance monitoring wells (MW-101, TES-MW-1, TX-03, MW-201, MW-202, and MW-203) will be submitted to the analytical laboratory for analysis of BTEX and TPH by the methods described above, methane (ASTM Method D2820) and sulfate (USEPA Method 300.0). These groundwater samples will also be analyzed in the field for alkalinity, carbon dioxide, dissolved oxygen, total iron, ferrous iron, hardness, oxidation/reduction potential (ORP), and pH. Alkalinity, carbon dioxide, total iron, ferrous iron, and hardness will be analyzed by Hach Kit Methods AL AP MG-L, CA-23, 8008, 8146, and 5-EP MG-L, respectively. Dissolved oxygen, ORP, and pH will be measured with field probes.

2.3.3 Field Quality Assurance Samples

Field quality assurance (QA) will be maintained through compliance with the sampling plan, collection of field QA samples, and the documentation of sampling plan alterations. Field QA samples will consist of duplicate samples and trip blanks.

Duplicate samples will be collected at a frequency of 5 percent of the total number of water samples. Duplicate samples will not be labeled as such but will be submitted blind to the laboratory. Wells in which duplicate samples will be collected will be selected to represent the anticipated range of constituent concentrations found at the site. Duplicate samples will be submitted for the same analyses as the original sample.

One trip blank will be submitted to the laboratory for every 20 water samples collected. Trip blanks will be analyzed for TPH-G and BTEX.

2.3.4 Sample Designation

Groundwater samples will be labeled with the monitoring well designation and a date suffix. The date suffix will include the month and year. For example, MW-213-399 would represent the water sample collected from MW-213 in March 1999. Duplicate samples will be labeled similar to groundwater samples but with a fictitious well number (e.g., MW-900). Trip blanks will be identified as such with a date suffix (e.g., TB1-399). Extra samples collected for laboratory duplicate and matrix spike and matrix spike duplicate (MS/MSD) analyses will be identified with the same designation as the sample.

2.3.5 Sampling Procedures

To collect a groundwater sample, polyethylene tubing will be lowered to a point approximately 2 feet below the water level in the well (Tables 2-1 and 2-2). Groundwater will then be extracted using a peristaltic pump. After purging is complete, a groundwater sample will be collected by placing the sample in the appropriate groundwater sample containers as described below.

Groundwater samples will be collected using the following procedures:

1. A round of groundwater levels will be measured in all available wells and piezometers before the sampling event (Figure 2-1). Water levels will be measured to the nearest 0.01 foot from the top of the wells using an electric well probe. Water depths will be recorded on a Field Sampling Data Form (Section 4) and will include date and time. If floating product is present, the thickness will be measured with an oil-water interface probe or bailer. Locations with floating product will not be sampled for groundwater. Floating product is defined as measurable product or an observed product film.
2. The monitoring wells will be purged with a peristaltic pump fitted with high density polyethylene tubing and silicone tubing at the pump head. The tubing intake will be placed about two feet below the water table in the wells.
3. The wells will be purged at a low flow rate (1 liter/minute or less) to minimize water level drawdown and the amount of suspended solids generated. Management of purge water is discussed in Section 2.5.
4. Water level in the wells, discharge rate, and field parameters (dissolved oxygen, pH, specific conductance, temperature, and turbidity) will be measured and recorded on the Field Sampling Data Form as frequently as possible during purging. Field parameters will be measured in a flow-through container.
5. The wells will be purged until specific conductance and dissolved oxygen are stable (±10 percent) for three consecutive readings. Measurements will be

recorded to the following standards: dissolved oxygen to 0.05 mg/L; pH to ±0.01 units; specific conductance to ±1 µS/cm (measured specific conductance ≤99 µS/cm), to ±10 µS/cm (99 µS/cm < specific conductance <1,000 µS/cm), or to ±100 µS/cm (measured specific conductance >1,000 µS/cm); temperature to ±0.5°C; and turbidity to 0.1 NTU. The pH/conductivity meter, the dissolved oxygen meter, and the turbidimeter will be calibrated near the beginning and end of each sampling day.

6. After parameter stabilization, groundwater samples will be collected from the discharge line of the peristaltic pump in the following order: TPH-G/BTEX, methane (if analyzed), TPH-D (extended), cPAHs, metals, and field analytes (if analyzed). Samples will be collected directly from the pump discharge line and transferred directly into a container prepared by the analytical laboratory for the given parameters. Dissolved metals samples will be collected from an in-line filter. Duplicate samples will be collected by alternately filling the sample and duplicate sample bottles. If samples are to be split with Ecology, the procedures outlined in Section 2.6 will be followed.

7. Decontamination procedures are described in Section 2.7. The sampler(s) will wear clean or new nitrile, vinyl, or neoprene gloves at each sampling location. New pump tubing will be used at each sampling location.

8. Samples will be labeled, handled, and shipped using the procedures described in Section 2.8. Sample custody will be maintained until delivery to the analytical laboratory. All sampling field activity and data will be recorded on a Field Sampling Data Form.

2.4 Well Abandonment

Well abandonments will be conducted per the requirements of WAC 173-160-560. The surface security casing will be removed, and the well casing will be filled with bentonite chips or bentonite grout. If grout is used, it will be pumped to the base of the well casing through a tremie pipe to displace water in the casing from the bottom up. Bentonite chips placed above the water table will be hydrated with water. If possible the upper piece of well casing will be removed at the end of abandonment. The upper 2 feet of the well or hole will be sealed with concrete or gravel, depending on the surrounding surficial material.

