VOLUME 4

GAS WORKS PARK ENVIRONMENTAL CLEANUP

CLEANUP ACTION PLAN AND SEPA CHECKLIST

Prepared for

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DECLARATIVE STATEMENT

Consistent with Chapter 70.150D RCW, "Model Toxics Control Act", as implemented by Chapter 173-340 WAC, "Model Toxics Control Act Cleanup Regulation", it is determined by the Washington State Department of Ecology (Ecology) that these selected cleanup actions for the Gas Works Park site are protective of human health and the environment, attain Federal and State requirements which are applicable or relevant and appropriate, comply with cleanup actions, and provide for compliance monitoring. The cleanup actions also satisfy the preference expressed in WAC 173-340-360 for the use of permanent solutions within a reasonable timeframe, and consider public concerns raised during public comments on the draft Cleanup Action Plan.

This Cleanup Action Plan, and the work in support thereof, has been completed in compliance with Chapter 173-340-550 WAC, and hence is "substantial equivalent" of a Cleanup Action Plan conducted or supervised by Ecology.

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1. INTRODUCTION

Gas Works Park (the Park) is the former location of a coal and oil gasification plant that operated from 1906 to 1956. The City of Seattle (the City) purchased the Park property from the Washington Natural Gas Company (now Puget Sound Energy) in 1962 and developed it into the Park, which opened in 1976. Studies conducted at the Park in the 1970s and 1980s indicated the presence of soil and groundwater contamination from the former gas plant operation. The Washington State Department of Ecology (Ecology), through execution of an Agreed Order dated August 1, 1997, required the City and Puget Sound Energy (PSE) to complete a Focused Feasibility Study (FFS) of cleanup alternatives and a Cleanup Action Plan (CAP) describing the recommended cleanup alternative. The FFS and supporting data are presented as Volumes 1 through 3 of the Gas Works Environmental Cleanup documents.

This CAP is Volume 4 of the Gas Works Park Environmental Cleanup documents and meets the requirements specified in Chapter 173-340-360(10) through (12) WAC, the Model Toxics Control Act (MTCA). The State Environmental Policy Act (SEPA) Checklist, Appendix A to this Cleanup Action Plan, has been completed per the requirements of Chapter 173-340-350(6)(h) WAC (the MTCA regulations) and of Chapter 197-11 WAC (the SEPA regulations). A determination of non-significance (DNS) for the actions proposed in this Cleanup Action Plan was declared by Ecology and is included as Appendix B.

2. SUMMARY OF SELECTED CLEANUP ACTIONS

2.1 UPWELLING TAR SOURCES

In 1997, the City and Puget Sound Energy (PSE) characterized known and suspected tar seeps at the Park, and conducted an interim action that removed and destroyed (by thermal desorption) as much of this material as practicable. The following year, additional tar surfaced from the general area of the previous excavations and was removed and treated. As part of this Cleanup Action Plan, the City and PSE will continue to remove and treat any residual tar which might seep from these and other areas[1].

2.2 SOIL

Much of the subsurface soil at Gas Works Park is contaminated with chemicals known as Polynuclear Aromatic Hydrocarbons (PAHs). Additionally, the site contains material that could be classified as Extremely Hazardous Waste[2] (EHW) under the State's Dangerous Waste Regulation (Ch. 173-303 WAC)[3]. Excavation and treatment of this material to a depth of 15 feet is technically impracticable[4].

Contact with underlying soils could result in unacceptable risks to Park users. Direct contact will be prevented by application of containment technologies and institutional controls. The proposed cleanup action for the Park includes placing a new vegetated soil cover over unpaved open areas in the north-central and southeastern portions of the Park. The soil cover will serve as a protective barrier between Park users and chemicals of concern.

2.3 GROUNDWATER

The groundwater at the southeast part of the Park is contaminated with oil, benzene, and other organics. An interim action to remove free product was initiated in October of 1998. The selected remedial action will consist of a system of air sparging and soil vapor extraction (SVE). This action will reduce contaminant concentrations in groundwater from 642 mg/L to 0.43 mg/L. Modeling of the biological attenuation of benzene estimates that, following treatment by air sparging/SVE, surface water criteria at discharge points into Lake Union will be met within 2 to 27 years. The

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[1] During the Public Comment period, concern was expressed about possible tar and free product seepage near the Prow area of the Park.

[2] In this case, material that contains in excess of 1% total polynuclear aromatic hydrocarbon content by weight.

[3] Washington Administrative Code

[4] Due to the complexities associated with coal tar migration in subsurface media at this site, coal tar accumulations would be difficult to locate. Conventional remediation methods, such as excavation, direct pumping, and groundwater treatment, generally are not effective for removing coal tar from the subsurface. It is estimated that less than 1 ton of material that could potentially be classified as EHW exists on site. This material is randomly distributed throughout the site and approximately 385,000 cubic yards of soil (much of it below the water table) would need to be excavated to ensure its complete removal. It is estimated that the cost of excavation and treatment would exceed $80,000,000. More information is available in the April 12, 1999 memorandum from ThermoRetec to Ecology "Extremely Hazardous Waste" (attached as Appendix C).

variation of restoration time frames depends primarily of the oxygen content of the aquifer. This cannot be accurately predicted before implementation of the air sparging/SVE remedial action and must be measured afterwards.

The groundwater at the western portion of the Park is contaminated with PAHs (including carcinogenic PAHs). Page 6-2 of the EPRI study (EPRI 1998) concluded that natural attenuation is reducing the concentrations of these chemicals to surface water cleanup criteria prior to their discharge into Lake Union. The City and Puget Sound Energy will be required to demonstrate that attenuation is actually occurring at a rate sufficient to meet surface water criteria within a reasonable restoration time frame. The effectiveness of attenuation as a remedial action will be evaluated during the first periodic review[5]. Should attenuation not be progressing as anticipated, other more active remedial actions may be required.

Additionally, due to concerns expressed during the public comment period[6], limited monitoring of MW-19 and MW-17 for chemicals of concern will be required.

2.4 SEDIMENTS

Sediment remediation (including sediment cleanup goals) is not addressed under this Cleanup Action Plan and will take place under a separate decree or order at a later date. Full analysis of any Gas Works Park upland to sediment pathways (including groundwater and shoreline erosion pathways) will be reserved for the next phase of cleanup analysis and action, under a separate decree or order.

2.5 INTERIM ACTION

The FFS field investigation of benzene-contaminated groundwater in the southeast part of the Park, confirmed the presence of light non-aqueous phase liquid (LNAPL), in the form of light oil containing a high percentage of benzene, in the soil pores immediately above the water table and floating on the water table. Results of the cleanup alternative analysis indicated that air sparging and soil vapor extraction, the technologies evaluated in detail, may not extract contamination efficiently due to the potential for emulsifying and dispersing the LNAPL.

With concurrence from Ecology, the City and PSE proceeded with development of plans for an interim action to remove LNAPL in the southeast area of the Park. The objectives of this interim action were to maximize elimination of LNAPL as the major some of benzene contamination to groundwater in this part of the Park, and to diminish the negative impacts that LNAPL could have on future cleanup actions.

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[5] WAC 173-340-420 Periodic review. (1) If the department selects or approves a cleanup action that results in hazardous substances remaining at a site at concentrations which exceed method A or method B cleanup levels established under WAC 173-340-700 through 173-340-760 or if conditional points of compliance have been established, the department shall review the cleanup action no less frequently than every five years after the initiation of such cleanup action to assure that human health and the environment are being protected.

[6] The hypothesis was proposed by Ecology's Northwest Regional Office that BTEX compounds in the groundwater could mobilize PAHs in the subsurface.

An "Interim Remedial Action Work Plan" was prepared by ThermoRetec (1998) to describe the rationale and implementation details for the interim action. The oil recovery system consists of a network of vertical wells in the southeastern shoreline area. The oil recovery was initiated in October 1998, at a time of year when Park use is greatly reduced. This timing also allowed oil recovery while the Lake Union and adjacent groundwater levels are lower, which is more favorable for oil recovery.

Mobile pumping equipment (e.g., vacuum truck) was used to recover oil and associated groundwater, and to minimize disruption of the park. From October to December, groundwater was pumped once or twice a week. Recovered oil was recycled by a fuel blending process at a permitted off-site facility. The oil recovery operation is ongoing.

3. CLEANUP STANDARDS

Cleanup of the Gas Works Park Site is being done under the authority of Chapter 70.105D RCW[7], *Hazardous Waste Cleanup – Model Toxics Control Act*, and its implementing regulation, Chapter 173-340 WAC, *The Model Toxics Control Act Cleanup Regulation* (MTCA). This law and regulation apply to the site in their entirety and govern all remedial actions at the site.

The most relevant sections of the statute and regulation with regard to this CAP are the following:

- RCW 70.105D.030(1)(b), which states in part that, " ... the department shall give preference to permanent solutions to the maximum extent practicable and shall provide for or require adequate monitoring to ensure the effectiveness of the remedial action.";

- RCW 70.105D.030(2), which states, "The department shall immediately implement all provisions of this chapter to the maximum extent practicable ... ";

- WAC 173-340-700 through -760, which specify how cleanup standards are to be set for the various environmental media of concern: groundwater, surface water, soil, sediment, and air; and

- WAC 173-340-360, Selection of cleanup actions. This specifies the requirements for cleanup actions and the criteria that are used to evaluate alternatives.

Taken together, the provisions of the statute and the regulation provide strong preference for permanent solutions, set specific cleanup standards for hazardous substances, and give specific requirements for selecting cleanup actions ("solutions"), including selecting remedies that are permanent to the maximum extent practicable.

3.1 SPECIFICATION OF CLEANUP STANDARDS

Specification of a cleanup standard for an environmental medium of concern (i.e., soil, groundwater, surface water, sediment, or air) requires specification of the following:

- Hazardous substance concentrations that protect human health and the environment. These concentrations are called cleanup levels. Indicator hazardous substances may be chosen from among the hazardous substances present at a site to define cleanup requirements.

- The location on the site where cleanup levels must be attained. This location is known as the point of compliance.

- Additional regulatory requirements that apply to a cleanup action because of the nature of the hazardous substances, type of action, location of the site, or other circumstances at the site. These requirements include legally applicable requirements promulgated under state or

[7] Revised Code of Washington

federal law and relevant and appropriate requirements that, while not legally applicable, address problems or situations sufficiently similar to those encountered at the site such that their use is well suited to the particular site. These "applicable or relevant and appropriate requirements" are usually referred to by the acronym ARARs.

3.2 SELECTION OF CLEANUP ACTIONS

Cleanup actions are selected according to the requirement that cleanup actions must meet the following: threshold requirements; the requirement to select cleanup actions that are permanent to the maximum extent practicable; consideration of restoration time frame; consideration of public concerns; preferences regarding cleanup technologies; and criteria for evaluating the degree to which alternative cleanup actions meet these requirements, considerations; and preferences. The process is set forth in WAC 173-340-360, Selection of cleanup actions.

The threshold requirements, which any cleanup action must meet to be considered for selection, are that the cleanup must:

- Protect human health and the environment,
- Comply with cleanup standards,
- Comply with applicable state and federal laws, and
- Provide for compliance monitoring.

Cleanup action alternatives which Ecology determines meet the above threshold requirements may then be considered for selection of an overall cleanup action.

Overall cleanup actions typically involve the use of several cleanup technologies or methods at a single site. In selecting an overall cleanup action from alternative choices that meet threshold requirements, the degree to which each alternative meets the following requirements is to be considered:

- Use of permanent solutions to the maximum extent practicable. A permanent solution meets cleanup standards without further action being required at the original site or any other site involved with the cleanup action, other than the approved disposal of any residue from preferred treatment technologies. In general, technologies, which reuse, recycle, destroy, or detoxify hazardous substances result in permanent solutions if residual hazardous substance concentrations are below cleanup levels established under MTCA. Containment of hazardous substances and/or institutional controls alone is not permanent solutions.

- Provision for a reasonable restoration time frame. Factors considered when establishing a reasonable restoration time frame include potential risks posed by the site to human health and the environment; the practicability of achieving a shorter restoration time; current and future use of the site, surrounding areas, and associated resources; availability of alternative water supplies; likely effectiveness and reliability of institutional controls; ability to control and monitor migration of hazardous substances from the site; toxicity of the hazardous

substances at the site; and natural processes which reduce concentrations of hazardous substances and have been documented to occur at the site or under similar site conditions.

- Consideration of public concerns raised during the public comment on the CAP.

When considering alternatives, preference is to be given to those incorporating cleanup technologies that provide greater long-term effectiveness and more permanent reduction of toxicity, mobility, and volume. Technologies that address these issues are considered in the following order of descending preference: (1) reuse or recycle; (2) destroy or detoxify; (3) separate, reduce the volume of, and/or reuse, recycle, destroy, or detoxify; (4) immobilize; (5) dispose of on-site or off-site at an engineered facility; (6) isolate or contain; and (7) provide institutional controls and monitoring. Institutional controls and monitoring are to be used to supplement engineering controls, and are not to be used as a substitute for cleanup actions that would otherwise be technically possible [WAC 173-340-440(2)].

In considering the degree to which alternative cleanup actions use permanent solutions to the maximum extent practicable, the following criteria are to be considered: (1) Overall protectiveness of human health and the environment; (2) long-term effectiveness; (3) short-term effectiveness; (4) permanent reduction of toxicity, mobility, and volume of the hazardous substances; (5) ability to be implemented; (6) cleanup costs; and (7) degree to which community concerns are addressed.

3.3 REMEDIATION LEVELS (CLEANUP ACTION LEVELS)

One other important concept should be discussed with regard to selection of cleanup standards. This concept is termed "remediation level" (or "cleanup action level"). As discussed above, cleanup actions typically involve a combination of technologies, and often not all contamination is taken off-site. A remediation level is a concentration of a hazardous substance at a location within a medium at which a different cleanup technology will be used. There are often multiple remediation levels; e.g. one for removal and treatment/disposal and one for material that may be contained on-site. Remediation levels may be based upon the concentration of a hazardous substance, upon the location of the hazardous substance, and often both. Remediation levels may only be established after all threshold requirements are met. Cleanup actions, which incorporate remediation level(s), must still be protective of human health and the environment and permanent to the maximum extent practicable.

Typically, a lower-preference, less-permanent remedy (such as containment) might be used as the cleanup action to address contaminant concentrations between a remediation level that equals the cleanup the level and a higher remediation level. Where contaminant concentrations exceed this higher level, a more permanent cleanup action (such as removal and off-site disposal) would be applied.

When a remediation level is set for a site it means that cleanup levels will be attained for only a portion of the site and that contamination will be left on-site. Institutional controls are required for sites where contamination remains on-site above cleanup levels.

Cleanup levels and their point of compliance must set for all sites to develop the cleanup standard; remediation levels and associated locations where the remediation levels must be met may or may not be used at a particular site.

In the draft Focused Feasibility Study for Gas Works Park (Parametrix 1998), the City and PSE proposed remediation levels of 10 times the surface water cleanup criteria at inland locations. These remediation levels assumed a dilution and attenuation factor (DAF) of 10 from the point of measurement to the surface water body (Lake Union). During the public comment period, considerable concern was expressed over the validity of the assumptions used in deriving the DAF of 10. Ecology has determined that there is not sufficient evidence available to support the conclusion that an assumed DAF of 10 is protective of human health and the environment. As a result, after installation and operation of the air sparging/SVE treatment system, monitoring will be done to measure the actual DAF at the site and confirm that the remedy is protective.

3.4 CLEANUP LEVELS

3.4.1 Soil

Soil cleanup levels at the Park (MTCA Method B) are based upon a future residential exposure scenario. The current land use at the Park is recreational. Table 3-1 lists the chemicals of concern and their cleanup levels.

Arsenic levels at the site exceed the 90% percentile for the Puget Sound regional background level of 7.3 mg/kg but fall within the range of concentrations observed in the study by Ecology (1994). Considering the present and likely future use of the Park as a recreational area[8], the MTCA Method A value of 20 mg/kg for arsenic is protective of human health and is acceptable for use as a cleanup level at this site.

Table 3-1 indicates that 1997 soil sample results all exceed the Method B cleanup levels, and are therefore all retained as chemicals of concern. This does not, however, indicate that Park users or workers have been or are currently exposed to unacceptable levels of risk. The risk assessment performed by the University of Washington (Ongerth 1985) concluded that health risks estimated from exposures to PAHs in soils over most of the Park (typical concentrations on the order of 20 milligrams per kilogram) are comparable to or less than exposures received during daily living.

The risk assessment recommended that localized spots of higher PAH in soils be removed or covered with clean material, and that signs be posted to discourage people (mainly children) from placing soil in their mouths. The City immediately implemented these recommendations in 1985. Application of the Method B cleanup levels for soils, which are much lower than the concentrations

[8] Chemical concentrations protective of human health in a recreational exposure scenario are generally higher than those in a residential exposure scenario due to decreased contact time.

Table 3-1. Cleanup levels for soil, Gas Works Park.

Chemical of Interest	Maximum 1997 Detected Concentration (mg/kg)	MTCA Method B Soil Cleanup Level (mg/kg)	Retained as Chemical of Concern?
Inorganic Chemicals			
Arsenic	10.9	20(1)	**Yes**
Carcinogenic PAHs			
Benzo(a)anthracene	23.3	0.137	**Yes**
Benzo(b)fluoranthene	35.4	0.137	**Yes**
Benzo(k)fluoranthene	12.0	0.137	**Yes**
Benzo(a)pyrene	36.0	0.137	**Yes**
Chrysene	27.7	0.137	**Yes**
Dibenzo(a,h)anthracene	5.57	0.137	**Yes**
Indeno(1,2,3-cd)pyrene	44.4	0.137	**Yes**
Other PAHs			
Naphthalene	11.5	3,200	**Yes**
Pyrene	102	2,400	**Yes**
Fluoranthene	62.5	3,200	**Yes**

NOTES:
mg/kg = milligrams per kilogram
PAH = Polynuclear aromatic hydrocarbon
(1) MTCA Method A cleanup level; see discussion in Section 3.4.1

addressed in the risk assessment, is a conservative approach that provides an added level of protection to Park users and workers.

3.4.2 Groundwater

Groundwater cleanup levels at the Park are based on the protection of surface water and will be the MTCA Method B Surface Water Cleanup Levels. In arriving at this decision, Ecology considered that:

- The shallow groundwaters underneath the Park are not usable as a drinking water source[9]
- Lake Union is not usable as a drinking water source[10]
- There are known and projected points of entry of the groundwater into the surface water.

[9] WAC 173-340-720(1)(c)
[10] WAC 173-340-720(1)(c)(ii) requires that the surface water body is not classified as a suitable domestic water supply source under chapter 173-201 WAC. Ecology's Northwest Regional Office has determined that Lake Union is not a suitable water supply source at the adjacent Metro Facilities North site.

- After the completion of cleanup actions, groundwater flow into surface waters will not result in exceedances of surface water cleanup levels at the point of entry or at any downstream location where it is reasonable to believe that hazardous substances may accumulate.

- Institutional controls will prevent the use of contaminated groundwater at any point between the source of hazardous substances and the point(s) of entry of the groundwater into the surface water

- It is unlikely that hazardous substances will be transported from the contaminated groundwater to groundwater that is a current or potential future source of drinking water at concentrations which exceed groundwater quality criteria published in chapter 173-200 WAC.

Table 3-2 lists the chemicals of concern for groundwater and their cleanup levels.

3.5 POINTS OF COMPLIANCE

A point of compliance is the point or points where cleanup levels established in accordance with WAC 173-340-720 through 173-340-760 must be attained.

When hazardous substances remain on-site as part of the cleanup action, the Department may approve a conditional point of compliance which shall be as close as practicable to the source of hazardous substances, not to exceed the property boundary. Where a conditional point of compliance is proposed, the person responsible for undertaking the cleanup action shall demonstrate that all practicable methods of treatment are to be utilized in the site cleanup.

3.5.1 Soil

The point of compliance is the point or points where the soil cleanup levels must be attained. For soil cleanup levels based on human exposure via direct contact, the point of compliance is established in soils throughout the site from the ground surface to 15 feet below the ground surface. Ecology recognizes that cleanup actions involving containment of hazardous substances will typically not meet the soil cleanup levels throughout the site to a depth of 15 feet. In these cases, the cleanup action may be determined to comply with cleanup standards, with the following provisions: a compliance monitoring program ensures the long-term integrity of the containment system; the cleanup action does not rely primarily on on-site disposal, isolation, or containment if it is practicable to reuse, destroy, or detoxify the hazardous substances; and long-term monitoring and institutional controls are implemented until residual hazardous substance concentrations no longer exceed site cleanup levels. [See (WAC 173-340-740(6)(c) and (d)]

MTCA requires that, for land to be returned to unrestricted use, soil cleanup levels be based on human exposure via direct contact with a point of compliance established in the soils throughout the site from the ground surface to 15 feet below the ground surface. This represents a reasonable estimate of the depth of soil that could be excavated and distributed at the soil surface as a result of site development activities [WAC 173-340-740(6)(c)]. However, Ecology recognizes that cleanup actions may be selected which involve containment of hazardous

Table 3-2. Cleanup levels for groundwater, Gas Works Park.

Chemical of Interest	Aqueous Solubility(1) (µg/L)	Maximum Leaching Test Concentrations (4) (µg/L)	Maximum 1997-1998 Detected Concentrations in All Wells (µg/L)	Maximum 1997-1998 Concentrations in Shoreline Wells(6) Conc. (µg/L)	Well No.	MTCA Method B Surface Water Cleanup Level(7) (µg/L)	Retained as Chemical of Concern?
Carcinogenic PAHs							
Benzo(a)anthracene	11	0.6	55	1.6	MLS-7	0.0296	Yes
Benzo(b)fluoranthene	1.5	< 0.6(5)	46.9	< 1.0	--	0.0296	Yes
Benzo(k)fluoranthene	0.81	< 0.6(5)	32.3	< 1.0	--	0.0296	Yes
Benzo(a)pyrene	6.3	0.1	70.1	1.4	MLS-7	0.0296	Yes
Chrysene	1.8(2)	0.4	57.2	0.2	MLS-7	0.0296	Yes
Dibenz(a,h)anthracene	0.5(2)	< 0.6(5)	1.4	< 1.0	--	0.0296	Yes
Indeno(1,2,3-cd)pyrene	0.53(3)	< 0.6(5)	75.2	< 1.0	--	0.0296	Yes
Other PAHs							
Fluoranthene	243	21	198	6.4	MLS-6	90.2	No
Fluorene	1,830	118	172	87	MLS-7	3,460	No
Naphthalene	32,200	19,800	16,000	16,000	MLS-7	9,880	Yes
Pyrene	129	23	246	9.7	MLS-6	2,590	No
Volatile Organic Chemicals							
Benzene	1,786,000	--	642,000	256,000	MW-12	43	Yes
Ethylbenzene	156,000	--	20,800	2,500	MW-12	6,910	Yes
Toluene	542,000	--	222,000	35,900	MW-12	48,500	Yes

NOTES: µg/L = micrograms per liter N/A = Not Available
PAH = Polynuclear Aromatic Hydrocarbon
U = undetected at the given detection limit
(1) MacKay et al. 1992, unless otherwise noted
(2) Montgomery and Welkom 1990
(3) U.S. Army Corps of Engineers 1997
(4) EPRI 1998; from solubility leaching tests, unless otherwise noted
(5) Predicted based on comparison to benzo(a)anthracene, which has a higher aqueous solubility
(6) Shoreline wells include: MLS-6, DW-6, MLS-7, MW-16, MW-21, MW-22, MW-23, MW-24, and MW-25; MW-13 was not considered because it is screened in a lampblack deposit. PAH data are from low-flow purge sampling event conducted in April 1998 (EPRI 1998).
(7) See Section 3.4.2 for application of MTCA B surface water cleanup levels to groundwater
□ = Exceeds aqueous solubility

substances on site, in which case the soil cleanup levels will typically not be met throughout the site from the ground surface to 15 feet below the ground surface. In these cases, the cleanup action may be determined to comply with cleanup standards [WAC 173-340-740(6)(d)], provided the compliance monitoring program is designed to ensure the long-term integrity of the containment system, and long-term monitoring and institutional controls are continued until residual hazardous substance concentrations no longer exceed site cleanup levels [See WAC 173-340-360(8)].

The overall approach at Gas Works Park will be to contain contaminated soils that are accessible (i.e., not under buildings, pavements, or other permanent structures) with a vegetated soil cover (described in Section 4.1.2) and develop institutional controls for the site that will ensure proper long-term management of the residual contamination left on-site. Any contaminated soils encountered during construction or subgrade preparation will be stockpiled, tested, and manifested for off-site disposal and treatment, as appropriate.

3.5.2 Groundwater

At Gas Works Park, the affected groundwater flows into nearby surface water (Lake Union), and the cleanup level will be based on protection of the surface water. Ecology will approve a conditional point of compliance that is located within the surface water, as close as technically possible to the point or points where groundwater flows into the surface water.

Ecology recognizes the technical difficulties inherent in measuring compliance at the actual locations at the Park where hazardous substances may be released to the surface water as a result of groundwater flow. Therefore, compliance monitoring points will be located upland and measured concentrations extrapolated to the surface water-groundwater interface.

No suitable monitoring points presently exist on-site. Actual locations will be specified in the Compliance Monitoring Plan that will be prepared under WAC 173-340-410.

In order to utilize a conditional point of compliance as outlined above, the following must be met:

- Use of a dilution zone under WAC 173-201-035 to demonstrate compliance with surface water cleanup levels shall not be allowed [WAC 173-340-720(6)(d)(i)].

- Groundwater discharges shall be provided with all known available and reasonable methods of treatment prior to release into surface waters [WAC 173-340-720(6)(d)(ii)].

- Groundwater discharges shall not result in violations of sediment quality values published in chapter 173-204 WAC [WAC 173-340-720(6)(d)(iii)].

- Groundwater monitoring shall be performed to estimate contaminant flux rates and to address potential bioaccumulation problems resulting from surface water concentrations below method detection limits.[WAC 173-340-720(6)(d)(iv)].

4. DESCRIPTION OF THE PROPOSED CLEANUP ACTION

4.1 CLEANUP ACTION COMPONENTS

The proposed cleanup action consists of an engineered soil cover to prevent human exposure to contaminated soils, an air sparging and SVE system for treatment of benzene-contaminated soil and groundwater at the southeast part of the Park, and confirmational monitoring of the modeled natural attenuation of the groundwater at the western part of the Park. The locations of these systems at the Park are shown on Figure 4-1.

4.1.1 Air Sparging With Soil Vapor Extraction

4.1.1.1 Process Description

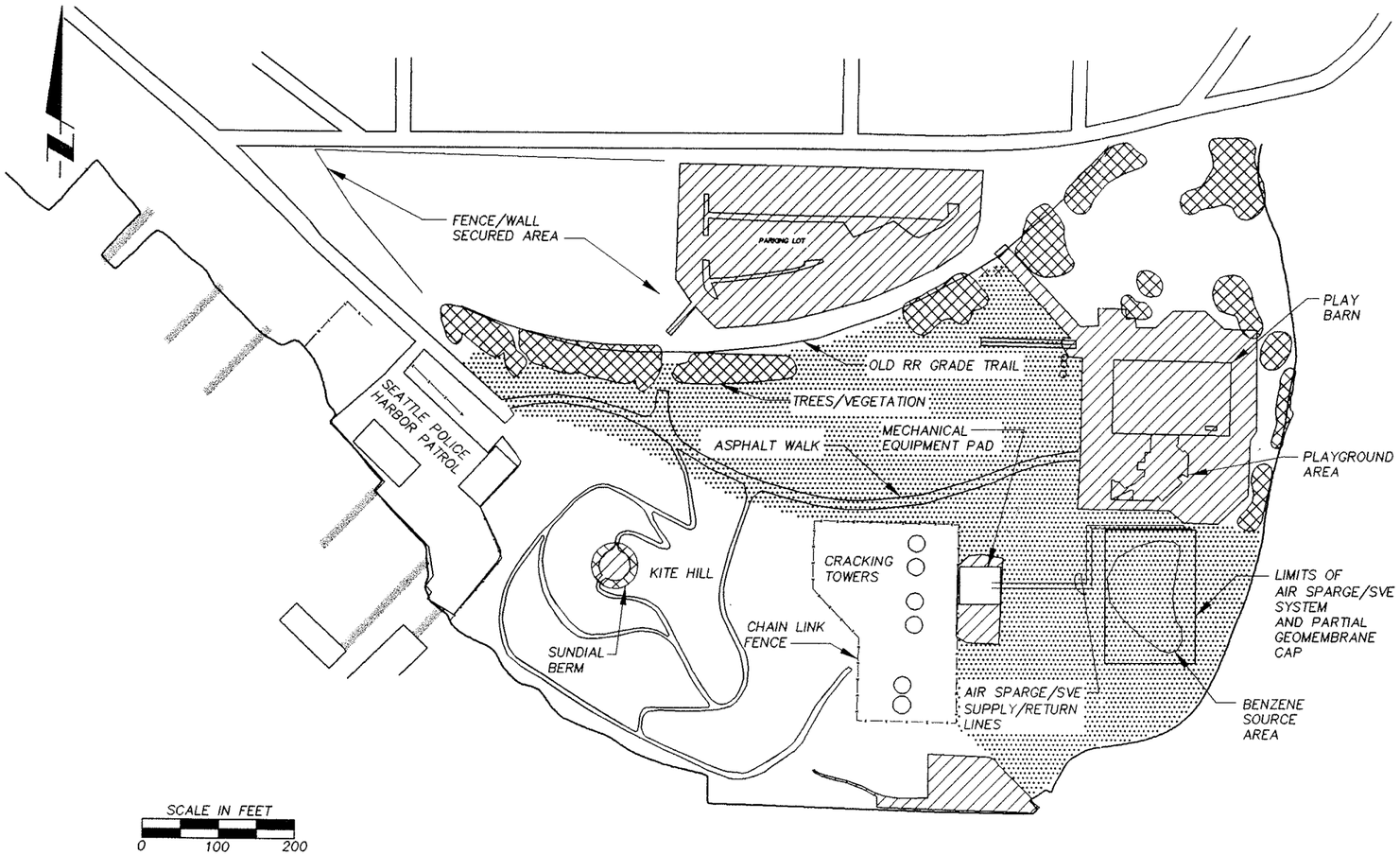
Air sparging is an in-situ process in which air is bubbled through a contaminated groundwater zone to remove volatile organic compounds such as BTEX (benzene, toluene, ethylbenzene, and xylene). Injected air bubbles move vertically and horizontally through the saturated soil zone, creating an underground air stripping process that removes contaminants through volatilization (Figure 4-2). Volatile compounds exposed to the sparged air convert to gas phase and are carried by the air into the unsaturated zone. SVE is used with air sparging to remove vapors from the unsaturated zone. Soil vapors collected by the SVE system are treated to control emissions of air pollutants.

Air sparging has seen a dramatic increase in use and acceptance in recent years, primarily because of its low cost, simplicity, and potential to greatly reduce remediation periods. In a report on innovative technologies, the U.S. Environmental Protection Agency estimated that air sparging is used 45 percent of the time (relative to other innovative technologies) at sites with contaminated groundwater (Environmental Technology 1997). The American Petroleum Institute (API) has assembled a database containing design and operating information on air sparging systems installed at 59 contaminated sites (Hinchee et al. 1995). Brown and Jasiolewicz (1992) estimated that the time and cost for remediating groundwater contaminated with volatile organic compounds may be reduced by as much as 50 percent using air sparging as compared to conventional pump and treat systems.

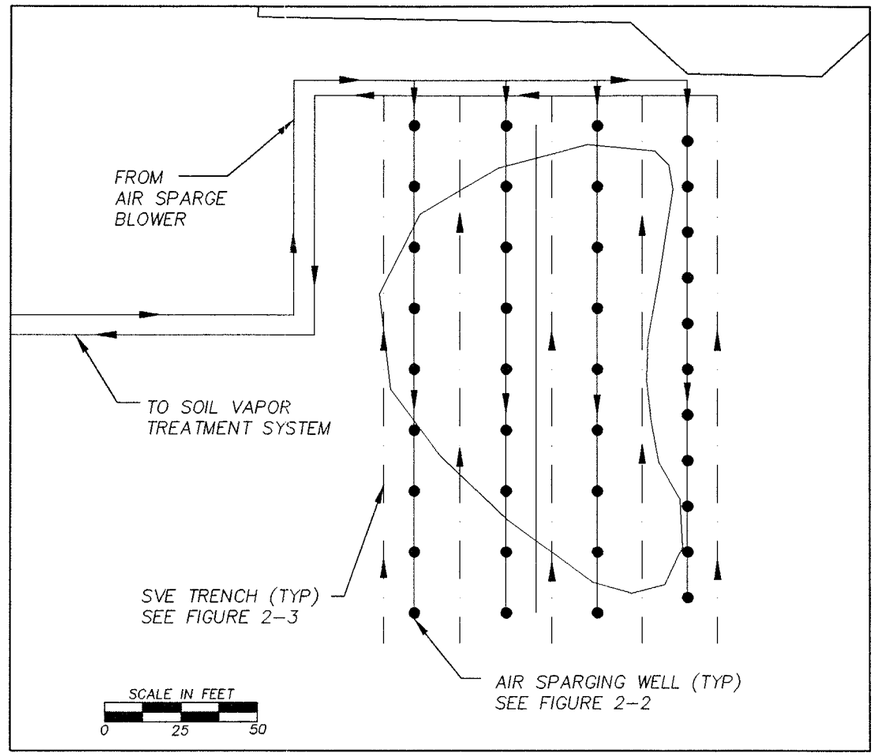
4.1.1.2 Description of Air Sparging/SVE System

The air sparging system at the Park will consist of six basic elements:

1. Air injection wells,
2. Air compressors or blowers and air distribution piping,
3. Soil vapor extraction system,
4. Geomembrane cap,
5. Soil vapor treatment, and
6. Groundwater monitoring wells.