2.5 Residuals Management

All residual water and used decontamination solutions will be handled appropriately. Residuals will be managed in accordance with all applicable local, state, and federal

requirements. Used disposable clothing and equipment will be handled as solid waste. Appropriate personal protective clothing will be worn during residuals transfers because of potential skin contact and splash hazards. The following residuals management procedures will be used:

- All water generated during sampling and decontamination activities will be placed in 55-gallon drums or tanks.
- Drums and tanks will be labeled with the date when filled, the sampling location from which the contents were collected, and a description of the contents (including approximate quantity).
- Drums and tanks will be sealed and secured daily. An on-site staging area for the accumulation of drums and tanks will be identified by Equilon. Drums and tanks will be stored in the designated temporary holding area until characterized for disposal.
- A record of all generated residuals as stored in drums and tanks will be maintained to expedite characterization and disposal upon completion of field activities.
- Recovered product and product/water mixtures will be placed in the appropriate collection tank in the main terminal and recycled by Equilon.
- Disposable clothing and equipment will be placed in plastic bags and disposed of as solid waste.
- Equilon will be responsible for the proper disposal of all wastes. Equilon's consultant will coordinate with Equilon for appropriate disposal of all wastes.

2.6 Guidelines for Splitting Samples

If requested by Ecology, Equilon's on-site representative will provide for the collection of split or replicate samples. The following sample splitting procedures will be followed:

- Samples will be collected as described above.
- If the well produces sufficient water for collecting a split sample, then either Ecology (or Ecology's representative) or Equilon's representative will collect a split sample in conjunction with Equilon sample collection, alternately filling like bottles. Equilon's representative will record the number and type of bottles

collected by Ecology, Ecology's sample designation, and the analyses to be performed on the split sample.

- If the well produces insufficient water for collecting a split sample, then the well will be allowed to recover after Equilon sample collection, and either Ecology (or Ecology's representative) or Equilon's representative will then collect the split sample.

- Under no circumstances will sample splitting compromise the sampling being performed by Equilon.

2.7 Decontamination Procedures

The electric well probe and oil-water interface probe will be rinsed with distilled water between uses in different monitoring wells. If visibly stained with product, the probe will also be rinsed with hexane and tap water. All disposable sampling equipment will be used once and then discarded.

2.8 Sample Labeling, Shipping, and Chain-of-Custody

2.8.1 Sample Labeling

Sample container labels will be completed immediately before or immediately after sample collection. Container labels will include the following information:

- Project name and number
- Sample number
- Name or initials of collector
- Date and time of collection
- Analyses requested

2.8.2 Sample Shipping

Water samples will be shipped to the selected analytical laboratory as follows:

- Sample containers will be transported in a sealed, iced cooler.

- In each shipping container, glass bottles will be separated by a shock-absorbing and absorbent material to prevent breakage and leakage.

- Ice or "blue ice," sealed in separate plastic bags, will be placed into each shipping container with the samples.
- All sample shipments will be accompanied by a Chain-of-Custody/Laboratory Analysis Request Form (Section 4). The completed form will be sealed in a plastic bag and taped to the inside lid of the shipping container.
- Signed and dated chain-of-custody seals will be placed on all shipping containers.
- The analytical laboratory's name and address and the sampling company's name and office (return) address will be placed on each shipping container prior to shipping.

2.8.3 Chain-of-Custody

Once a sample is collected, it will remain in the custody of the sampler or other company personnel until shipment to the laboratory. Upon transfer of sample containers to subsequent custodians, a Chain-of-Custody/Laboratory Analysis Request Form will be signed by the persons transferring custody of the sample container. A signed and dated chain-of-custody seal will be placed on each shipping container prior to shipping. Upon receipt of the samples at the laboratory, the shipping container seal will be broken, and the condition of the samples will be recorded by the receiver. Chain-of-custody records will be included in the analytical report prepared by the laboratory.

2.9 Sampling Procedure Alterations

Deviations from the general sampling procedures presented here will be brought to the attention of the consultant project manager, and a Sample Alteration Checklist will be filled out (Section 4).

3 QUALITY ASSURANCE PROJECT PLAN

3.1 Quality Assurance Objectives

The overall quality assurance (QA) objective for measurement data is to ensure providing data of known and acceptable quality. All measurements will be made to yield accurate and precise results representative of the media and conditions measured. Chemical analyses will be performed in accordance with the requirements of WAC 173-340-830. All sample results will be calculated and reported in the units presented in Tables 3-1 and 3-2 to allow comparison of the sample data with regulatory criteria and federal, state, and local databases. QA objectives for precision, accuracy, and completeness have been established for each measurement variable, where possible (Tables 3-1 and 3-2).

3.2 Analytical Procedures

Analytical methods and references for most analyses are summarized in Tables 3-1 and 3-2. The laboratory will use United States Environmental Protection Agency (USEPA) and Ecology methods. Data reporting requirements for all analyses are presented in Section 3.3.

Routine analysis of environmental samples will be performed using procedures based on the following methods:

- USEPA Method 8021: BTEX by gas chromatography/photoionization detector (GC/PID) (USEPA, 1996)
- WTPH-G: gasoline and volatile fraction petroleum hydrocarbons by purge and trap with gas chromatography/flame ionization detection (GC/FID) (Ecology 1992)
- WTPH-D (extended): diesel and fuel oil petroleum hydrocarbons by GC/FID (Ecology 1992)
- USEPA Method 8310: cPAHs by high pressure liquid chromatography (HPLC) (USEPA, 1986)

Methane will be analyzed using ASTM Method D2820, sulfate will be analyzed by USEPA Method 300.0 (USEPA, 1983), and arsenic and lead will be analyzed by

Method 200.9 (USEPA, 1996). Field analysis of alkalinity, carbon dioxide, total iron, ferrous iron, and hardness (Hach Company Methods AL AP MG-L, CA-23, 8008, 8146, and 5-EP MG-L, respectively) will be performed according to the Hach Company instruction manuals. Field measurements of pH (Method 150.1), conductivity (Method 120.1), temperature (Method 170.1), turbidity (Method 180.1) and dissolved oxygen (Method 360.1) will be performed according to USEPA (1983) methods, where applicable, and instrument manufacturer's instructions (Table 3-2).

3.3 Data Reduction, Validation, and Reporting

The laboratory performing sample analyses will be required to submit summary data and QA information to permit independent and conclusive determination of data quality. The determination of data quality will be performed using the following as guidelines for data review: USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review (USEPA, 1994a) and USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review (USEPA, 1994b).

Laboratory deliverable requirements for BTEX, cPAHs, and petroleum hydrocarbon (TPH-G and TPH-D) analyses will include the information outlined below and in Table 3-3.

- A cover letter for each sample batch will include a summary of any quality control, sample, shipment, or analytical problems, and will document all internal decisions. Problems will be outlined and final solutions documented. A copy of the signed chain-of-custody form for each batch of samples will be included in the narrative packet.
- Sample concentrations will be reported on standard data sheets in proper units and to the appropriate number of significant figures. For undetected values, the lower limit of detection for each compound will be reported separately for each sample. Dates of sample extraction or preparation and analysis must be included.
- A method blank summary will be included.
- Surrogate percent recovery will be calculated and reported.
- Laboratory control sample (LCS) results.
- Matrix spike/matrix spike duplicate (MS/MSD) percent recoveries, spike level, and relative percent difference will be included.
- Laboratory duplicate results.

All laboratory deliverables will be reviewed for data validation of chemical analyses. The main items for review are described in Table 3-4.

3.4 Performance and System Audits

Performance and system audits for sampling and analysis operations consist of on-site review of field and laboratory QA systems and on-site review of equipment and methods for sampling.

The Equilon consultant QA/QC Coordinator will develop and conduct external system audits as required or requested. If required, performance evaluation audits will be conducted before the measurement system begins generating data. The audits will be repeated periodically as required by task needs, duration, and costs.

3.5 Preventive Maintenance

Preventive maintenance of equipment is essential if project resources are to be used cost-effectively. Preventive maintenance is comprised of: (1) a schedule of preventive maintenance activities to minimize downtime and ensure accuracy of measurement systems and (2) availability of critical spare parts and backup systems and equipment. The preventive maintenance approach for specific pieces of equipment used in sampling, monitoring, and documentation will follow manufacturers' specifications and good field and laboratory practices. Performance of these maintenance procedures will be documented in the field logbooks.

3.6 Data Assessment Procedures

Accuracy, precision, completeness, representativeness, and comparability are terms used to describe the quality of analytical data. Accuracy is a measure of the bias in a measurement system and is determined by comparing a measurement with an accepted reference or true value. Precision is a measure of the reproducibility of analyses under a given set of conditions and is determined by measuring the scatter of a group of measurements made at the same specified conditions around their average. Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount that could be expected to be obtained under "normal" conditions. Representativeness expresses the degree to which sampling data accurately and precisely represent selected characteristics. Comparability is an expression of the confidence with which one data set can be compared to another.

Routine procedures for measuring precision and accuracy include use of replicate analyses, standard reference materials (SRMs), matrix spikes, and procedural blanks.

Replicate matrix spikes and method blanks will be analyzed by the selected laboratory. Additional spikes and replicate analyses may be implemented. The minimum frequencies are as follows:

- Replicate analysis
  - WTPH-G, WTPH-D (extended), metals: one replicate analysis will be conducted per sample batch
  - BTEX, cPAHs: one replicate matrix spike analysis will be conducted per sample batch
- Matrix Spike
  - WTPH-G, WTPH-D (extended), metals: one matrix spike or laboratory control sample will be analyzed per sample batch
  - BTEX, cPAHs: one matrix spike/matrix spike duplicate analysis will be conducted per sample batch
- Method Blank
  - WTPH-G, BTEX: one method blank will be analyzed for each 12-hour shift.
  - WTPH-D (extended), cPAHs, metals: one preparation blank per matrix will be analyzed for each sample preparation batch.
- LCS or SRM
  - WTPH-G, WTPH-D (extended): one LCS will be analyzed per sample batch

Quality of analytical data represented by precision and accuracy are calculated using the mean, standard deviation, and percent recoveries. The mean, $\overline{C}$, of a series of replicate measurements of concentration, C_i, for a given analyte will be calculated as:

$$\overline{C} = \frac{1}{n} \sum_{i=1}^{n} C_i$$

where:

n = Number of replicate measurements

The estimate of precision of a series of replicate measurements can be expressed as the relative standard deviation, RSD:

$$\text{RSD} = \frac{SD}{\overline{C}} \text{ x } 100\%$$

where:

SD = Standard deviation:

$$\text{SD} = \sqrt{\frac{\sum_{i=1}^{n} (C_i - \overline{C})^2}{(n-1)}}$$

Alternatively, for data sets with a small number of points (e.g., duplicate measurements), the estimate of precision will be expressed as a relative percent difference (RPD):

$$\text{RPD} = \frac{C_1 - C_2}{\overline{C}} \text{ x } 100$$

where:

C_1 = First concentration value or recovery value measured for a variable

C_2 = Second concentration value or recovery value measured for a variable

Accuracy as measured by matrix spike or laboratory control sample results will be calculated as:

$$\text{Recovery} = \frac{\Delta C}{C_s} \text{ x } 100$$

where:

ΔC = The measured concentration increase due to spiking (relative to the unspiked portion)

C_s = The known concentration increase in the spike

Accuracy can also be measured by analysis of standard reference material (SRM) or regional reference material and will be determined by comparing the measured value with the 95 percent confidence interval established for each analyte.

Completeness will be measured for each set of data received by dividing the number of valid measurements actually obtained by the number of valid measurements that were planned.