AIR SPARGING/SVE SYSTEM
SITE PLAN
1"=200'



AIR SPARGING/SVE SYSTEM
CONCEPTUAL LAYOUT
1"=50'

LEGEND

- SHORELINE BOUNDARY
- PARK BOUNDARY
- IMPERVIOUS AREAS (3.5 AC)
- TREES/VEGETATION
- SOIL COVER (5.7 AC)
- AIR SUPPLY/RETURN LINE FLOW DIRECTION
- SVE TRENCH
- AIR SPARGING WELL

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Figure 4-1
Plan View of Proposed Air Sparging/ Soil Vapor Extraction (SVE) System
Gas Works Park

Each of these elements is described in the following sections. The description and sizing of components presented in this section are based on work completed during the FFS and are presented with a conceptual level of detail. More detailed design criteria will be developed and presented in the Engineering Report. Certain specific design elements presented in this CAP may change based on further detailed analysis in the Engineering Report.

Air Sparging Wells

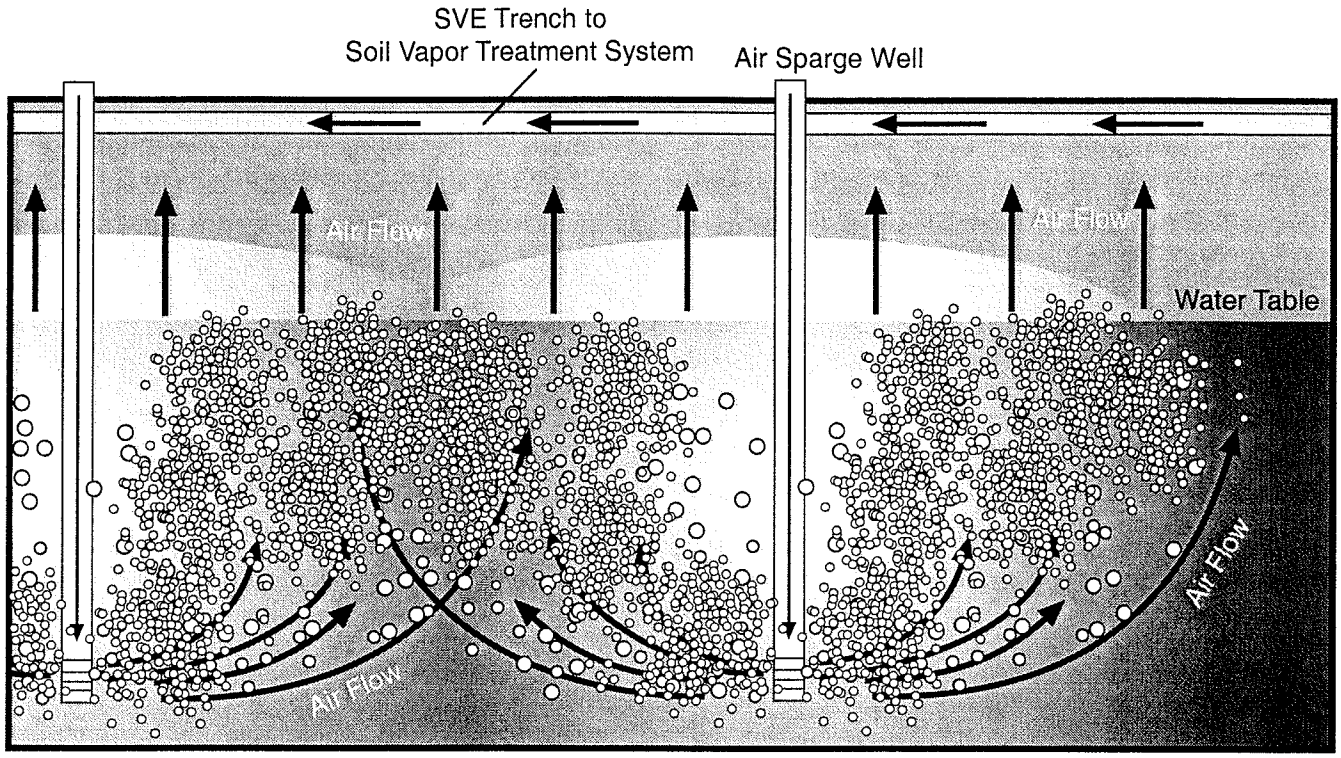
A typical air sparging well is shown on Figure 4-2. The air sparging wells will extend down to the Vashon Till and be constructed of 2-inch-diameter steel pipe. The bottom of each well will consist of 1 to 2 feet of well screen. The sparging wells will be completed by placing a sand or gravel pack around the well screen. A 1-ft bentonite seal will be placed above the sand or gravel pack. The well annulus will then be grouted to the ground surface. The sparge well will be flush at the ground surface with a vault cover to protect the well and piping.

Based on previous reports (RETEC 1998), the sparging system is expected to reduce benzene concentrations at the edge of the treatment zone to levels not greater than 430 µg/L. Preliminary estimates indicate that the area of influence of each sparging well may be as much as 35 feet (RETEC 1998). These estimates do not consider the influence of biological degradation, which will occur in the shallow groundwater zone and overlying unsaturated zone to some extent. As a result, cleanup times and BTEX removal rates may be better than expected.

A conceptual layout of sparging wells is shown on Figure 4-1. The layout shows closely-spaced sparging wells spaced at approximately 15 feet on center along the shoreline, downgradient of the source area. These wells will serve primarily to ensure containment of BTEX contamination and prevent further migration of contaminants to surface water. Performance monitoring wells will be located within the downgradient zone of sparging influence. Approximately three rows of additional wells will be located upland, in and around the original source area of contamination. These upland wells will primarily serve to facilitate cleanup of groundwater and soils in the most heavily contaminated area. The actual well spacing and total number of wells will be determined in the Engineering Report.

Blower System

Air will be injected into sparging wells under pressure with mechanical blowers. A pipe manifold constructed of small-diameter plastic pipe will be used to convey air from the blowers to each well (see Figure 4-1). The manifold will be located below grade and beneath the cover, as shown on Figure 4-3. The static water head above the sparge point, the air entry pressure of the saturated soils, and the air injection flow rate govern air injection pressure. Working pressures on the order of 15 pounds per square inch (psi) are typical. Airflow rates typically used in the field are between 3 to 10 standard cubic feet per minute (SCFM) (Rast 1997).



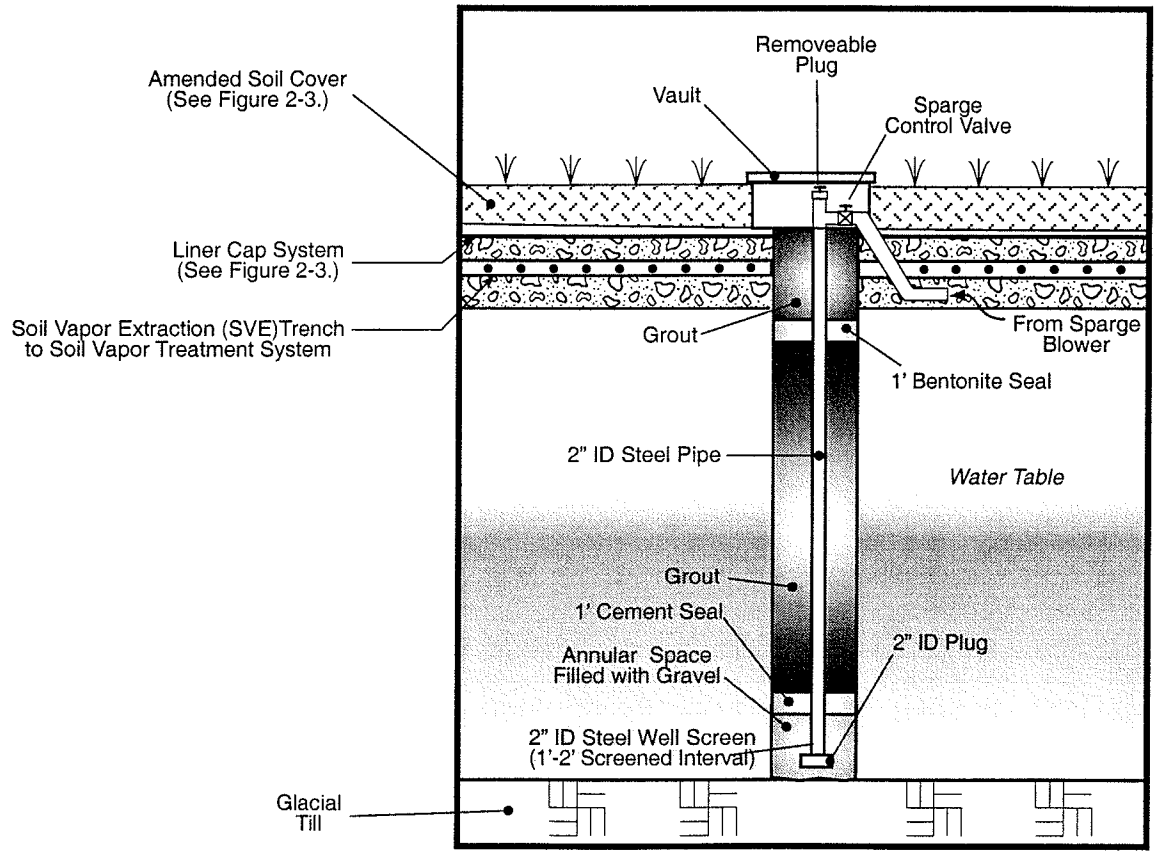
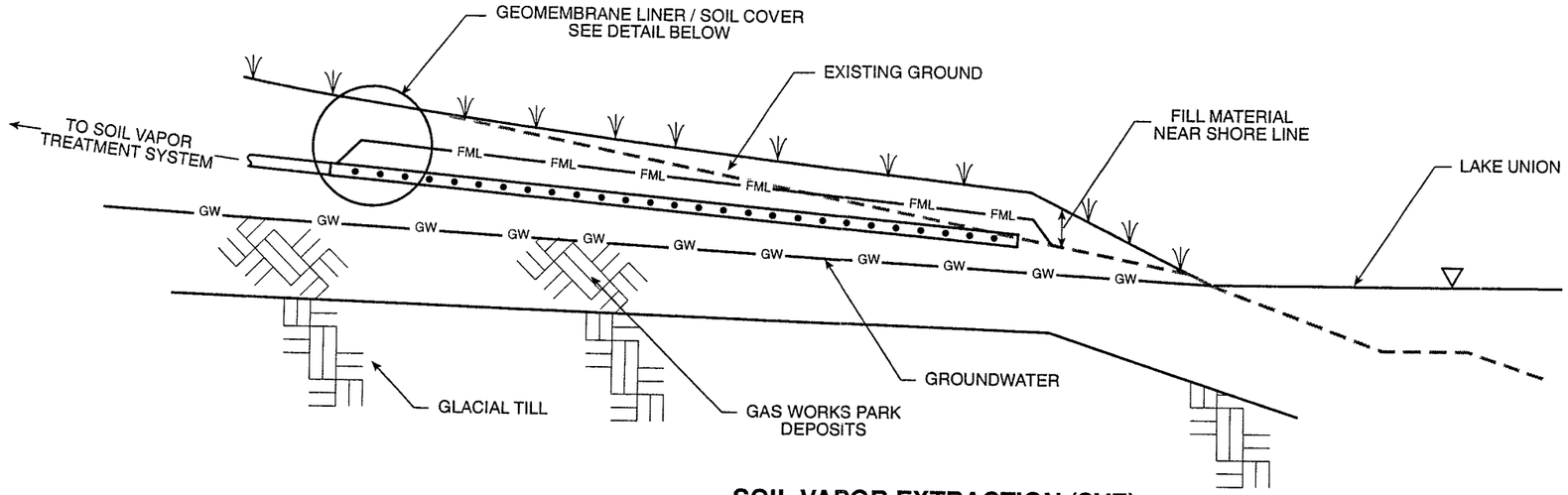
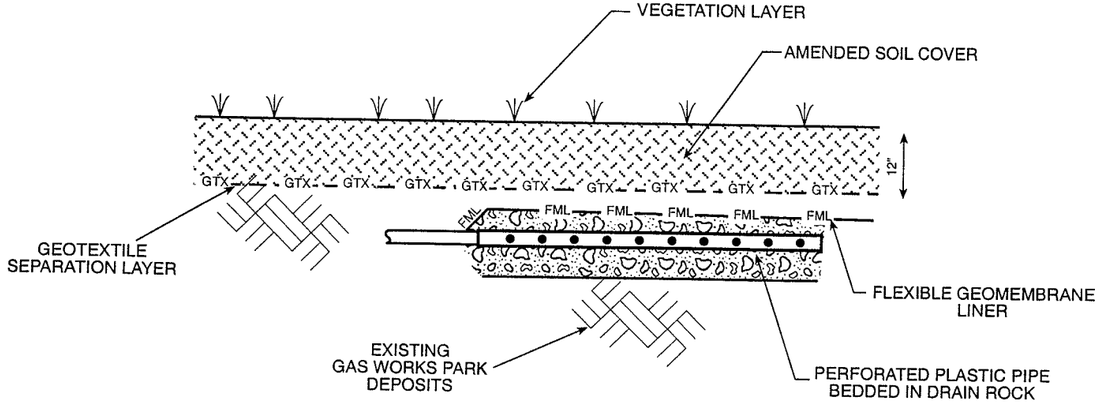


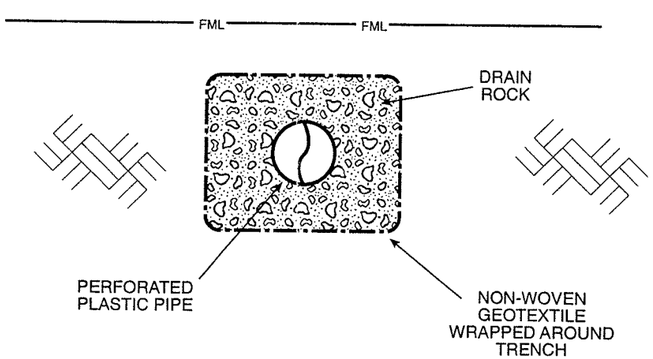
Figure 4-2.
Proposed Air Sparging System Detail
Gas Works Park



**SOIL VAPOR EXTRACTION (SVE)
SECTION**



**SVE TRENCH, LINER,
AND COVER SOIL
DETAIL**



**SVE TRENCH
END VIEW**

Gasworks Park/55-2175-06(301) 7/99

Glacial Till
Gas Works Deposit
Amended Soil Cover
Drain Rock

FML — Flexible Geomembrane Liner
GTX — Composite Geotextile Separation Layer
Existing Ground
GW — Groundwater

Final Grade / Vegetation Layer
Perforated Plastic Pipe
Solid Wall Plastic Pipe
Non-woven Geotextile

NOT TO SCALE

**Figure 4-3.
Proposed Soil Cover and Soil Vapor Extraction (SVE) System Detail
Gas Works Park**

SVE System

Vapors that are mobilized by air sparging will be controlled by the SVE system, which consists of collection piping and a gas extraction blower. As shown on Figures 4-2 and 4-3, perforated pipe will be placed in gravel-filled trenches. The trenches and piping will be installed directly beneath the geomembrane cover and within the existing Gas Works soil deposits. As shown on the site layout (see Figure 4-1), approximately five trenches will be constructed, running parallel with the air sparging lines. The piping manifold will be connected to the extraction blower, which will pull a slight vacuum beneath the cover and remove gases from the soil. The SVE system, in combination with the cover system, will remove BTEX vapors from the vadose zone and prevent soil gas from migrating to the atmosphere.

Geomembrane Cap

To ensure that the vapor extraction system does not simply pull air from the atmosphere above the trenches, a low-permeability cover must be installed over the entire area of influence. The Park air sparging/SVE system will use a geomembrane liner system, consisting of an HDPE liner and geonet drainage system. The advantages of the geomembrane plastic cover versus clay are low profile (the geomembrane and geonet together are less than ½ inches thick), extremely low permeability, ease of construction, and lower cost. The geonet consists of an open ¼-inch-thick HDPE net that can drain as much water as 18 inches of free-draining gravel. The geonet will drain water that has infiltrated through the overlying clean cover soil. The water flowing off of the geonet will drain to the lower edge of the geomembrane and enter drain rock at the edge of Lake Union. The vegetated cover soil described in Section 4.1.2 will cover the geomembrane/geonet composite as well as the surrounding soils. The geotextile element of the vegetated cover soil will prevent clogging of the geonet.

Soil Vapor Treatment

Soil vapor collected by the SVE system will be piped through a treatment unit located with the blowers on a mechanical equipment pad (Figure 4-1). Soil vapor treatment options to be considered include oxidizers (catalytic, thermal, or electric), biofilters, and carbon.

Monitoring

A number of parameters will be tested to monitor the performance of the air sparging/SVE system. Performance parameters include BTEX concentration, dissolved oxygen (DO), water table elevation, and soil gas vacuum from the SVE system. The unsaturated zone will also be monitored for vacuum pressure to verify that the SVE system is successfully containing and preventing soil vapors from migrating to the atmosphere.