3.7 Corrective Actions

Corrective actions consist of (1) handling of analytical or equipment malfunctions, (2) handling of nonconformance or noncompliance with the established QA requirements, and (3) alterations to sampling procedures or locations due to uncontrollable circumstances. During field operations and sampling procedures, the field team leader will be responsible for correcting equipment malfunctions. All corrective measures will be documented in the project file using a sampling alteration checklist (Section 4).

The analytical laboratory must adhere to standard operating procedure guidelines and specifications. When instrument response, quality control sample (SRM or matrix spike duplicate) precision or accuracy, or blank analyses indicate exceedance of control limits, the cause of the exceedance of control limits must be determined and documented, and corrective actions must be initiated before continuing with sample analysis.

3.8 Data Validation Reports

A data validation report will be prepared for each sampling event. The handling and content of the data report are discussed below.

3.9 Data Management

Raw data generated in the field or received from the analytical laboratory will be validated, entered into a computerized database, and verified for consistency and correctness.

3.9.1 Field Data Management

Accurate documentation of field activities, (e.g., pH measurements, conductivity measurements, field notes) will be maintained using field log books, field data forms, correspondence records, and/or photographs. Entries will be made in sufficient detail to provide an accurate record of field activities without reliance on memory.

Field log entries will be dated and include a chronological description of task activities, names of individuals present, names of visitors, weather conditions, etc. All entries will be legibly entered in ink and initialed.

When photographs are taken, the project number, date, picture, number, and description of the photograph will be entered on a photography log.

3.9.2 Analytical Data Management

Following validation, all analytical data will be entered into a computerized database. The data may require some manipulation, such as common unit conversions and extraction from support information. To accomplish these manipulations, data reduction and tabulation techniques will be applied to the data and documented. Several different tabular reports will be generated from the database. All analytical, locational, and tracking data will be stored in the database. Data reports for each type of analysis will be generated to product standard reports.

All data validation, document control, and locational and analytical information generated by this project will be entered, store, and generated by IBM/PC-compatible machines. Commercially available software products will be used. The volume of digital data anticipated on this project may be accommodated on a single PC work station. Project data backups will be made on a periodic basis. Access to the database will be limited to the data manager and other authorized project personnel.

3.9.3 Sample Management

The sample management system forms the foundation of all other analytical data collection, verification, and validation tasks. Analytical data cannot be considered valid unless all proper sample management steps have been carried out. These include:

- Sample documented on a Field Sampling Data Form or in a field log book
- Chain-of-Custody requirements met
- All sample-related documents filed
- Use of unique sample identification numbers

Data that do not pass the validation process either will be assigned data qualifiers to restrict or modify usage, or will be rejected for use. Modifications to the use of data will be documented in data validation reports.

4 STANDARD FIELD FORMS AND EQUIPMENT LIST

Standard field forms used to record monitoring and sampling data are:

- Field Sampling Data Form (Figure 4-1)
- Chain of Custody/Laboratory Analysis Request Form (Figure 4-2)
- Photograph Log (Figure 4-3)
- Sampling Alteration Checklist (Figure 4-4)

A blank copy of each form is presented in this section. Equipment that may be used during field activities is presented in Table 4-1.

LIMITATIONS

The services described in this report were performed consistent with generally accepted professional consulting principles and practices. No other warranty, express or implied, is made. These services were performed consistent with our agreement with our client. This report is solely for the use and information of our client unless otherwise noted. Any reliance on this report by a third party is at such party's sole risk.

Opinions and recommendations contained in this report apply to conditions existing when services were performed and are intended only for the client, purposes, locations, time frames, and project parameters indicated. We are not responsible for the impacts of any changes in environmental standards, practices, or regulations subsequent to performance of services. We do not warrant the accuracy of information supplied by others, nor the use of segregated portions of this report.

REFERENCES

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TABLES

Table 2-1

RI/FS Monitoring Well Construction Details
Compliance Sampling and Analysis Plan
Equilon Seattle Sales Terminal

Well Number	Date Installed	Horizontal Coordinates[a] North	Horizontal Coordinates[a] East	Ground Elevation[b] (ft NGVD)	Top-of-Casing Elevation[b] (ft NGVD)	Total Depth (ft bgs)	Screened Interval (ft bgs)
MW-101	04/06/93	216513.97	1625248.36	9.96	15.14	15.0	5.0 - 14.5
MW-102	03/17/93	216541.64	1624924.84	9.64	12.51	15.0	5.0 - 14.5
MW-103	03/17/93	216552.89	1624925.49	9.51	12.34	49.5	39.5 - 49.0
MW-104	03/19/93	215796.13	1625250.42	10.44	10.22	15.0	5.0 - 14.5
MW-105	03/24/93	215730.60	1624975.86	9.46	9.05	15.0	5.0 - 14.5
MW-106	03/24/93	215768.13	1624914.24	9.82	9.39	15.0	5.0 - 14.5
MW-107	03/19/93	215707.12	1624875.12	10.11	13.09	15.0	5.0 - 14.5
MW-108	03/22/93	215694.78	1624875.41	10.18	12.86	50.5	40.5 - 50.0
MW-109	03/22/93	215639.53	1624921.64	8.17	8.01	15.0	5.0 - 14.5
MW-110	03/15/93	215339.22	1624871.10	8.84	8.46	15.0	5.0 - 14.5
MW-111	03/15/93	215495.53	1625228.68	8.98	8.61	15.0	5.0 - 14.5
MW-112	03/15/93	215300.95	1625227.80	10.51	9.98	15.5	5.5 - 15.0
MW-201	03/18/93	217289.30	1625137.03	10.21	17.07	15.0	5.0 - 14.5
MW-202	03/18/93	217103.96	1625182.42	9.97	16.77	15.0	5.0 - 14.5
MW-203	03/17/93	217157.23	1625294.18	11.33	11.04	15.0	5.0 - 14.5
MW-204	03/17/93	217308.88	1625251.33	11.63	14.21	15.0	5.0 - 14.5
MW-205	03/19/93	217308.77	1625258.62	11.70	14.10	48.5	38.5 - 48.0
MW-206	03/17/93	217060.84	1625420.05	11.28	10.75	15.0	5.0 - 14.5
MW-207	03/23/93	217110.96	1625471.08	10.63	10.38	15.0	5.0 - 14.5
MW-208	09/07/94	217959.56	1625518.70	9.00	8.61	16.5	5.0 - 14.5
MW-209	09/12/94	217958.74	1625513.08	8.95	8.87	50.5	39.5 - 49.0
MW-210	10/25/95	217937.39	1625563.86	9.50	9.13	15.5	5.0 - 15.0
MW-211	02/27/96	NA	NA	NA	NA	13.5	3.0 - 13.0
MW-212	02/27/96	NA	NA	NA	NA	13.5	3.0 - 13.0
MW-213	04/02/97	NA	NA	NA	NA	40.3	29.8 - 39.8
MW-214	04/04/97	NA	NA	NA	NA	40.0	29.5 - 39.5
P-101	08/16/95	215638.99	1624926.66	8.03	7.72	51.0	39.7 - 49.7
P-102	08/16/95	215630.64	1625085.11	8.38	8.11	14.0	3.0 - 13.0
P-103	08/15/95	215663.44	1625032.91	8.46	8.05	15.0	3.2 - 13.2
P-104	08/15/95	215629.98	1624988.24	8.04	7.58	15.0	4.5 - 14.5
P-105	08/16/95	215637.60	1624881.81	9.81	9.50	14.0	3.0 - 13.0
P-106	08/17/95	215576.79	1624833.19	9.53	9.32	14.0	4.0 - 14.0
P-107	08/16/95	215635.71	1624832.46	11.22	10.98	15.0	5.0 - 15.0
WP-1	02/27/96	NA	NA	NA	NA	10.0	3.0 - 10.0
WP-2	02/27/96	NA	NA	NA	NA	10.0	3.0 - 10.0
WP-3	09/19/96	NA	NA	NA	NA	13.0	3.0 - 13.0
WP-4	09/19/96	NA	NA	NA	NA	13.0	3.0 - 13.0
WP-5	09/19/96	NA	NA	NA	NA	13.0	3.0 - 13.0
WP-6	09/19/96	NA	NA	NA	NA	13.0	3.0 - 13.0
WP-7	09/19/96	NA	NA	NA	NA	13.0	3.0 - 13.0
WP-8	09/19/96	NA	NA	NA	NA	13.0	3.0 - 13.0

NOTE: ft bgs = feet below ground surface.
NA = not available.

[a] NAD 1927 = Washington Coordinate System, North zone, 1927.

[b] ft NGVD = feet relative to the National Geodetic Vertical Datum of 1929.

Table 2-2

Pre-RI Monitoring Well Construction Details
Compliance Sampling and Analysis Plan
Equilon Seattle Sales Terminal

Well Number	Date Installed	Horizontal Coordinates[a] North	Horizontal Coordinates[a] East	Top-of-Casing Elevation[b] (ft NGVD)	Total Depth[d] (feet)	Screened Interval (ft bgs)	Well Diameter (in)
TES-MW-1	02/19/92	216723.41	1625407.10	13.10 A[c]	18.0	3-18	4
TX-03	08/13/91	216801.93	1625168.19	9.58 F	16.0	6-16	2
TX-04	08/12/91	216227.72	1625421.54	14.36 A	16.0	6-16	2
TX-06	09/27/91	216331.55	1624843.48	8.58 F	15.8	5.5-15.5	2
MW-05	01/25/91	215812.38	1625390.58	10.39 F	18.9	5-15	2
MW-06	02/07/89	215798.84	1625389.96	10.74 F	67.6	55-66	2
SH-04	10/01/91	215577.61	1625413.77	12.92 A	18.1	6-16	2
DP-06	09/19/91	216240.27	1625421.41	14.25 A	67.0	55-65	2
MW-2	12/16/92	216211.30	1625510.80	11.36	13.0	3-13	4
MW-6	12/16/92	215717.10	1625494.20	11.15	13.0	3-13	4
A-23	11/07/91	NA	NA	10.68	14.5	5-14.5	4
A-28	01/24/92	215328.76	1625408.73	10.68 F	16.5	6-16	4
AR-04	09/27/91	215880.70	1624627.40	11.26 A	17.7	5.5-15.5	2
TD-05	08/12/91	216800.50	1624654.90	11.68 A	17.3	6-16	2

NOTE: ft bgs = feet below ground surface.
NA = not available.

[a] NAD 1927 = Washington Coordinate System, North zone, 1927.

[b] ft NGVD = feet relative to the National Geodetic Vertical Datum of 1929.

[c] A = aboveground completion.
F = flushmount completion.

[d] Total depth from top of casing.

Table 3-1

Objectives for Measurement of Data — Water Quality Analyses
Compliance Sampling and Analysis Plan
Equilon Seattle Sales Terminal