4.1.2 Soil Cover

The proposed cleanup action for the Park includes placing a new vegetated soil cover over unpaved open areas in the north-central and southeastern portions of the park (about 5.7 acres), as shown on

Figure 4-1. These areas of the Park experience heavy use and show signs of erosion and soil wear. The vegetated soil cover will be at least 12 inches thick and separate Park users from the chemicals of concern in existing surficial soils. The new vegetated soil cover will consist of (from top to bottom):

- Grass turf vegetation layer,
- 12 inches of sandy loam topsoil, and
- Geotextile fabric.

The vegetated soil cover will be compatible with the air sparging/SVE system described in Section 4.1.1 and will be placed over the partial geomembrane cap. A typical section of the vegetated soil cover is shown on Figure 4-3.

The grass turf vegetation layer will be a blend of grass seed mixes as approved by the City. The seed mix will be a durable blend capable of withstanding the heavy use associated with the Park in dry late-summer weather. The vegetation layer will minimize surface erosion and improve Park aesthetics. The vegetation layer will be the first layer of separation between Park users and the surficial soils; therefore, the vegetation layer will be a primary contributor to the effectiveness of the soil cover system.

The 12-inch sandy loam soil layer will be a free-draining soil that supports the vegetation layer. The free-draining nature of the soil will minimize surface erosion, improve the vegetation layer sustainability by resisting soil compaction from the heavy Park use, and enhance oxygen transfer to the underlying soils. The top 6 inches of the soil layer will be amended with organic material and approved fertilizers consistent with existing City specifications. The amendments will be tilled into the top 6 inches after soil placement and will enhance the establishment of a sustained vegetation layer.

A nonwoven geotextile layer will be placed over the existing Park deposits before soil placement. The geotextile will physically separate the existing soils from the overlying vegetative soil layer, and thus eliminate commingling of these soils. The geotextile will also provide a visual barrier that will alert maintenance workers or others if the vegetative soil layer has been compromised. The geotextile will not be installed near any existing Park vegetation, and the final design will ensure that both existing and proposed vegetation are not adversely affected by geotextile placement.

Before the soil cover is placed, the existing soil surface must be prepared. This subgrade preparation will consist of minor site grading to correct surface water problems (such as ponding or erosion), installation of surface water drainage structures and piping, and installation of irrigation mainlines and some laterals. Also, existing grass and herbaceous vegetation will be removed or, at a minimum, sprayed with an appropriate herbicide to prevent growth through the new soil cover, and the surface will be scarified to enhance air infiltration into the soil. Measures will be taken to ensure that the vegetative cover soil effectively blends with the surrounding vegetated and paved areas. The transition areas will be excavated and tapered so that a berm is not formed at the transition edge that could collect surface water or present a tripping hazard. Contaminated soils encountered during subgrade preparation will be stockpiled, tested, and manifested for off-site disposal.

4.2 COMPLIANCE MONITORING

Chapter 173-340-410 WAC specifies the following types of compliance monitoring regarding cleanup actions:

- Protection monitoring: Confirm that human health and the environment are adequately protected during construction, operation, and maintenance of the cleanup action

- Performance Monitoring: Confirm that the cleanup action has attained cleanup standards and other appropriate performance standards.

- Confirmational Monitoring: Confirm the long-term effectiveness of the cleanup action once cleanup standards and other appropriate performance standards have been attained.

A compliance monitoring plan will be prepared as part of the cleanup action design report submittal. This plan will address compliance monitoring for soil, groundwater, surface water runoff, waste materials, and construction work environment, and will include a Sampling and Analysis Plan (SAP) and data analysis procedures that meet requirements specified in Chapter 173-340-820 WAC. Compliance monitoring anticipated for the Park site is described in the following sections.

4.2.1 Soil

During construction of the soil cover and air sparging/soil vapor extraction system, excavated soils will be stockpiled and tested to determine off-site disposal or recycling options. After the cover is in place, the condition of the cover will be checked on a regular basis by Park maintenance crews, and an irrigation plan will be developed to ensure the viability of the turf. Soil generated during any future Park construction projects will be stockpiled and characterized for off-site disposal or recycling (see Section 7).

4.2.2 Water

No dewatering of groundwater is anticipated during construction of the cleanup action. Controls will be established during construction to divert clean surface water runoff away from the construction area and prevent discharges from the work area. After the construction has been completed, a network of monitoring wells will be established over the Park area, including installation of new monitoring wells to supplement the existing well network. The monitoring well locations, testing frequency, and chemical parameters will be specified in the SAP.

4.2.3 Waste Materials

Waste materials encountered during construction will be managed in the same manner as soils, as described in Section 4.2.1.

5. SUMMARY OF NON-SELECTED CLEANUP ACTIONS AND JUSTIFICATION FOR THE PROPOSED CLEANUP ACTION

5.1 EVALUATION CRITERIA

Requirements for evaluating and selecting cleanup actions under MTCA are specified in Chapter 173-340-360 WAC. Criteria to be used in this process are summarized as follows:

- Meet threshold requirements:
  - Protection of human health and the environment
  - Compliance with MTCA cleanup standards and applicable state and federal laws
  - Provision for compliance monitoring

- Use permanent solutions to the maximum extent practicable:
  - Technology preference for cleanup of contamination (in order of decreasing preference):
    1) Reuse or recycling
    2) Destruction or detoxification
    3) Separation or volume reduction followed by (1) or (2)
    4) Immobilization
    5) On-site or off-site disposal at a permitted facility
    6) Isolation or containment with engineering controls
    7) Institutional controls and monitoring
  - Short-term and long-term effectiveness
  - Implementability

- Provide for a reasonable restoration time frame

- Possess a cost that is proportionate to the incremental degree of protection achievable over a lower preference cleanup action

5.2 COMPARATIVE EVALUATION AND SELECTION OF RECOMMENDED ALTERNATIVE

The five remedial action alternatives described in the FFS were compared with respect to the MTCA criteria, as shown in Table 5-1. On the basis of this analysis, Alternative 3 (air sparging with soil vapor extraction, partial geomembrane cap, and soil cover) was selected as the recommended cleanup action alternative. The rationale for this selection is summarized as follows:

- Alternative 1 (no action) is not acceptable, because it does not meet cleanup levels for soil or groundwater and provides no mitigation of potential benzene impacts from groundwater to Lake Union. Although the interim action (described in Section 2 of this report) was implemented to remove recoverable benzene oil, residual benzene in the soil pores and dissolved in groundwater greatly minimize the potential for natural attenuation to decrease benzene concentrations in the long term, resulting in an indefinite restoration time frame.

Table 5-1. Comparison of cleanup action alternatives.

Alternatives	Evaluation Factors					
	Permanence					
	Threshold Criteria	Technology Preference (Rank with Respect to 7 MTCA Preferences)	Effectiveness and Implementability	Restoration Time Frame	Park Use Compatibility and Public Concerns	Cost
1–No Action	• Acceptable protection of human health • No mitigation of potential benzene impacts from groundwater to Lake Union • Does not comply with cleanup standards or applicable laws • Does not provide compliance monitoring	• 7th (lowest), since only institutional controls will be continued	• Does not meet cleanup levels for soil or groundwater • Low short- and long-term effectiveness • By definition, fully implementable • No reduction of contaminant toxicity, mobility, or volume for impacted soils or groundwater	Not applicable	• No direct effect on current Park use; lack of long-term effectiveness may significantly effect future Park use	$0

Table 5-1. Comparison of cleanup action alternatives (continued).

Alternatives	Evaluation Factors					
	Permanence					
	Threshold Criteria	Technology Preference (Rank with Respect to 7 MTCA Preferences)	Effectiveness and Implementability	Restoration Time Frame	Park Use Compatibility and Public Concerns	Cost
2–Soil Cover	• Soil cover provides high degree of human health protection • Minimal mitigation of potential benzene impacts from groundwater to Lake Union • Complies with cleanup standards and applicable laws for soil only • Provides compliance monitoring	• 6th for containment of impacted soil	• Meets cleanup levels for surficial soil • Will not meet cleanup levels for groundwater for many years • High short- and long-term effectiveness for isolation of the public from impacted soil • Low short- and long-term effectiveness in mitigating potential benzene impacts from groundwater to Lake Union and meeting cleanup action levels for groundwater over time • No reduction of contaminant toxicity, mobility, or volume for impacted soil or groundwater • Highly implementable	• Short for soil • Indefinite for ground-water	• Significant short-term impacts during construction • Full use of Park during O&M period	$2.8M

Table 5-1. Comparison of cleanup action alternatives (continued).

Alternatives	Evaluation Factors					
	Permanence					
	Threshold Criteria	Technology Preference (Rank with Respect to 7 MTCA Preferences)	Effectiveness and Implementability	Restoration Time Frame	Park Use Compatibility and Public Concerns	Cost
3–Air Sparging with Soil Vapor Extraction, Partial Geomembrane Cap, and Soil Cover	• Soil cover provides high degree of human health protection • Air sparging system provides high degree of mitigation of potential benzene impacts from groundwater to Lake Union • Complies with cleanup standards and applicable laws • Provides compliance monitoring	• 2nd for extraction and thermal destruction of benzene source materials • 6th for containment of soil	• Meets cleanup levels for soil and groundwater • High short- and long-term effectiveness for isolation of the public from impacted surficial soils • Moderate short- and long-term effectiveness for mitigation of potential benzene impacts from groundwater to Lake Union • High degree of reduction of contaminant toxicity, mobility, and volume for impacted soils in the soil cover area • Highly implementable	• Short for soil cover • Short to moderate for air sparging	• Significant short-term impacts during construction • Use of area south of Play Barn restricted occasionally during O&M period of air sparging system (approx. 3 yr) • Area of air sparging system restricted from future Park development during O&M period (approx. 3 yr)	$3.6M

Table 5-1. Comparison of cleanup action alternatives (continued).

Alternatives	Evaluation Factors					
	Permanence					
	Threshold Criteria	Technology Preference (Rank with Respect to 7 MTCA Preferences)	Effectiveness and Implementability	Restoration Time Frame	Park Use Compatibility and Public Concerns	Cost
4–Downgradient Cut-Off Wall and Soil Cover	• Soil cover provides high degree of human health protection • Cut-off wall provides high degree of mitigation of potential benzene impacts from groundwater to Lake Union • Complies with cleanup standards and applicable laws • Provides compliance monitoring	• 6th for containment of soil, benzene source materials, and benzene-impacted groundwater	• Meets cleanup levels for surficial soils and groundwater • High short- and long-term effectiveness for isolation of the public form impacted soil • Moderate short-term and high long-term effectiveness for mitigation of potential benzene impacts from groundwater to Lake Union • No reduction of contaminant toxicity, mobility, and volume for impacted soil • Impacted groundwater: high degree of reduction in contaminant mobility; moderate degree of reduction in contaminant toxicity and volume • Highly implementable	• Short for surficial soil cover • Moderate to long for cut-off wall	• Significant short-term impacts during construction • Full use of Park during O&M period • Area of cut-off wall restricted from future Park development during long restoration period	$4.3M

Table 5-1. Comparison of cleanup action alternatives (continued).

Alternatives	Evaluation Factors					
	Permanence					
	Threshold Criteria	Technology Preference (Rank with Respect to 7 MTCA Preferences)	Effectiveness and Implementability	Restoration Time Frame	Park Use Compatibility and Public Concerns	Cost
5–Excavation of Surficial Soils and Benzene Source with Off-Site Disposal	• Excavation of impacted soil provides high degree of human health protection • Long-term reduction in benzene concentrations in groundwater provide moderate to high degree of mitigation of potential benzene impacts from groundwater to Lake Union • Complies with cleanup standards and applicable laws • Provides compliance monitoring	• 5th for off-site disposal of surficial soils and benzene source materials	• Meets cleanup levels for soil • Meets cleanup action levels for groundwater in the long-term • High short- and long-term effectiveness for removal of impacted soil • Low short-term and moderate to high long-term effectiveness for mitigation of potential benzene impacts from groundwater to Lake Union • Potential toxicity reduction of impacted soil via off-site treatment • Moderate to high degree of reduction in toxicity, mobility, and volume of impacted groundwater in the long-term	• Short for soil removal • Moderate to long for groundwater	• Significant short-term impacts during construction • Full use of Park during O&M period	$19.9M

- Alternative 2 (soil cover) meets cleanup levels for soil. However, this alternative will not meet cleanup action levels for groundwater and provides no mitigation of potential impacts from groundwater to Lake Union, for the same reasons described above for Alternative 1.

- Alternative 3 (air sparging with soil vapor extraction, partial geomembrane cap, and soil cover) is the recommended cleanup alternative, because it meets cleanup levels in a short time frame and for a cost that is proportionate to the degree of protection to human health and the environment (with respect to the other alternatives).

- Alternative 4 (downgradient cutoff wall) meets cleanup levels for soil and groundwater, but applies a lower technology preference, has only a moderate short-term effectiveness, and requires a longer restoration time frame, at a cost exceeding that of Alternative 3.

- Alternative 5 (excavation of unsaturated soil and benzene source with off-site disposal) provides high long-term effectiveness with respect to removal of impacted unsaturated soil and residual benzene source material in saturated soil but at a cost that is about 5.5 times that of Alternative 3. The incremental cost of this option is substantial and disproportionate to the incremental degree of protection that it would achieve over a cleanup action of equal or lower preference.

6. IMPLEMENTATION SCHEDULE

Figure 6-1 presents the planned implementation schedule for the proposed cleanup action described in Section 2. The final design of the cleanup actions will begin with approval of the final Cleanup Action Plan. Construction will begin after final design, contract document (plans and specifications) preparation, and contract bidding.

The items presented as design and construction of cleanup systems include: the air sparging/soil vapor extraction system and impermeable geomembrane cap; subgrade preparation and incidental hot spot removal; and cover soil placement (geotextile, soil, irrigation system, hydroseeding, and surface water management). Post-cleanup monitoring and maintenance will begin immediately after construction is complete.

All durations shown in the proposed implementation schedule are approximate, and are based on information available as presented in this report. Since final design of the cleanup action is yet to be completed, the exact nature of these systems and therefore the time required to implement them cannot be known at this time. The ultimate implementation schedule will therefore be different from the target schedule presented in Figure 6-1.

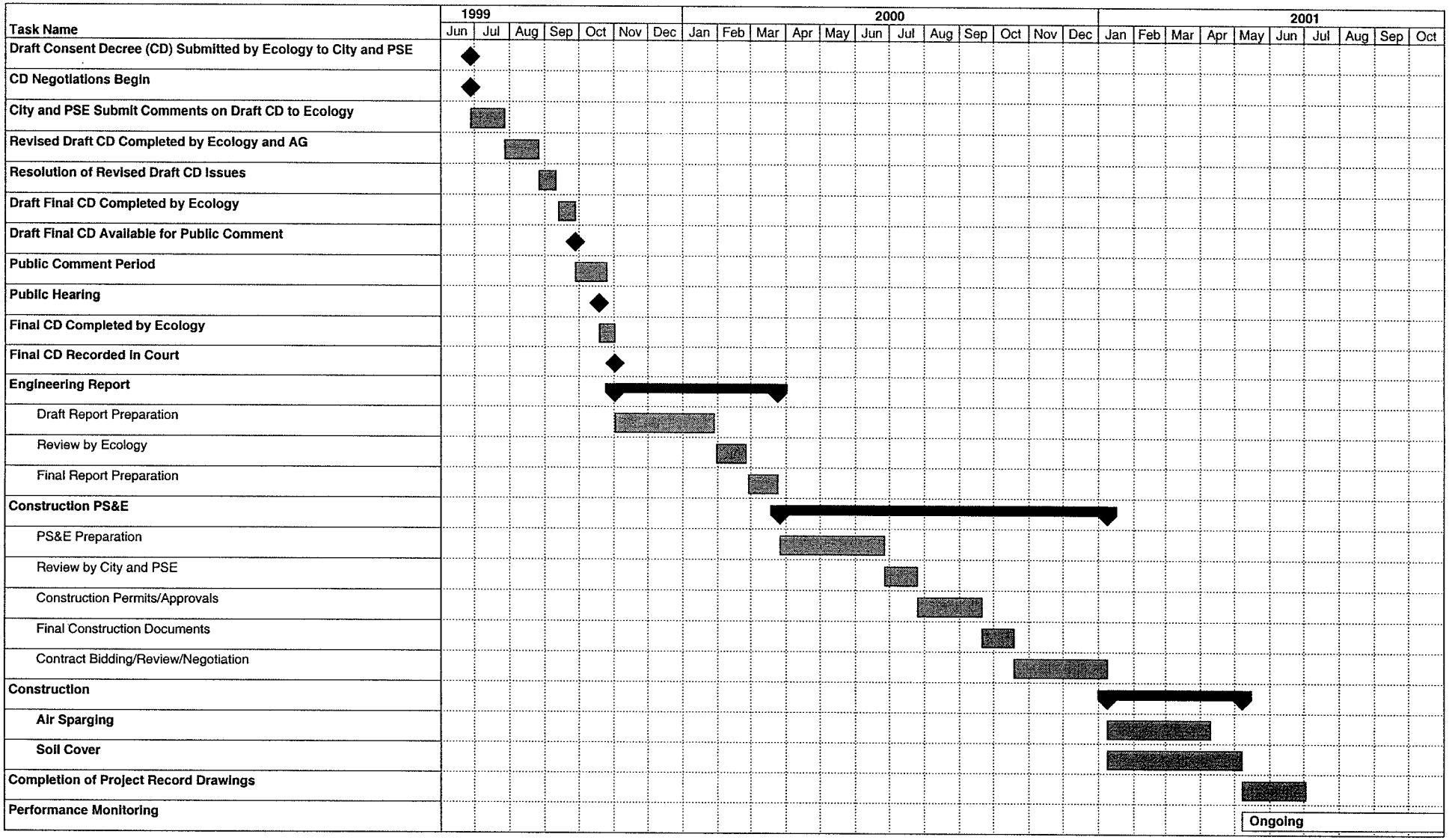


Figure 6-1. Preliminary Implementation Schedule for Gas Works Park Cleanup Action

7. INSTITUTIONAL CONTROLS AND SITE USE RESTRICTIONS

Institutional controls, as defined by Chapter 173-340-440(1), are measures undertaken to limit or prohibit activities that may interfere with the integrity of a cleanup action, or result in exposure to hazardous substances at the site. Institutional controls are incorporated into the cleanup action proposed for the Park because residual concentrations of hazardous substances in soil and groundwater will remain at the site after cleanup action implementation, as described in Section 11 of this Cleanup Action Plan. The following institutional controls will be incorporated into the proposed cleanup action for the Park:

Physical Measures

- Maintenance and improvement (as necessary) of existing fencing around the cracking towers and the northwest area of the Park;
- Inspection and maintenance of the soil cover system; and
- Maintenance and improvement (as necessary) of existing warning signs in place at the Park. These signs warn users not to eat dirt, drink water from Lake Union, wade in Lake Union, or swim in Lake Union.

Restrictive Covenant for the Park and Harbor Patrol Properties

- Restriction of activities that could disturb soils or shallow groundwater at the Park;
- Procedures to be followed for Park projects that may disturb soil or groundwater (such as development of contingency plans for characterization and disposal or hazardous substances);
- Prohibition of extraction of shallow groundwater beneath the site for purposes other than remediation; and
- Construction requirements for any deep wells or borings that might penetrate the glacial till layer, to prevent introduction of shallow contamination into deeper groundwater zones.

8. JUSTIFICATION FOR SELECTING LOWER PREFERENCE CLEANUP TECHNOLOGIES

Chapter 173-340-360(4) WAC specifies that cleanup technologies for hazardous substances applied in cleanup actions are to be considered in the following order of decreasing preference:

(1) Reuse or recycling;

(2) Destruction of detoxification;

(3) Separation of volume reduction, followed by reuse, recycling, reduction, or detoxification;

(4) Immobilization;

(5) On-site or off-site disposal at an engineered facility designed to minimize future release of hazardous substances and in accordance with applicable state and federal laws;

(6) Isolation or containment with attendant engineering controls; and

(7) Institutional controls and monitoring.

The components of the proposed cleanup action at the Park that utilize lower preference cleanup technologies are the containment of contaminated soils throughout the Park, and the use of institutional controls and monitoring to address tar-impacted soil and groundwater beneath the western part of the Park and the Harbor Patrol site (sixth and seventh of the seven preferences, respectively). The proposed air sparging and soil vapor extraction components of the proposed cleanup action utilize high-preference technologies (reuse/recycling and destruction/detoxification). The justification for the cleanup technologies applied in the proposed cleanup action is described in Section 14 of the Focused Feasibility (FFS) report.

As discussed in the FFS report, investigations conducted at the Park from the early 1970s to the present indicate that most of the Park was filled with varying thicknesses of materials derived from the former manufactured gas plant operation (including waste debris containing hazardous materials). Most of these soils exceed MTCA Method B soil cleanup levels for the chemicals of concern identified in the FFS report (arsenic and polynuclear aromatic hydrocarbons [PAHs]). The FFS report concluded that cost of removal and off-site disposal of contaminated soils at the Park is substantial and disproportionate to the incremental degree of protection provided by this alternative (per Chapter 173-340-360(5)(vi) WAC), in comparison to the proposed combination containment with a soil cover and by institutional controls.

The FFS report also concluded that tar impacts on soil and shallow groundwater beneath upland areas in the western part of the Park and the adjacent Harbor Patrol property are mitigated by natural attenuation processes and do not result in exceedances of groundwater cleanup action levels at the points where groundwater discharges to Lake Union. The tar-impacted soils above the water table are contained by soil cover or paving. Tar that migrated downward through the shallow groundwater zone has moved along the surface of the low-permeability glacial till to depths below the bottom of Lake Union, such that the tar is isolated from the Lake. The glacial till also prevents

the tar from moving downward into deeper groundwater zones. Application of institutional controls to soil and groundwater in the area of the tar impacts will prevent future activities from causing contact of tar-impacted soil or groundwater with humans or the environment.

9. COMPLIANCE WITH APPLICABLE STATE AND FEDERAL LAWS

This section describes the state and federal laws that were determined by the FFS as applicable to the proposed cleanup action selection at the Park. Chapter 173-340-710 (b)(2) WAC specifies that site cleanup actions shall comply with "applicable state and federal laws". This term is interpreted to include legally applicable requirements and those requirements that are relevant and appropriate. Legally applicable requirements include those cleanup standards, standards of control, and other environmental protection requirements, criteria, or limitations promulgated under Federal or State law that specifically address a hazardous substance, contaminant, remedial or cleanup action, location, or other situation at the site. Relevant and appropriate requirements are those promulgated under Federal and State law that are not directly applicable, but still address problems or situations sufficiently similar to those encountered at the site that their use is well suited to the particular site.

Applicable requirements are determined on a case-by-case basis for each cleanup site. Ecology makes the final interpretation as to whether these requirements are correctly identified and are legally applicable or relevant and appropriate. The applicable state and federal laws described in Table 9-1 were considered in the development of cleanup levels for the Park.

Table 9-1. Summary of state and federal laws potentially applicable to cleanup actions at Gas Works Park.

Statute/Regulation	Requirements	Discussion
City of Seattle Building Code *Citation* Section 3.06.040 SMC	Local ordinances implement codes and standards for all construction activities.	Plan review and building permit not required, but planned facilities must meet substantive requirements of applicable codes.
Federal Clean Air Act: New Source Performance Standards, National Emission Standards for Hazardous Air Pollutants, National Ambient Air Quality Standards *Citation* 42 USC 7401-7642 40 CFR Subpart 50, 60, 61, 63	Establishes program for source registration and fee payment to restrict emissions, use Best Available Control Technology, and ensure compliance with air quality standards.	Emissions to the atmosphere will comply with substantive requirements of these regulations; however, source registration is not required per MTCA exemption.
Federal Resource Conservation and Recovery Act (RCRA) *Citation* 42 USC 6902 et seq	Requires permits for facilities that treat, store, or dispose of hazardous waste.	Hazardous/dangerous waste generated during Park cleanup will be manifested only to permitted disposal facilities.
Federal Safe Drinking Water Act *Citation* 42 USC 300f et seq 40 CFR 141,143	Defines Maximum Contaminant Levels:	Neither shallow groundwater zone beneath the Park nor Lake Union are usable for water supply.
Federal Water Pollution Control Act (aka Clean Water Act), National Pollutant Discharge Elimination System (NPDES) *Citation* 33 USC Sec. 303, 304 40 CFR Part 122, 125	Establishes State permit program for discharge of pollutants and wastewater to surface waters. Requires all known, available and reasonable methods of treatment (AKART).	No such discharges are planned at the Park.
Federal Water Pollution Control Act (aka Clean Water Act), Surface Water Quality Standards *Citation* 33 USC Sec. 303, 304 40 CFR 131. Qlty Criteria for Water (EPA, 1986, rev. 1987)		Same as above.

Table 9-1. Summary of state and federal laws potentially applicable to cleanup actions at Gas Works Park (continued).

Statute/Regulation	Requirements	Discussion
State Water Pollution Control Act, NPDES Regulations *Citation* RCW 90.48 WAC 1773-220		Same as above.
State Water Pollution Control Act, Water Quality Standards for Surface Water *Citation* RCW 90.48 WAC 173-201		Same as above.
Federal Water Pollution Control Act (aka Clean Water Act) *Citation* 33 USC 1251-1387 33 CFR 320-330 40 CFR 230	Add	Add
State Shoreline Management Act (1971) *Citation* RCW 90.58 WAC 173-27	Establishes permit program for activities performed within 200 ft of shoreline (including wetlands).	Construction activities will comply with substantive requirements of these regulations; however, permit not required per MTCA exemption.
Puget Sound Air Pollution Control Agency (PSAPCA) *Citation* Regulation III		See Federal Clean Air Act.
State Clean Air Laws: Controls for Air Toxics (Air Quality Standards) *Citation* RCW 70.94 WAC 173-460	Air quality standards for toxics:	See Federal Clean Air Act.
State Environmental Policy Act (SEPA) *Citation* RCW 43.21C WAC 197-11	Requires submittal of checklist describing environmental impacts of proposed projects, public notice, and possibly additional project analyses and public involvement.	SEPA checklist is submitted with CAP.

Table 9-1. Summary of state and federal laws potentially applicable to cleanup actions at Gas Works Park (continued).

Statute/Regulation	Requirements	Discussion
State Hazardous Waste Management Act *Citation* RCW 70.105		
Definition/generation of hazardous/dangerous waste *Citation* 40 CFR 261, 262, 264 WAC 173-303-070 through 110	Defines threshold levels and criteria to determine whether materials are hazardous/dangerous wastes.	Dangerous/hazardous waste generated during Park cleanup will comply with these regulations.
Transportation of hazardous/dangerous waste *Citation* 40 CFR 263 29 CFR WAC 446-50	Defines requirements for off-site transportation of waste.	Proper transportation of waste off-site will be conducted.
Disposal Requirements and Land Disposal Restrictions **Solid Waste Disposal Facilities** *Citation* 40 CFR 268 WAC 173-303-140	Defines pre-treatment and land disposal restrictions for certain wastes	Proper disposal of hazardous/dangerous wastes off-site will occur. Wastes probably will not require additional treatment.
State Hydraulics Act *Citation* RCW 75.20 WAC 220-110	Establishes permit program under Dept. of Wildlife/Fisheries for projects that may change natural flow of "waters of the state."	Construction activities will comply with substantive requirements of these regulations; however, permit not required per MTCA exemption.
State Model Toxics Control Act *Citation* RCW 70.105D.090	Defines hazardous waste cleanup policies. Actions conducted under consent decree are exempt from the procedural requirements or RCW 70.94, 70.95, 70.105, 75.20, 90.48, and 90.58 and the procedural requirements of any laws requiring or authorizing government permits or approvals for remedial actions. Action shall comply with substantive requirements adopted pursuant to such laws and shall consult with government agencies charged with implementing such laws.	FFS and CAP for the park were performed under Agreed Order. Cleanup activities will comply with substantive requirements.

Table 9-1. Summary of state and federal laws potentially applicable to cleanup actions at Gas Works Park (continued).

Statute/Regulation	Requirements	Discussion
State Model Toxics Control Act ***Citation*** RCW 70.105D WAC 173-340-720	Soil and groundwater cleanup levels	Method B cleanup levels applied to the Park
State Water Quality Standards for Groundwaters ***Citation*** WAC 173-200	Groundwater Quality Standards	Shallow groundwater at the Park is not a current or future source of drinking water.

10. COMPLIANCE WITH MTCA REQUIREMENTS

The cleanup levels will be met at the specified points of compliance by the proposed cleanup actions to be implemented at Gas Works Park, and human health and the environment will be protected. The following discussion relates the analysis and evaluations presented in this Cleanup Action Plan to the requirements for selection of cleanup actions contained in WAC 173-340-360. This discussion is presented in order to show that the minimum requirements of MTCA will be met by the proposed cleanup actions.

10.1 THRESHOLD REQUIREMENTS

The proposed cleanup action must comply with the MTCA threshold requirements (WAC 173-340-360(2)). The four threshold requirements are listed and addressed below:

10.1.1 Protect Human Health and the Environment

Each action proposed for Gas Works Park environmental cleanup has been evaluated for protection of human health and the environment. Ecology has determined that the proposed cleanup actions meet this first threshold requirement.

10.1.2 Comply with Cleanup Standards

The proposed actions comply with the cleanup standards summarized in Section 3 of this CAP.

10.1.3 Comply with State and Federal Laws

Compliance with applicable state and federal laws has been determined for the proposed cleanup actions through the detailed analysis presented in Section 9 of the FFS report and Sections 8 and 9 of this CAP.

10.1.4 Provide Compliance Monitoring

The compliance monitoring program is described in Section 4.2 of this CAP.

10.2 OTHER REQUIREMENTS

The proposed cleanup action must also comply with other requirements listed in WAC 173-340-360(3). The three other requirements are listed and addressed in the following sections.

10.2.1 Use Permanent Solutions

WAC 173-340-360(5)(d) states that "Ecology recognizes that permanent solutions may not practicable for all sites," and proceeds to list seven criteria that should be used to determine whether a cleanup action is "permanent to the maximum extent practicable." The seven criteria are listed and addressed below for the proposed cleanup actions:

1. **Overall protectiveness of human health and the environment.** The proposed cleanup actions will meet the cleanup standards for soils and groundwater over time within a reasonable restoration time-frame.

2. **Long-term effectiveness.** The actions provide a highly effective long-term solution for impacted soil using well-established means of containment. The air sparging/soil vapor extraction system provides an effective long-term solution by reducing benzene levels in groundwater over the operating life of the system.

3. **Short-term effectiveness.** Once installed, the actions provide a highly effective short-term solution for soil using well-established means of containment. During construction, effective controls will be in place to reduce potential for migration of contaminants from the site to air or surface water. The air sparging/soil vapor extraction system will gradually increase the net removal of contaminants and reduce benzene levels over the operating life of the system.

4. **Permanent reduction of toxicity, mobility, and volume of the hazardous substance.** The cleanup actions, especially air sparging and soil vapor extraction, actively remove contamination from the groundwater and soil and prevent or minimize present and future releases of the contaminants.

5. **Ability to be implemented.** All of the technologies used in the proposed cleanup actions are proven and effective means of removal or containment. Offsite treatment and disposal facilities are well established in the northwest for any contaminated materials that need to be removed offsite. The services and materials are readily available in the Seattle area, and the size and complexity of the project are well within the means of area contractors. Construction will cause short-term disruptions to current park activities, but the long-term operation and maintenance of the cleanup activities will be fully compatible with continued park use.

6. **Cleanup costs.** Cleanup costs for the proposed cleanup actions are not substantially greater than costs for the lower-preference cleanup action alternative 2 (soil cover only), are less than costs for alternative 4 (downgradient cut-off wall), and are much less than the costs for contaminant source excavation and off-site disposal.

7. **The degree to which community concerns are addressed.** The cleanup actions address community concerns, especially with regards to prevention of public contact with soil and groundwater contamination, and restoration of the Park for public use after construction of the cleanup action.

Based upon these evaluations and the supporting analysis contained in the FFS, the proposed cleanup actions will meet the requirements of WAC 173-340-360(5)

WAC 173-340-360(5)(e) lists requirements intended to ensure a bias toward permanent solutions. The five requirements are listed and addressed below:

1. **The cleanup action shall prevent or minimize present and future releases and migration of hazardous substances in the environment.** The cleanup actions, especially air sparging and soil vapor extraction, actively remove contamination from the groundwater and soil and prevent or minimize present and future releases of the contaminants. The soil cover greatly minimizes potential exposure of the public to soil and groundwater contaminants.

2. **The cleanup action shall provide for a net reduction in the amount of a hazardous substance being released from the source area.** The cleanup action of air sparging and soil vapor extraction reduces the amount of hazardous substances available for release, and the geomembrane cap over the air sparging system further reduces surface water infiltration and thus groundwater flux from the contaminant source area.

3. **The cleanup action shall not rely primarily on dilution and dispersion of the hazardous substance if active remedial measures are technically possible.** Active remedial measures are being taken to reduce the amount of hazardous substances in the source area and surrounding soils. Thus the cleanup action does not rely on dilution and dispersion.

4. **A cleanup action relying primarily on institutional controls and monitoring shall not be used where it is technically possible to implement a cleanup action alternative that utilizes a higher preference cleanup technology for all or a portion of the site.** The cleanup action does not rely primarily on institutional controls and monitoring.

5. **A cleanup action involving off-site transport and disposal of hazardous substances without treatment shall not be used if a treatment technology or method exists which will attain cleanup standards and is practicable.** Off-site transport and disposal of hazardous substances is minimized. The air sparging and soil vapor extraction system will treat on-site contaminated materials to cleanup standards. Materials that are transported off-site will be treated as appropriate before land disposal at an appropriate landfill (soils) or recycled as supplementary fuel (benzene, etc.).