Variable	Units	Typical Method Detection Limit	Accuracy[a]	Precision[a]	Completeness	Method No.[b]	Bottle/Preservative	Maximum Holding Time[c]
BTEX	µg/L	0.5	±25%	±25%	90%	8021B	Two 40-mL vials; PTFE lined silicon septum cap/HCl to pH <2; fill completely with no headspace	14 days
TPH-G	mg/L	0.250	±25%	±25%	90%	WTPH-G	Two 40-mL vials; PTFE lined silicon septum cap/HCl to pH <2; fill completely with no headspace	14 days
TPH-D, TPH-O	mg/L	0.250-Diesel 0.750-Oil	±25%	±25%	90%	WTPH-D (extended)	One 1-L amber glass bottle; PTFE lined lid/keep on ice (4°C)	7 days/ 30 days
cPAHs	µg/L	0.006 - 0.08	±25%	±25%	90%	8310	One 1-L amber glass bottle; PTFE lined lid/keep on ice (4°C)	7 days/ 40 days
Methane	µg/L	15	±25%	±25%	90%	D2820	Two 40-mL vials; PTFE lined silicon septum cap/HCl to pH <2; fill completely with no headspace	7 days
Sulfate	mg/L	0.2	±25%	±25%	90%	300.0	500-mL HDPE/keep on ice (4°C)	28 days
Arsenic	mg/L	0.001	±25%	±25%	90%	200.9	500-mL HDPE/keep on ice (4°C) w/nitric acid to pH <2	6 months
Zinc	mg/L	0.001	±25%	±25%	90%	200.9	500-mL HDPE/keep on ice (4°C) w/nitric acid to pH <2	6 months

[a] Accuracy and precision results may deviate from these criteria as identified by the analytical method reference on a substance specific basis.
[b] Method numbers and analytical methods are from USEPA, 1986 (8310, 300.0) and 1996 (8021B, 200.9); Ecology, 1992 (WTPH-D, WTPH-G); ASTM (D2820).
[c] Where two times are given, the first refers to the maximum time from sample collection to extraction, the second to the maximum time prior to extract analysis.

Table 3-2

Objectives for Measurement of Data - Field Analyses
Compliance Sampling and Analysis Plan
Equilon Seattle Sales Terminal

Variable	Units	Lower Limit of Detection	Accuracy[a]	Precision[a]	Completeness	Method	Method No.[b]	Bottle	Maximum Holding Time
Water									
Alkalinity	mg/L	5	±10%	±10%	90%	Titration	AL AP MG-L	25-mL bottle	1 hour
Carbon Dioxide	mg/L	1.25	±10%	±10%	90%	Titration	CA-23	250-mL bottle	1 hour
Total Iron	mg/L	0.01	±10%	±10%	90%	Spectrophotometer	8008	25-mL bottle	1 hour
Ferrous Iron	mg/L	0.01	±10%	±10%	90%	Spectrophotometer	8146	25-mL bottle	1 hour
Hardness	mg/L	20	±10%	±10%	90%	Titration	5-EP MG-L	25-mL bottle	1 hour
ORP	mV	-1250	±15%	±15%	90%	Probe	2580B	500-mL bottle	Immediate
pH	—	0.01	±10%	±10%	90%	Probe	150.1	500-mL beaker	Immediate
Conductivity	µS/cm	5	±10%	±10%	90%	Probe	120.1	500-mL beaker	Immediate
Temperature	°C	0.5	±10%	±10%	90%	Mercury thermometer	170.1	500-mL beaker	Immediate
Dissolved Oxygen	mg/L	0.05	±15%	±15%	90%	Probe	360.1	500-mL beaker	Immediate
Turbidity	NTU	0.01	±10%	±10%	90%	Turbidimeter	180.1	500-mL beaker	48 hours

[a] Accuracy and precision results may deviate from these criteria as identified by the analytical method reference.
[b] Methods 120.1, 150.1, 170.1, 180.1, and 360.1 from USEPA (1983); 2580B from Standard Methods (1992); AL AP MG-L, CA-23, 8008, 8146, and 5-EP MG-L from Hach Company.

Table 3-3

Required Laboratory Deliverables
Compliance Sampling and Analysis Plan
Equilon Seattle Sales Terminal

The following items will be delivered to support data validation:

- A transmittal letter and case narrative which includes information about receipt of the samples, the analytical results, and any significant problems in any aspect of sample analysis (e.g., deviation from methodologies or quality control.
- Sample analytical results:
  - Water results in mg/L or µg/L
  - Method detection limit for undetected values reported for each analyte on a sample-by-sample basis
  - Date of sample preparation/extraction
  - Date of sample analysis
- Method blank results, including the samples associated with each blank
- Surrogate recovery results reported as percent recoveries, including actual spike levels
- Duplicate results for WTPH-G, WTPH-D, and metals analyses
- Matrix spike/matrix spike duplicate (MS/MSD) results for BTEX and cPAH analyses and matrix spike results for WTPH-G, WTPH-D, and metals analyses, reported as percent recoveries, including actual spike levels
- Copies of signed chain-of-custodies

Table 3-4

Data Validation of Chemical Analyses
Compliance Sampling and Analysis Plan
Equilon Seattle Sales Terminal

The following items will be reviewed for data validation:

- Holding times
- Method blank results
- Surrogate recovery results for organic analyses
- Field duplicate results
- Laboratory duplicate results for WTPH-G, WTPH-D, and metals analyses
- Matrix spike/matrix spike duplicate (MS/MSD) results for organic analyses
- Matrix spike results for WTPH-G, WTPH-D, and metals analyses
- Completeness
- Reported detection limits
- Laboratory control sample results
- Copies of signed chain-of-custodies

Table 4-1

Field Equipment and Supplies
Compliance Sampling and Analysis Plan
Equilon Harbor Island Terminal