10.2.2 Provide Reasonable Restoration Time Frame

Factors considered when establishing a reasonable restoration time frame include potential risks posed by the site to human health and the environment; the practicability of achieving a shorter restoration time; current and future use of the site, surrounding areas, and associated resources; availability of alternative water supplies; likely effectiveness and reliability of institutional controls; ability to control and monitor migration of hazardous substances from the site; toxicity of the hazardous substances at the site; and natural processes which reduce concentrations of hazardous substances and have been documented to occur at the site or under similar site conditions. Additionally, a longer period of time may be used for the restoration time frame for a site to achieve cleanup levels at the point of compliance if higher preference cleanup

technologies are used. The permanent destruction of contaminants by the air sparging/SVE remedial action is such a higher preference technology.

Modeling shows that, following treatment by air sparging/SVE, surface water criteria will be met within 2 to 27 years. The variation of restoration time frames depends primarily of the oxygen content of the aquifer. This cannot be accurately predicted before implementation of the air sparging/SVE remedial action and must be measured afterwards.

10.2.3 Consider Public Concerns

Concerns expressed by the public to date (preventing contact of soil and groundwater contamination with Park users; restoring the Park to a usable condition after construction of the cleanup action) are addressed by the proposed cleanup action. Additional public concerns presented during the public comment period will be addressed by a responsiveness summary and submitted with the final Park environmental cleanup documents.

11. MANAGEMENT OF HAZARDOUS SUBSTANCES REMAINING ON THE SITE

As described in previous sections of this Cleanup Action Plan, the proposed cleanup action for the Park utilizes containment and institutional controls to protect human health and the environment from hazardous substances that will remain at the site. The hazardous substances in soil and groundwater were summarized in Tables 3-1 and 3-2, which include chemical names, maximum detected concentrations, and applicable cleanup levels. The hazardous substances remaining in place at the Park will be managed by means of the compliance monitoring described in Section 4.2 and the containment measures and institutional controls described in Section 7 of this Cleanup Action Plan, such that migration and contact with these substances will be prevented.

12. REFERENCES

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APPENDIX A

STATE ENVIRONMENTAL POLICY ACT (SEPA) ENVIRONMENTAL CHECKLIST

STATE ENVIRONMENTAL POLICY ACT (SEPA)
ENVIRONMENTAL CHECKLIST

A. BACKGROUND

1. Name of proposed project, if applicable:

Gas Works Park Environmental Cleanup

2. Name of applicant:

City of Seattle and Puget Sound Energy

3. Address and phone number of applicant and contact person:

Ms. Robin Kordik
City of Seattle, Department of Parks and Recreation
2911 2nd Avenue, 4th Floor
Seattle, Washington 98121-1079
Telephone: (206) 233-7938

Mr. Steven Secrist, Director of Environmental Services
Puget Sound Energy
815 Mercer Street MER-4
Seattle, Washington 98111
Telephone: (206) 224-2353

4. Date checklist prepared:

October 30, 1998

5. Agency requesting checklist:

Washington State Department of Ecology

6. Proposed timing or schedule (including phasing, if applicable):

Construction is scheduled to occur over a seven-month period in the spring and summer of 2000. Construction will occur in two phases. Installation of the air sparging system will begin around March 1 through and completed before July 4. After installation, the air sparging system will operate continuously until targeted cleanup levels have been achieved, an estimated period of three years. Installation of the soil cover will begin after July 4 and be completed by October 1.

7. Do you have any plans for future additions, expansion, or further activity related to or connected with this proposal? If yes, explain.

There are no plans for future additions, expansions, or activity related to this proposal except for ongoing operations, and environmental and performance monitoring.

8. List any environmental information you know about that has been prepared, or will be prepared, directly related to this proposal.

Gas Works Park Environmental Cleanup, Draft Focused Feasibility Study, October 1998

Gas Works Park Environmental Cleanup, Draft Cleanup Action Plan, October 1998

9. Do you know whether applications are pending for governmental approvals of other proposals directly affecting the property covered by your proposal? If yes, explain.

There are no such applications pending.

10. List any government approvals or permits that will be needed for your proposal, if known.

PSAPCA

Air Contaminant Source Registration/New Source Approval

Washington State Department of Ecology

Temporary Modification of Water Quality Standards Approval

City of Seattle

Clearing and Grading Permit

Shoreline Substantial Development Permit

11. Give brief, complete description of your proposal, including the proposed uses and the size of the project and site. There are several questions later in this checklist that ask you to describe certain aspects of your proposal. You do not need to repeat those answers on this page. (Lead agencies may modify this form to include additional specific information on project description.)

The Gas Works Park site is the former location of a coal and oil gasification plant that operated from 1906 to 1956. Although some of the residues from the gas production process were removed during Park construction, studies conducted in the 1980s indicated that chemicals associated with these residues were present in soils and groundwater beneath the site. The Focused Feasibility

Study (FFS) identified soil and groundwater contaminants at the site in concentrations that exceed cleanup levels specified in the Washington State Model Toxics Control Act (MTCA). These include arsenic and PAHs in existing surface soils, and benzene-contaminated shallow groundwater in the southeast corner of the site.

The proposed project will implement several cleanup technologies to achieve site cleanup. Benzene and other volatile (readily vaporized) and semi-volatile contaminants will be removed from the contaminated shallow groundwater zone using an air sparging and soil vapor extraction system. The air sparging system is a series of vertical wells drilled into the ground that blow air into the saturated soil below the groundwater table. Air bubbling up through the saturated soil will carry benzene and other soil vapors to the unsaturated soil above the water table. The vapors will be collected by the soil vapor extraction (SVE) system. The SVE system consists of a series of horizontal, perforated pipes buried in the ground above the groundwater table and connected to a vacuum system that collects the vapors and draws them into a treatment system. The treatment system has a catalytic oxidizer that uses heat to break down the contaminants to carbon dioxide and water vapor, which are then discharged to the air.

To protect Park users from contact with contaminated soil, a portion of unpaved areas on the site will be covered with a 1-foot-thick layer of clean soil, then reseeded with grass. Any visibly contaminated soil encountered during site preparation will be excavated and removed from the site for appropriate disposal. Refer to the project Cleanup Action Plan (CAP) for more detailed information regarding onsite contamination and the proposed remediation methods.

12. Location of the proposal. Give sufficient information for a person to understand the precise location of your proposed project, including a street address, if any, and section, township, and range, if known. If a proposal would occur over a range of area, provide the range or boundaries of the site(s). Provide a legal description, site plan, vicinity map, and topographic map, if reasonably available. While you should submit any plans required by the agency, you are not required to duplicate maps or detailed plans submitted with any permit applications related to this checklist.

The site is located in central Seattle, between I-5 and Aurora Avenue (Highway 99). The Gas Works Park site street address is: 2000 N. Northlake Way, Seattle, Washington. It is located in Sections 19 and 20, Township 25 North, Range 3 East, City of Seattle, King County, Washington State.

The Park, which covers approximately 20.5 acres, is located on the north shore of Lake Union and is bounded by the following: Northlake Way on the north, Lake Union on the east and south, and City of Seattle Harbor Patrol and Northlake Place on the west.

TO BE COMPLETED BY APPLICANT

B. ENVIRONMENTAL ELEMENTS

1. Earth

a. General description of the site (circle one): Flat, rolling, hilly, steep slopes, mountainous, other _____.

The northern portion of the site is relatively flat, and is separated from the rest of the site by an old railroad grade. Kite Hill is the most prominent topographic feature of the Park, rising about 35 feet above the surrounding land surface. The southeastern part of the site slopes gently toward Lake Union. A large regional upland rises steadily from the Lake Union shoreline to the north, attaining elevations up to 300 ft higher than land surface at the Park.

b. What is the steepest slope on the site (approximate percent slope)?

A maximum slope of 28% occurs on Kite Hill, a 35-foot-high constructed mound of earth located in the southwest portion of the site.

c. What general types of soils are found on the site (for example, clay, sand, gravel, peat, muck)? If you know the classification of agricultural soils, specify them and note any prime farmland.

Exiting near-surface soils and topography on the site are the result of extensive past filling and grading activities. When the gas plant was constructed in the early 1900's, the peninsula upon which it was located was narrower than today. Waste and debris generated during operation of the gas plant were used as fill to extend the plant property more than 100 feet beyond the original shoreline. Additional upland grading and filling occurred during demolition of the gas plant and construction of the Park in the 1960s and 1970s.

Geologic conditions at the site were assessed in detail as part of a cooperative groundwater investigation that was initiated by the USGS and the City in 1986. This investigation involved incorporation of subsurface explorations from the 1970s with data from new monitoring wells and test borings. The geologic framework of the site developed by the USGS indicates that the Park is underlain by the following geologic units:

- A surficial layer of vegetated soil, established after final grading during Park construction; a few inches to a foot thick.
- Soil imported for filling and grading when the Park was constructed; classified as artificial fill; 1 to 5 ft thick, except under Kite Hill, where 50 ft or more may be present.

- A layer of fill and native soil mixed with materials derived from the gas plant operation, including cinders, brick, wood, concrete, lampblack, tar, and various types of oil; classified as the Gas Works deposit; up to 15 ft thick.

- A natural glacial deposit of sand with some clay and gravel, classified as recessional stratified drift; not present under the entire Park, but up to 25 ft thick at some locations.

- A dense, compacted glacial deposit comprised of clay, silt, sand, gravel, and boulders, classified as Vashon till; underlies the entire Park, and was 33 ft thick at the single well location where it was fully penetrated. The till separates the overlying deposits from deeper glacial strata.

d. Are there surface indications or history of unstable soils in the immediate vicinity? If so, describe.

There are no indications or history of unstable soils.

e. Describe the purpose, type, and approximate quantities of any filling or grading proposed. Indicate source of fill.

The air sparging/soil vapor extraction treatment will be installed in the southeast corner of the site (Figure 4-1 of the CAP). To install the treatment system, air sparging wells, constructed of 2-inch diameter steel pipe, will be spaced over the 0.7-acre treatment area. Horizontal trenches will be excavated for installation of the soil vapor collection pipes and backfilled with gravel. An impermeable geomembrane cap will be laid over the entire treatment area to contain soil vapors and promote system efficiency. The area will then be covered with 1 foot of imported soil and seeded with grass. Refer to Section 4.1.1 of the CAP for a more detailed description of air sparging system installation.

To isolate park users from soil contaminants, a soil cover will be placed over the southeast and north central portions of site, with the exception of paved areas, (see Figure 4.1 of the CAP). The area will first be graded to remove the existing lawn cover. The soil cover will consist of a 1-foot-thick layer of imported soil underlain by geotextile fabric. The fabric will provide a barrier for physical migration of underlying materials to the surface and a visual indicator if the soil is later removed (through digging or erosion) and must be replaced. About 5.7 acres will be covered with approximately 9,200 cubic yards of soil. The soil cover will then be seeded with grass.

During grading prior to placement of the soil cover, the potential exists for encountering visibly contaminated soil or waste materials (such as tar). This material will be excavated and hauled offsite for disposal. It is assumed that such incidental "hot spots" will occur over 5% of the area to receive the soil cover, excavated to a depth of 2 feet, and taken offsite. Based on these assumptions, approximately 920 cubic yards of contaminated soil will be removed from the site and replaced with an equal amount of clean fill. Refer to Section 4.1.2 of the CAP for a more detailed description of soil cover installation.

Approximately 10,000 cubic yards of imported soil will be required for the project. The material will be obtained from outside sources. Some soil is currently stockpiled onsite and may be used for the project if determined to be suitable.

f. Could erosion occur as a result of clearing, construction, or use? If so, generally describe.

Approximately 5.7 acres of soil will be exposed during removal of the exiting lawn, excavation and backfilling of "hot spots," and placement of the soil cover. Erosion of exposed soils could occur until vegetative cover is reestablished. Erosion of stockpiled soil also could occur. Excavation and grading of existing contaminated soils has the greatest potential for adverse impacts, particularly because of the site's proximity to Lake Union.

g. About what percent of the site will be covered with impervious surfaces after project construction (for example, asphalt or buildings)?

The project will result in the creation of approximately 2,500 square feet of new impervious surfaces associated with the soil vapor treatment equipment station. All existing impervious surfaces will be retained.

h. Proposed measures to reduce or control erosion, or other impacts to the earth if any:

An erosion and sedimentation plan will be prepared in accordance with City of Seattle standards. Control measures will include:

- Silt fencing to capture construction generated sediments;
- Covering stockpiled material with a waterproof covers;
- Backfilling and seeding excavated and filled areas as soon a possible;
- Combining seed with mulch and tacifier to better retain soil; and
- Completing construction and replanting before October 1.

2. Air

a. What types of emissions to the air would result from the proposal (i.e., dust, automobile, odors, industrial wood smoke) during construction and when the project is completed? If any, generally describe and give approximate quantities if known.

Air quality impacts during the seven-month excavation/construction phase include exhaust emissions and dust generation. Trucks hauling soil to and from the site and construction equipment powered by gasoline and diesel engines will generate carbon monoxide, oxides of nitrogen, and unburned hydrocarbons. Dust will be generated during land clearing, excavation, filling, and grading activities.

Carbon dioxide and water vapor will be emitted from the soil vapor treatment unit during operation of the air sparging/soil vapor extraction system.

No emissions will be generated by the completed project.

b. Are there any off-site sources of emissions or odor that may affect your proposal? If so, generally describe.

There are no off-site emissions or odors that would affect the project.

c. Proposed measures to reduce or control emissions or other impacts to air, if any:

Construction measures:

- Spray exposed soils lightly with water to reduce dust emissions.
- Cover all trucks transporting materials to reduce dust emissions during transportation.
- Provide wheel washers to remove dirt from trucks leaving the site.
- Require appropriate emission-control devices on all construction equipment powered by gasoline or diesel fuel.
- Plant vegetative cover as soon as possible after final grading to reduce windblown particulates in the area.

3. Water

a. Surface

1) Is there any surface water body on or in the immediate vicinity of the site (including year-round and seasonal streams, saltwater, lakes, ponds, wetlands)? If yes, describe type and provide names. If appropriate, state what stream or river it flows into.

No surface water body is located on the site. Surface runoff from the site drains to Lake Union, which forms the southern and eastern boundaries of the site. Lake Union is a freshwater lake that drains to Puget Sound via the Ship Canal and the Hiram Chittenden Locks.

2) Will the project require any work over, in, or adjacent to (within 200 feet) the described waters? If yes, please describe and attach available plans.

Clearing, grading, and filling associated with installation of the air sparging system and installation of the soil cover will occur along approximately 500 feet of Lake Union shoreline (See Figure 4-1 of the CAP).

3) Estimate the amount of fill and dredge material that would be placed in or removed from surface water or wetlands and indicate the area of the site that would be affected. Indicate the source of fill material.

No fill and dredge material will be placed in or removed from surface waters or wetlands.

4) Will the proposal require surface water withdrawals or diversions? Give general description, purpose, and approximate quantities if known.

No surface water withdrawals or diversions will be required.

5) Does the proposal lie within a 100-year floodplain? If so, note location on the site plan.

The proposed project does not lie within a 100-year floodplain.

6) Does the proposal involve any discharges of waste materials to surface waters? If so, describe the type of waste and anticipated volume of discharge.

The proposal does not involve any discharges of waste materials to surface waters.

b. Ground:

1) Will groundwater be withdrawn, or will water be discharged to groundwater? Give general description, purpose, and approximate quantities if known.

The proposal does not involve groundwater withdrawal or discharges to groundwater, with the exception of limited groundwater sampling. Less than 500 gallons per year of groundwater would be withdrawn for well purging and sampling.

2) Describe waste material that will be discharged into the ground from septic tanks or other sources, if any (for example: Domestic sewage; industrial, containing the following chemicals . . .; agricultural; etc.). Describe the general size of the system, the number of such systems, the number of houses to be served (if applicable), or the number of animals or humans the system(s) are expected to serve.

No waste material will be discharged into the ground.

c. Water Runoff (including storm water):

1) Describe the source of runoff (including storm water) and method of collection and disposal, if any (include quantities, if known). Where will this water flow? Will this water flow into other waters? If so, describe.

All runoff from the site is generated by precipitation and drains to Lake Union. The only visible drainage features are a swale between Kite Hill and the cracking towers, and a shallow swale in the southeast section of site near the Play Barn and the picnic shelter. Water flows in these swales only after heavy rains. Storm drains direct runoff from the sundial at the top of Kite Hill, from the parking lot, and from the low grassy area in the northeast corner of the Park.

After completion of the project, site drainage will be similar to existing conditions and will continue to drain to Lake Union. No new stormwater collection facilities will be constructed as a result of the project. Bioswales will be incorporated into the final design to improve stormwater quality.

2) Could waste materials enter ground or surface waters? If so, generally describe.

The project will not cause waste materials to enter ground or surface water. Contaminated soil or groundwater encountered during construction and operation of the project will be contained, tested, and transported off site to a permitted disposal facility.

d. Proposed measures to reduce or control surface, ground, and runoff water impacts, if any:

An Erosion and Sedimentation Plan will be prepared and implemented to control sedimentation impacts to surface water.

4. Plants

a. Check or circle types of vegetation found on the site:

- x **deciduous tree: alder, maple, aspen, other**
- x **evergreen tree: fir, cedar, pine, other**
- x **shrubs**
- x **grass**
- **pasture**
- **crop or grain**
- x **wet soil plants: cattail, buttercup, bulrush, skunk cabbage, other**
- **water plants: water lily, eelgrass, milfoil, other**
- **other types of vegetation**

b. What kind and amount of vegetation will be removed or altered?

Approximately 5.7 acres of poor quality lawn will be removed for soil cover placement. The area will be reseeded with lawn grasses after final site grading has been completed.

c. List threatened or endangered species known to be on or near the site.

No threatened or endangered plant species are known to be on or near the site (see Section 3.6 and Appendix G of the FFS report).

d. Proposed landscaping, use of native plants, or other measures to preserve or enhance vegetation on the site, if any:

Only lawn areas will be cleared. All existing shrubs and trees on the site will be retained. Willows or other appropriate plants will be planted along the shoreline to stabilize the shore and promote removal of volatile groundwater contaminants via plant transpiration.

5. Animals

a. Circle any birds and animals which have been observed on or near the site or are known to be on or near the site:

birds: hawk, heron, eagle, songbirds, other (Canadian geese, thrushes, waterfowl)
mammals: deer, bear, elk, beaver, other (raccoons, squirrels, possum, mice, rats)
fish: bass, salmon, trout, herring, shellfish, other: (peamouth, northern squawfish, yellow perch, brown bullhead, black crappie, carp)

b. List any threatened or endangered species known to be on or near the site.

Only the Chinook Salmon (listed as a threatened species under the ESA on March 16, 1999) is known to be near the site (see Section 3.6 and Appendix G of the FFS report).

c. Is the site part of a migration route? If so, explain.

This site is adjacent to Lake Union, which is a salmon migration corridor for Chinook and other salmonoid species.

d. Proposed measures to preserve or enhance wildlife, if any:

Willows planted along the shoreline will screen waterfowl on the Lake from park users.

6. Energy and Natural Resources

a. What kinds of energy (electric, natural gas, oil, wood stove, solar) will be used to meet the completed project's energy needs? Describe whether it will be used for heating, manufacturing, etc.

During operation of the air sparging system, the sparging and extraction blowers will be powered by electricity, and the soil vapor treatment unit will be powered by natural gas or propane. Little energy will be required for the completed project.

b. Would your project affect the potential use of solar energy by adjacent properties? If so, generally describe.

The project will not affect the potential use of solar energy by adjacent properties.

c. What kinds of energy conservation features are included in the plans of this proposal? List other proposed measures to reduce or control energy impacts, if any:

The soil vapor treatment system has been designed to use clean hot air exiting the system to preheat cold air entering the system, thereby reducing fuel demand.

7. Environmental Health

a. Are there any environmental health hazards, including exposure to toxic chemicals, risk of fire and explosion, spill, or hazardous waste, that could occur as a result of this proposal? If so, describe.

Work crews could be exposed to potential health risks during excavation of existing contaminated soils. Exposure could occur via inhalation of wind-blown dust containing contaminated soil particles, inhalation of soil gases released during excavation, and direct contact and inadvertent ingestion of contaminated soil. Appropriate personal protective measures will be implemented in accordance with a site-specific Health and Safety Plan.

After completion, the project will result in a reduction in environmental health hazards by preventing exposure of park users to contaminated soils, and reducing the concentration of groundwater contaminants migrating to Lake Union.

1) Describe special emergency services that might be required.

No special emergency services will be required.

2) Proposed measures to reduce or control environmental health hazards, if any:

During installation of the air sparging system, fencing will be installed around the construction area to prevent public access. The park will be closed to the public during excavation of contaminated soils and installation of the soil cover. A site-specific Health and Safety Plan will be implemented to guide construction activities and reduce potential health hazards to work crews. Mitigation measures could include:

- Dust suppression techniques, such as water spray, application of polymer layers, and covering stockpiles with tarps;
- Prompt filling and covering of excavated areas; and

- Monitoring emission levels from soil and air sparging/soil vapor extraction system and implementing appropriate occupational health and safety standards.

b. Noise

1) What types of noise exist in the area which may affect your project (for example: traffic equipment, operation, other)?

The project will not be affected by existing noise.

2) What types and levels of noise would be created by or associated with the project on a short-term or a long-term basis (for example: traffic, construction, operation, other)? Indicate what hours noise would come from the site.

Short-term noise will result from operation of earthmoving and drilling equipment and from trucks hauling material to and from the site. Truck and construction equipment operation during soil cover placement and air sparging system installation will be intermittent over a three-month and four-method period, respectively. Maximum noise levels generated by construction equipment range from about 70 to 100 dBA at a distance of 50 feet from the sound source. Actual noise levels will be less than this maximum because construction equipment will be turned off, idling, or operating at less than full power at any time.

Noise will also be generated during the operation of the air sparging/soil vapor evaporation system. Although the noise level will be relatively low, the noise will be continuous for a period of approximately three years.

No noise will be generated by the completed project.

3) Proposed measures to reduce or control noise impacts, if any:

Temporary noise during construction could be mitigated by one or more of the following measures:

- Limiting construction to normal working hours;
- Installing mufflers on all internal combustion engine-driven equipment and pneumatic tools;
- Turning off idling equipment; and
- Constructing noise barriers or curtains around stationary equipment.

8. Land and Shoreline Use

a. What is the current use of the site and adjacent properties?

The site is a public urban park owned by the City of Seattle. Recreational facilities include picnic areas, play areas, a 35-foot-high hill, and a small system of trails.

The area north of the site is primarily industrial. These properties include two hazardous waste cleanup sites. The moorage for the City of Seattle Harbor Patrol is located to the west of the park.

b. Has the site been used for agriculture? If so, describe.

The site has not been used for agriculture.

c. Describe any structures on the site.

Restroom facilities and a picnic shelter have been constructed on the site. The undeveloped northwest corner of the Park is enclosed by a masonry wall and fence with a locked gate, and was the former location of two large above-ground fuel oil storage tanks associated with the gas plant operations. A number of structures from the former gas plant were retained as part of the Park design. These include gas generators and associated structures (referred to as the cracking towers), a boiler house and pump house (renovated as the Play Barn), seven vertical steel vessels and associated equipment housing, concrete trestles of an abandoned railroad spur, and a concrete barge-unloading platform.

d. Will any structures be demolished? If so, what?

No structures will be demolished.

e. What is the current zoning classification of the site?

The site is zoned Industrial Buffer (IB) by the City of Seattle.

f. What is the current comprehensive plan designation of the site?

The Seattle Comprehensive Plan designation is Parks/Open Space.

g. If applicable, what is the current shoreline master program designation of the site?

The City of Seattle Shoreline Master Plan Designation is Conservancy Management (Cm).

h. Has any part of the site been classified as an "environmentally sensitive" area? If so, specify.

The City of Seattle does not classify the site as environmentally sensitive.

i. Approximately how many people would reside or work in the completed project?

The completed project will not create any new residences or jobs.

j. Approximately how many people would the completed project displace?

No people will be displaced as a result of the project.

k. Proposed measures to avoid or reduce displacement impacts, if any:

N/A

l. Proposed measures to ensure the proposal is compatible with existing and projected land uses and plans, if any:

The proposal will comply with all City of Seattle land use regulations and policies. The proposed cleanup methods were selected, in part, because they will cause minimal disruption to recreational activities on the site. The project will reduce the risk to human health and the environment posed by onsite contaminants and, therefore, improve the suitability of the site for its designated parks/open space land use.

9. Housing

a. Approximately how many units would be provided, if any? Indicate whether high, middle, or low-income housing.

No housing will be provided by the project.

b. Approximately how many units, if any, would be eliminated? Indicate whether high, middle, or low-income housing.

No housing will be eliminated by the project.

c. Proposed measures to reduce or control housing impacts, if any:

N/A

10. Aesthetics

a. What is the tallest height of any proposed structure(s), not including antennas; what is the principal exterior building material(s) proposed?

The soil vapor extraction system will have an exhaust stack approximately 30 feet tall. The above-ground equipment will be contained within a 2,500-square foot area enclosed by fencing.

b. What views in the immediate vicinity would be altered or obstructed?

The soil vapor extraction exhaust stack may be visible to Park users, to motorists and pedestrians traveling on N Northlake Way, and to businesses and residences on the hillslopes facing the Park. No views will be obstructed, however.

c. Proposed measures to reduce or control aesthetic impacts, if any:

Most of the air sparging/soil vapor extraction system equipment will be buried underground and will not be visible to Park users. To minimize impacts to the visual cohesion of the Park, the exhaust stack and equipment staging area may be located next to the cracking towers, which are four vertical tanks that were part of the former gas works operation. The exhaust tower and above ground equipment will be removed after completion of groundwater remediation, approximately three years after initiation.

11. Light and Glare

a. What type of light or glare will the proposal produce? What time of day would it mainly occur?

No light or glare will be produced as a result of the proposal.

b. Could light or glare from the finished project be a safety hazard or interfere with views?

No light or glare will be created.

c. What existing off-site sources of light or glare may affect your proposal?

The project will not be affected by off-site sources.

d. Proposed measures to reduce or control light and glare impacts, if any:

N/A

12. Recreation

a. What designated and informal recreational opportunities are in the immediate vicinity?

The site is a designated public park. Recreational features include a picnic shelter, a lakeside promenade, a system of asphalt and gravel paths, and about eight acres of open area, primarily covered with lawn. The Play Barn, one of the abandoned gas works facilities, has been painted with bright colors and is used as a play area for children. Sand boxes and swings are located next to the

Play Barn. The Prow, a large concrete structure with railings, abuts Lake Union and provides a clear view of downtown Seattle. Another feature is Kite Hill, which is a steep-sloped artificially created hill with trails and a large sundial on top.

The City frequently permits special activities to occur at the site, including concerts, art- and film-related events, and fund-raising activities, such as walk-a-thons. Although access to the shoreline of Lake Union is available at the site, it is not encouraged. Several signs warn park users that lake sediments and water near the park are contaminated.

b. Would the proposed project displace any existing recreational uses? If so, describe.

During installation of the air sparging system, the southeast corner of the site will fenced off and inaccessible to Park users. The remainder of the Park will be open to Park users. The entire Park will be closed for approximately four months during excavation and placement of the soil cover. Afterward, access to some areas of the Park may be restricted until the seeded lawn is established. No recreational uses will be displaced during operation of the air sparging system or after the cleanup is completed.

c. Proposed measures to reduce or control impacts, if any:

The Park is a popular site for viewing Fourth of July fireworks displays. The construction schedule has been designed so the Park can be open during that holiday. The air sparging system was selected as the preferred groundwater cleanup method, in part, because it will cause minimal disruption to park use. After installation, most of the system will be underground and not detectable to park users.

13. Historic and Cultural Preservation

a. Are there any places or objects listed on, or proposed for, national, state, or local preservation registers known to be on or next to the site? If so, generally describe.

Several components of the original gas works facility have been retained and incorporated in the Park design. The City of Seattle considers the structures and their park setting to be a valuable historic resource because they provide a link to the city's industrial history. The site is not listed or proposed for the national or state historic preservation register.

b. Generally describe any landmarks or evidence of historic, archaeological, scientific, or cultural importance known to be on or next to the site.

Several structures associated with the former gas works are present in their original locations throughout the Park. The most significant of these structures are located in the southern and eastern portions of the Park:

- Six original gas generators and associated structures, commonly referred to as the "cracking towers;" surrounded by a locked chain-link fence.

- Structures and equipment associated with the Boiler House and the Pump House, which were modified and preserved in an area of the Park known as the Play Barn.

- Two tall vertical steel vessels (light-oil absorber, gas cooler), a short rectangular structure housing the meters that measured gas output from the plant, and a small brick building (the former Foamite Building), all located southwest of the Play Barn.

- A group of five vertical steel vessels located directly west of the Play Barn. These structures were part of a high-BTU oil gas system that produced a "richer" gas for blending with the lower quality gas from the six oil gas generator sets in the cracking tower area.

- Concrete trestles located northwest of the Play Barn, which formerly supported a railroad spur used for coal unloading.

- The "Prow," a concrete structure located south of the cracking towers on the Lake Union shoreline, which was formerly used for unloading coal from barges.

c. Proposed measures to reduce or control impacts, if any:

The historic structures will not be directly affected by the proposal. The exhaust tower of the soil vapor treatment system will have a temporary, minor visual impact on the setting of these structures. The exhaust tower will be removed upon completion of the site cleanup.

14. Transportation

a. Identify public streets and highways serving the site, and describe proposed access to the existing street system. Show on site plans, if any.

A paved parking lot is located in the north-central portion of the site and has two entrances off N. Northlake Way.

b. Is site currently served by public transit? If not, what is the approximate distance to the nearest transit stop?

The site is served by King County Metro transit. The nearest bus stop is for bus route 26 and is located at the intersection of N. 35th Street and Wallingford Avenue N, about two blocks north of the site.

c. How many parking spaces would the completed project have? How many would the project eliminate?

No parking spaces will be created or eliminated as a result of the project.

d. Will the proposal require any new roads or streets, or improvements to existing roads or streets, not including driveways? If so, generally describe (indicate whether public or private).

No new roads or streets, or improvements to roads or streets, will be required.

e. Will the project use (or occur in immediate vicinity of) water, rail, or air transportation? If so, generally describe.

The project will not use water, rail, or air transportation.

f. How many vehicular trips per day would be generated by the completed project? If known, indicate when peak volumes would occur.

No vehicle trips will be generated by the completed project.

g. Proposed measures to reduce or control transportation impacts, if any:

The selected soil cover cleanup method minimizes the amount of imported fill required for the project, and, therefore, minimizes the number of truck trips to the site. The excavation and removal method considered in the FFS would have generated more truck trips. Installation of geotextile fabric reduces the required thickness of the soil cover.

15. Public Services

a. Would the project result in an increased need for public services (for example: fire protection, police protection, health care, schools, other)? If so, generally describe.

The project will not increase the need for public services.

b. Proposed measures to reduce or control direct impacts on public services, if any.

N/A

16. Utilities

a. Circle utilities currently available at the site: electricity, natural gas, water, refuse service, telephone, sanitary sewer, septic system, other.

b. Describe the utilities that are proposed for the project, the utility providing the service, and the general construction activities on the site or in the immediate vicinity which might be needed.

Electricity will be needed to operate the air sparging/soil vapor extraction equipment for groundwater remediation. The equipment will be connected to existing Seattle City Light electrical lines. No new electrical lines will be required. The soil vapor treatment equipment is powered by natural gas or propane. If powered by natural gas, the system could be connected to existing Puget Power natural gas lines that are located on the site. If powered by propane, an above ground tank would be installed.

C. SIGNATURE

The above answers are true and complete to the best of my knowledge. I understand that the lead agency is relying on them to make its decision.

Signature: John V. Kodis

Date Submitted: 10-30-98

APPENDIX B

DETERMINATION OF NON-SIGNIFICANCE (DNS)

SEPA RULES

DETERMINATION OF NONSIGNIFICANCE

Description of proposal: Gas Works Park environmental cleanup (per WAC 173-340).

Proponent: City of Seattle, Department of Parks and Recreation.

Location of proposal, including street address, if any: 2000 N. Northlake Way, Seattle, Washington.

Lead agency: Washington State Department of Ecology

The lead agency for this proposal has determined that it does not have a probable significant adverse impact on the environment. An environmental impact statement (EIS) is not required under RCW 43.21C.030 (2)(c). This decision was made after review of a completed environmental checklist and other information on file with the lead agency. This information is available to the public on request.

__There is no comment period for this DNS.

__This DNS is issued after using the optional DNS process in WAC 197–11–355. There is no further comment period on the DNS.

__X__This DNS is issued under WAC 197–11–340(2); the lead agency will not act on this proposal for 14 days from the date below. Comments must be submitted by December 31, 1998.

Responsible official: Carol Kraege

Position/title Phone: Section Head, Toxics Cleanup Program (360) 407-7175

Address: Washington Department of Ecology, Toxics Cleanup Program, P.O. Box 47600 Olympia, WA 98054-7600

Date: Wednesday, December 09, 1998

Signature: Carol Kraege

(optional)

X You may appeal this determination to: Carol Kraege or Charles San Juan, Washington Department of Ecology, Toxics Cleanup Program, P.O. Box 47600 Olympia, WA 98054-7600

Carol Kraege: (360) 407-7175, e-mail: ckra461@ecy.wa.gov
Charles San Juan (360) 407-7191, e-mail: csan461@ecy.wa.gov

at (location): Same as above

no later than (date): December 31, 1998

by (method): phone, fax, or e-mail: any method may be used, phone and e-mail above, fax: (360) 407-7154

You should be prepared to make specific factual objections.

Contact to read or ask about the procedures for SEPA appeals.

__There is no agency appeal.

[Statutory Authority: 1995 c 347 (ESHB 1724) and RCW 43.21C.110. 97–21–030 (Order 95–16), § 197–11–970, filed 10/10/97, effective 11/10/97. Statutory Authority: RCW 43.21C.110. 84–05–020 (Order DE 83–39), § 197–11–970, filed 2/10/84, effective 4/4/84.]