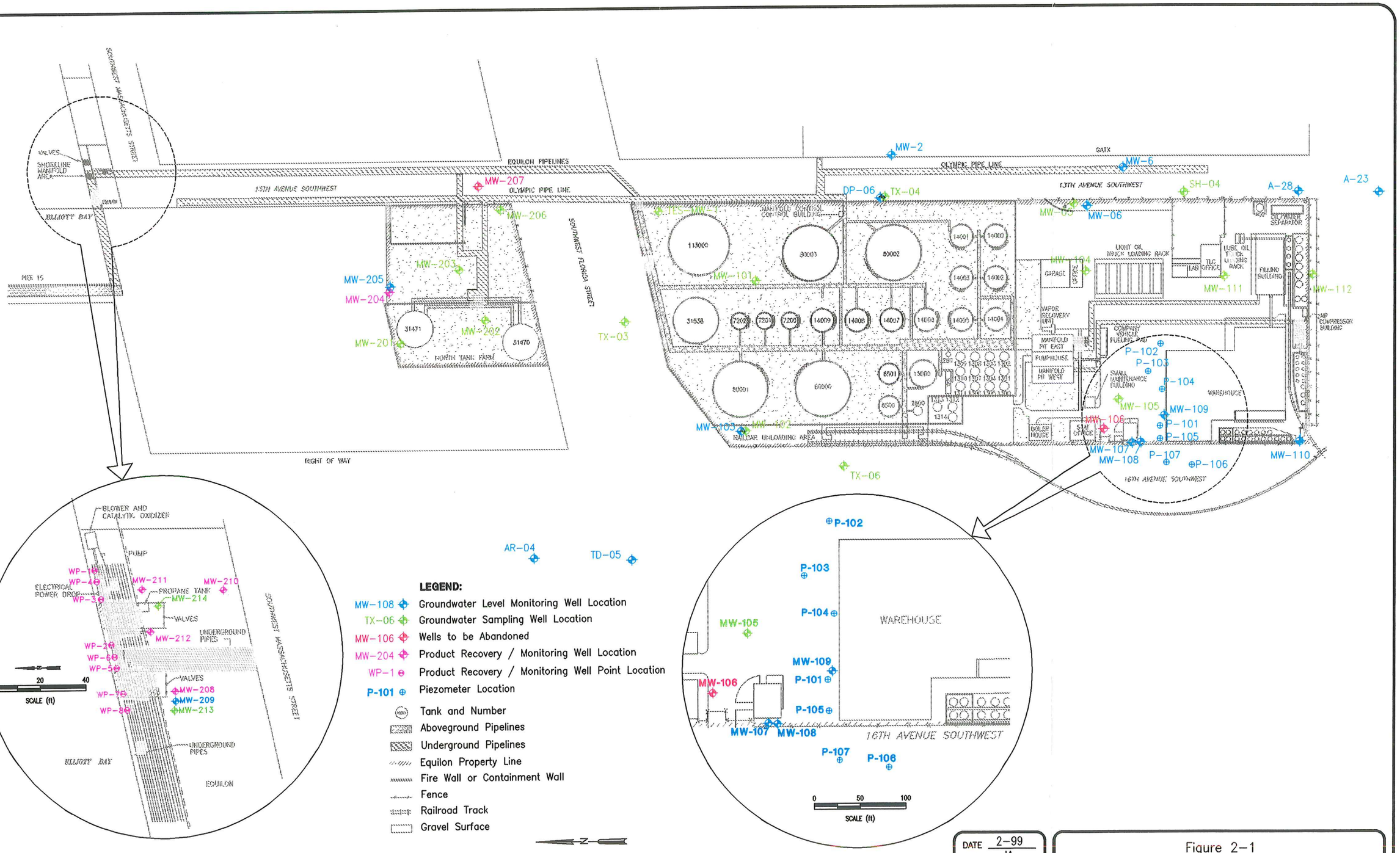
Forms/Documentation
• Field logbooks • Field sampling data sheet • Chain-of-custody/laboratory analysis report form • Custody seal • Project photo log • Drum labels • Field sampling and analysis plan (SAP)
Tools
• Fiberglass tape with stainless-steel weight • Tape measure calibrated to 0.1 inch • Decon brushes • Extension cord • Flashlight • Padlocks with matching keys • Stop watch • Tool kit • Small sledge hammer
Groundwater Investigation and Sampling
• pH/conductivity meter • Water-level probe • Oil-water interface probe • Dissolved oxygen meter • Turbidimeter • Generator (100-volt Honda or equivalent) • Large and small capacity peristaltic pump • Thermometers (°C) • Disposable plastic beakers • pH paper • In-line filtration cartridges (0.45 micron) • Polyethylene tubing • Silicon tubing for peristaltic pump • Sample jars and labels • Distilled Water
Health and Safety Equipment
• Fire extinguisher • Half-face respirators • Organic vapor/acid gas cartridges with dust filters • First aid kits • Safety glasses • Eyewash • Ear plugs • Tyvek® • Gloves-vinyl, nitrile, and neoprene • Duct tape

Table 4-1

Field Equipment and Supplies
Compliance Sampling and Analysis Plan
Equilon Harbor Island Terminal

Miscellaneous Equipment
• Spray paint, pencils, pens, labels
• Waterproof markers
• Paint pens for drums
• Bubble wrap and tape for shipping
• Cameras and film
• Vermiculite
• Resealable plastic bags
• Paper towels
• Visqueen sheets
• Buckets
• Squirt bottle (wash)
• Nalgene wash bottles
• Reagent bottles
• Coolers (sample shipping)
• Scrub brushes
• Plastic tubs
• Ice, in leak-proof bags
• Drinking water
• Large-scale site map

FIGURES



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REV.
APPR.
PROJECT NO.
41236-001.001

Figure 2-1
EQUILON SEATTLE SALES TERMINAL
SEATTLE, WASHINGTON

MONITORING WELL LOCATIONS

1=200 2-25-99 G:\DWG\40750001\B0021N10

EMCON
Northwest, Inc.

18912 North Creek Parkway, Suite 100 ● Bothell, WA 98011
Office (206) 485-5000 ● FAX (206) 486-9766

Field Sampling Data

LOCATION/ADDRESS _____
PROJECT NAME _____ # _____
CLIENT/CONTACT _____

Well or Surface Site Number _____
Sample Designation _____
Date, Time _____
Weather _____

HYDROLOGY MEASUREMENTS:

(Nearest .01 ft.)	Elevation	Date, Time	Method Used (M-Scope Number or Other)

WELL EVACUATION:

Gallons	Pore Volumes	Method Used	Rinse Method	Date, Time

Surface Water Flow Speed _____ Measurement Method _____ Date, Time _____

SAMPLING:

Sample	Date, Time	Method	Volume (ml)	Container Type	Depth Taken (feet)	Field Filtered (yes,no)	Preservative	Iced (yes,no)	Sampler Cleaning Method
									Non-Phosphatic detergent wash H2O rinse MeOH rinse Distilled H2O rinse

FIELD WATER QUALITY TESTS:

Pore Vol. Number	pH	Conductivity	Temp	Eh				

NOTES:

Total # of Bottles: _____ Signature: _____

SEA-400-01

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Figure 4-1
EQUILON SEATTLE SALES TERMINAL
SEATTLE, WASHINGTON

FIELD SAMPLING DATA FORM

EMCON

CHAIN OF CUSTODY/LABORATORY ANALYSIS REPORT FORM

DATE _____ PAGE _____ OF _____

PROJECT NAME _____ # _____

PROJECT _____

COMPANY/ADDRESS _____

_____

_____ PHONE _____

SAMPLERS SIGNATURE _____

SAMPLE I.D.	DATE	TIME	LAB I.D.	SAMPLE MATRIX	NUMBER OF CONTAINERS	ANALYSIS REQUEST: PETROLEUM HCS: TPH - HCID State:	TPH - G State:	BTEX	TPH - D State:	OIL	TPH - 418.1 State:	TPH - Other	ORGANIC: Halogenated or Aromatic Volatiles 601/8010	Volatile Organics GC/MS 624/8240	Base/Neut/Acid Organics GC/MS 625/8270	Pesticides/PCBS 8080	PCB ONLY	PAH 8310	HPCL	TCLP Semi VOA Metals VOA Metals Total	Fecal/Fare	List Below	DISS	Cyanide	pH, Cond, Cl, SO4, PO4, F, Br	NO2, NO3 (Circle)	NH3, N, COD, Total-P TKN, TOC	TOX (Circle)	REMARKS

RELINQUISHED BY:	RECEIVED BY:	TURNAROUND REQUIREMENTS	REPORT REQUIREMENTS	INVOICE INFORMATION:	SAMPLE RECEIPT:
Signature	Signature	____ 24 hr ____ 48 hr. ____ 5 day	____ I. Routine Report	P.O.# _____	Shipping VIA: _____
Printed Name	Printed Name	____ Standard (10-15 working days)	____ II. Report (includes DUP MAS, MSD, as required, may be charged as samples)	Bill To _____	Shipping to: _____
Firm	Firm	____ Provide Verbal Preliminary Results	____ III. Data Validation Report (includes All Raw Data)	_____	Condition: _____
Date/Time	Date/Time	____ Provide FAX preliminary Results	____ IV. CLP Deliverable Report	_____	_____
		Requested Report Date _____		_____	Lab No: _____

RELINQUISHED BY:	RECEIVED BY:	SPECIAL INSTRUCTIONS/COMMENTS:
Signature	Signature	
Printed Name	Printed Name	
Firm	Firm	
Date/Time	Date/Time	

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PROJECT NO.
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Figure 4-2
EQUILON SEATTLE SALES TERMINAL
SEATTLE, WASHINGTON

CHAIN OF CUSTODY / LABORATORY ANALYSIS REQUEST FORM

PROJECT PHOTO LOG

Sheet ____ of ____

PROJECT NO: _____
PROJECT NAME: _____
PROJECT LOCATION: _____
CLIENT: _____
PHOTOGRAPHER: _____
Slides ____ Prints ____ Negatives ____

SITE CATEGORY (CHECK ONE):

- ☐ Chemical Plant
- ☐ Sanitary Landfill
- ☐ Sludge
- ☐ Hazardous Waste
- ☐ Fabrication Facility
- ☐ Water Supply
- ☐ Woodwaste
- ☐ Wood Treatment
- ☐ Light Industry
- ☐ Metal Plating
- ☐ Other _____

TYPE OF WORK:

Geotechnical Exploration	Water Quality Monitoring	Gas Monitoring	Water Supply	Other
☐ Test Pits	☐ Drilling	☐ Drilling	☐ Drilling	_____
☐ Drilling	☐ Well Installation	☐ Well Installation	☐ Well Installation	_____
☐ Mapping	☐ Ground Water Sampling	☐ Recovery Systems	☐ Aquifer Testing	_____
☐ Waste Characterization	☐ K-testing	☐ Sampling	☐ Sampling	_____
	☐ Surface Monitoring		☐ Pump Installation	_____
	☐ Surface Sampling			

PHOTO NO.	DATE	DESCRIPTION

PHOTO NO.	DATE	DESCRIPTION

EMCON

DATE 6-98
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APPR. _____
PROJECT NO.
41236-001.001

Figure 4-3
EQUILON SEATTLE SALES TERMINAL
SEATTLE, WASHINGTON

PHOTOGRAPH LOG

SAMPLING ALTERATION CHECKLIST

Sample program identification: _____

Material to be sampled: _____

Measurement variable: _____

Standard procedure for analysis: _____

_____

Reference: _____

_____

_____

Variation from standard procedure: _____

_____

_____

_____

_____

_____

Reason for variation: _____

_____

_____

_____

_____

_____

Resultant change in field sample procedure: _____

_____

_____

_____

Special equipment, material, or personnel required: _____

_____

_____

Author's name: _____ Date: _____

Approval: _____ Title: _____

Date: _____

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REV. _____
APPR. _____
PROJECT NO.
41236-001.001

Figure 4-4
EQUILON SEATTLE SALES TERMINAL
SEATTLE, WASHINGTON

SAMPLING ALTERATION CHECKLIST