APPENDIX C

MEMORANDUM FROM THERMORETEC TO THE DEPARTMENT OF ECOLOGY DATED APRIL 12, 1999

ThermoRetec Corporation
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Seattle, WA 98134-1162

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MEMORANDUM

TO:	Craig Thompson, Dept. of Ecology	**CLIENT:**	Seattle Department of Parks & Recreation and Puget Sound Energy
FROM:	Dan Baker	**PROJECT:**	Gas Works Park
DATE:	April 12, 1999	**RE:**	Extemely Hazardous Waste

As defined in the Washington Department of Ecology (Ecology) Dangerous Waste Regulations (WAC 173-303-100), solid wastes containing greater than 1% total polycyclic aromatic hydrocarbons (PAH) are considered extremely hazardous waste (EHW). The presence of tar and elevated PAH concentrations in soil at Gas Works Park suggests that some of the soil could potentially classify as EHW if excavated and disposed. Cleanup actions in the Focused Feasibility Study (FFS; Parametrix, pending) are based on risk. Although soil cleanup levels are not governed by Dangerous Waste Regulations, questions have been raised by Ecology and EPA regarding the presence of soils exceeding 1% total PAH. This memorandum attempts to answer the following questions regarding soils at Gas Works Park:

- How much soil at Gas Works Park exceeds the 1% total PAH criterion?
- Where is the soil of concern located?
- Would soil classify as EHW if excavated and characterized for off-site disposal?

An updated cost estimate for excavation to a depth of 15 feet is also provided, which will replace "Alternative 5" in the FFS report and the CAP.

Amount of Soils Exceeding 1% Total PAH: We have reviewed soil analytical data to determine the amount of soils exceeding 1% total PAH. The reason that soil would exceed 1% total PAH is the presence of tar. Pure tar from the Park has exceeded the 1% EHW criterion, based on sampling of seasonal tar seeps that occurred in the past on the north side of Kite Hill. Tar collected from seeps has been characterized as EHW for disposal purposes. All known surficial tar deposits identified by the October 1997 test pit investigation have been removed from the Park.

Existing soil data indicate there are some discrete areas that may exceed 1% total PAH. A review of the historic database indicates that only 3 of 145 samples analyzed for PAH

exceeded 1% total PAH. These data are compiled in Table 1 and Table 3-8 of the EPRI report, and sampling locations are shown in Figure 2-4 of the FFS and Figure 2-1 of the EPRI report (attached). It should be noted that there has been bias toward collecting the most heavily impacted soil for characterization in at least some of these sampling programs (i.e., "hot spot" sampling). Of the three samples that exceeded 1% total PAH, two were near surface samples of soils that have been excavated and properly disposed, and the other one was at a depth of 16.5 feet -- beyond a reasonable depth for excavation and below the 15-foot MTCA point of compliance depth. Because all of the surficial areas known to exceed 1% total PAH have been removed, there is no analytical evidence of soils within 15 feet of the ground surface exceeding 1% total PAH.

Sampling programs with the objective of analyzing the most heavily impacted soil, such as the recent EPRI sampling program, suggest that most tarry soils have less than 1% total PAH. Five of the six tarry soil samples submitted in this study did not exceed 1% total PAH and none of the 3 samples collected above 15-foot depth is above the 1% criterion. Data from discrete soil samples suggest it would be reasonable to assume that 2% (3/145) of the soils are greater than 1% total PAH. However, these data are biased as described above. The amount of soil exceeding the 1% criterion is likely much less than 2% of the total soil volume.

Location of Tarry Soils: Investigations have shown that tar occurs in small pockets, lenses, or thin layers. Tar has accumulated in some of the wells in the western park area downgradient of the former American Tar Company tar refinery. Tar has been noted in surface fill material, the Gas Works deposit, and locally in the underlying native stratified drift. All known areas of tar in the surface fill identified by the October 1997 test pit investigation have been excavated. The only area where tar is known to exist in the stratified drift is the western park area where it is mostly below 15-foot depth.

Tarry soils are randomly distributed throughout the Park in the Gas Works deposit. The nature of the Gas Works deposit, consisting of manufactured gas plant residues, is such that all of the Gas Works deposit is potentially tarry. However, a very small percentage of the soil (much less than 2% because of the bias in sampling) is likely to be greater than 1% PAH. The Gas Works deposit is thought to be present beneath most of the Park. Due to the redistribution of soils during park construction and heterogeneous nature of the Gas Works deposit, there are no specific target areas for tarry soils (i.e., no "hot spots"). A schematic diagram depicting the conceptual model of tar occurrence at the park is provided as Figure 1.

Excavated Soil Versus the EHW Criterion: Soils are not a solid waste and could not be classified as an EHW unless excavated and disposed. Based on available data on the concentrations and distribution of tarry soils, soils would not classify as EHW if excavated and characterized for disposal. Only a small percentage of the soil that would be

excavated may exceed 1% total PAH. This soil could not be segregated into a separate stockpile based on visual identification because of the random and widely dispersed nature of the tar. Therefore, the concentrations in the soil stockpiles after the excavation activities would be below 1% total PAH. Furthermore, characterization for waste disposal would be based on composite sampling of stockpiled soil. Composite sampling would reflect average soil concentrations which are less than 1% total PAH. For example, samples collected from soil stockpiles during tar removal had concentrations less than 0.1% total PAH and the associated excavation targeted an area of known tarry soils.

Costs for Removing Soils Potentially Exceeding 1% Total PAH: Due to the random distribution of tarry soils in the Gas Works deposit, there are no specific target areas for excavation. However, because the potential exists, the majority of the Park area would need to be excavated to a depth of 15 feet (the MTCA point of compliance) to remove tarry soils possibly exceeding 1% total PAH. Excavation would be difficult due to:

- Excavation beneath the water table
- Proximity to shoreline
- Existence of the Gas Works deposit beneath existing structures

Tables 13-5a through 13-5c present a revised FFS cost estimate developed by Parametrix for excavation of the upper 15 feet of soil that exceeds MTCA Method B soil cleanup levels over the entire Park in the 8.8-acre area assumed for the FFS excavation alternative. This is a larger area than estimated for the soil cover in the FFS (Alternatives 2, 3, and 4) as excavation would presumably be necessary in areas capped with clean fill due to the presence of the underlying Gas Works deposit. The estimated $80 million cost of this alternative includes excavation beneath existing structures such as the cracking towers and Play Barn which are underlain by the Gas Works deposit.

Conclusion: Excavation to a depth of 15 feet to remove all soils exceeding MTCA Method B cleanup levels (including soils potentially exceeding 1% total PAH) would be impracticable due to the random and widespread distribution of tarry soils, existing park conditions, and the shallow water table. Excavation to remove soils exceeding MTCA Method B cleanup levels and 1% total PAH is substantial and disproportionate for the following reasons:

- High cost
- The low percentage of soil exceeding 1% total PAH
- The likely outcome of producing no EHW
- Soil excavation will not provide a greater degree of human health protection as the risk would be managed by the proposed soil cover and air sparging/SVE system presented in the FFS and CAP as Alternative 3.

cc: Steve Secrist, Steve Feller - PSE
Robin Kordik, Peter Hapke - City of Seattle
Harry Grant - Graham & James/Riddell Williams
John Ryan, Jennifer Pilling, File 1-3916 - ThermoRetec

Table 1 PAH Concentrations in Soil—Gas Works Park

Constituent	Site: / Sample ID: / Date: / Depth (ft): / Result Type:	84EPA100 148 4/2/84 0.08 Primary	84EPA200 149 4/2/84 0.08 Primary	84EPA300 150 4/2/84 0.08 Primary	84EPA31 142 3/21/84 0.08 Primary	84EPA32 144 3/21/84 0.08 Primary	84EPA33 146 3/21/84 0.08 Primary	84EPA400 151 4/2/84 0.08 Primary	84EPA500 152 4/2/84 0.08 Primary	84EPA600 153 4/2/84 0.08 Primary
Starting Depth	(feet)	0	0	0	0	0	0	0	0	0
Ending Depth	(feet)	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
Acenaphthene	(mg/kg)	0.34	0.69	NA	0.034	0.27	0.22	0.13	0.1	58
Acenaphthylene	(mg/kg)	5	8.3	5.2	0.13	NA	0.85	0.21	0.1	3000
Fluorene	(mg/kg)	3	3.1	NA	0.098	0.48	0.51	0.1	NA	400
Anthracene	(mg/kg)	2.1	10	3.4	0.29	NA	5.4	0.5	NA	1000
Fluoranthene	(mg/kg)	70	78	17	4.5	3.2	34	6.5	0.4	8000
Phenanthrene	(mg/kg)	110	126	43	3.2	2.8	18	3.3	0.18	14000
Benzo(a)anthracene	(mg/kg)	42	39	9.9	2.1	2.2	12	3.6	0.39	3000
Benzo(b)fluoranthene	(mg/kg)	36	64	11	2	2.9	13	4.9	0.56	4000
Benzo(k)fluoranthene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pyrene	(mg/kg)	120	107	22	4.9	11	40	10	0.8	16000
Chrysene	(mg/kg)	46	80	31	2.7	7.9	18	4.8	0.64	6000
Benzo(a)pyrene	(mg/kg)	44	63	19	0.76	1.2	22	6.9	0.75	10000
Dibenzo(a,h)anthracene	(mg/kg)	52	37	5	1.5	NA	8.9	8.5	NA	2000
Indeno(1,2,3-c,d)pyrene	(mg/kg)	29	130	18	1.8	1.5	13	18	NA	11000
Benzo(g,h,i)perylene	(mg/kg)	38	92	12	2	1.8	18	26	NA	23000
Dibenzo(a,e)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,h)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,i)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,l)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenz(a,j)acridine	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total PAHs	(mg/kg)	597.44	838.09	196.5	26.012	35.25	203.88	93.44	3.92	101458
Total PAHs	%	0.059744	0.083809	0.01965	0.0026012	0.003525	0.020388	0.009344	0.000392	**10.1458**

NOTES:

NA - Not Analyzed

For RCL DRF-REQ

Table 1 PAH Concentrations in Soil—Gas Works Park (Continued)

Constituent	Site: / Sample ID: / Date: / Depth (ft): / Result Type:	84EPA700 154 4/2/84 0.08 Primary	95EPA-32 40 1/23/95 0.08 Primary	95EPA-33 210 1/23/95 0.08 Primary	95EPA-35 42 1/23/95 0.08 Primary	B30 44 3/15/85 0.16 Primary	B36 45 3/15/85 0.16 Primary	B6 43 3/15/85 0.16 Primary	C11 46 3/15/85 0.16 Primary	C27 47 3/15/85 0.16 Primary
Starting Depth	(feet)	0	0	0	0	0	0	0	0	0
Ending Depth	(feet)	0.08	0.08	0.08	0.08	0.16	0.16	0.16	0.16	0.16
Acenaphthene	(mg/kg)	27	0.464	1.02	4.38	2	20	20	0.2	2
Acenaphthylene	(mg/kg)	900	2.3	1.07	65.8	1	10	10	0.1	1
Fluorene	(mg/kg)	2000	2.34	0.353	29	0.2	7.4	2	0.02	0.2
Anthracene	(mg/kg)	640	2.74	0.773	66.8	0.18	3.9	0.64	0.002	0.068
Fluoranthene	(mg/kg)	6000	23	3.26	442	2.5	32	15	0.067	1
Phenanthrene	(mg/kg)	9000	9.04	0.943	311	1.4	32	4.4	0.033	0.67
Benzo(a)anthracene	(mg/kg)	3000	8.34	2.29	197	1.6	4.5	8.6	0.03	0.46
Benzo(b)fluoranthene	(mg/kg)	3000	11.1	1.44	213	1.6	12	10	0.047	0.6
Benzo(k)fluoranthene	(mg/kg)	NA	3.65	0.582	61.2	0.7	5.9	4.7	0.022	0.27
Pyrene	(mg/kg)	18000	25.7	5.07	375	4.5	49	28	0.09	1.7
Chrysene	(mg/kg)	4000	11.2	2.37	208	2	21	12	0.048	0.67
Benzo(a)pyrene	(mg/kg)	7000	8.16	1.75	162	2	16	10	0.04	0.7
Dibenzo(a,h)anthracene	(mg/kg)	830	1.37	0.266	34.4	0.4	4	4	0.04	0.4
Indeno(1,2,3-c,d)pyrene	(mg/kg)	1000	8.43	0.781	130	2.5	16	13	0.074	1
Benzo(g,h,i)perylene	(mg/kg)	4000	8.46	0.673	110	2.9	21	16	0.11	1.2
Dibenzo(a,e)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,h)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,i)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,l)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenz(a,j)acridine	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total PAHs	(mg/kg)	59397	126.294	22.641	2409.58	25.48	254.7	158.34	0.923	11.938
Total PAHs	%	5.9397	0.0126294	0.0022641	0.240958	0.002548	0.02547	0.015834	0.0000923	0.0011938

NOTES:

NA - Not Analyzed

For RCL DRF-REQ

Table 1 PAH Concentrations in Soil—Gas Works Park (Continued)

Constituent	Site: / Sample ID: / Date: / Depth (ft): / Result Type:	C37 / 48 / 3/15/85 / 0.16 / Primary	D32 / 50 / 3/15/85 / 0.16 / Primary	D8 / 49 / 3/15/85 / 0.16 / Primary	E17 / 51 / 3/15/85 / 0.16 / Primary	E25 / 52 / 3/15/85 / 0.16 / Primary	EPA1 / 155 / 4/17/84 / 0.5 / Primary	EPA1 / 179 / 4/17/84 / 3 / Primary	EPA10 / 164 / 4/17/84 / 0.5 / Primary	EPA10 / 188 / 4/17/84 / 3 / Primary
Starting Depth	(feet)	0	0	0	0	0	0	2.75	0	2.75
Ending Depth	(feet)	0.16	0.16	0.16	0.16	0.16	0.5	3.25	0.5	3.25
Acenaphthene	(mg/kg)	20	20	0.2	2	200	0.044	0.899	0.08	0.476
Acenaphthylene	(mg/kg)	10	10	0.1	1	10	0.31	0.899	0.17	0.283
Fluorene	(mg/kg)	2	2	0.02	0.2	6.4	0.06	0.899	0.2	0.476
Anthracene	(mg/kg)	2	2.3	0.002	0.14	2.3	0.076	0.899	0.2	0.476
Fluoranthene	(mg/kg)	9.2	34	0.01	1.1	20	3	3.876	0.76	0.663
Phenanthrene	(mg/kg)	7.5	11	0.0097	1.1	15	1.3	2.467	0.62	0.048
Benzo(a)anthracene	(mg/kg)	3.3	15	0.01	0.53	12	1.8	2.467	0.2	0.092
Benzo(b)fluoranthene	(mg/kg)	3	11	0.0089	0.65	13	3.4	1.798	2.2	0.952
Benzo(k)fluoranthene	(mg/kg)	1.3	5.4	0.005	0.3	5.7	NA	1.798	NA	0.952
Pyrene	(mg/kg)	12	56	0.02	1.8	38	5.6	6.829	1.4	0.373
Chrysene	(mg/kg)	6.1	18	0.01	0.96	14	1.8	2.511	0.97	0.114
Benzo(a)pyrene	(mg/kg)	3.8	14	0.01	0.75	18	2.7	1.798	0.2	0.952
Dibenzo(a,h)anthracene	(mg/kg)	4	4	0.04	0.4	4	6	1.798	2	0.952
Indeno(1,2,3-c,d)pyrene	(mg/kg)	3.6	13	0.01	1.1	19	2.4	1.798	2	0.952
Benzo(g,h,i)perylene	(mg/kg)	3.3	15	0.02	1.3	22	3.5	1.798	2	0.952
Dibenzo(a,e)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,h)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,i)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,l)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenz(a,j)acridine	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total PAHs	(mg/kg)	91.1	230.7	0.4756	13.33	399.4	31.99	32.534	13	8.713
Total PAHs	%	0.00911	0.02307	0.00004756	0.001333	0.03994	0.003199	0.0032534	0.0013	0.0008713

NOTES:

NA - Not Analyzed

For RCL DRF-REQ

Table 1 PAH Concentrations in Soil—Gas Works Park (Continued)

Constituent	Site: / Sample ID: / Date: / Depth (ft): / Result Type:	EPA11 165 4/17/84 0.5 Primary	EPA11 189 4/17/84 3 Primary	EPA12 166 4/17/84 0.5 Primary	EPA12 190 4/17/84 3 Primary	EPA13 167 4/17/84 0.5 Primary	EPA13 191 4/17/84 3 Primary	EPA14 168 4/18/84 0.5 Primary	EPA14 192 4/18/84 3 Primary	EPA15 169 4/18/84 0.5 Primary
Starting Depth	(feet)	0	2.75	0	2.75	0	2.75	0	2.75	0
Ending Depth	(feet)	0.5	3.25	0.5	3.25	0.5	3.25	0.5	3.25	0.5
Acenaphthene	(mg/kg)	0.04	0.25	0.14	0.449	0.77	0.58	0.4	0.0114	0.6
Acenaphthylene	(mg/kg)	0.23	0.955	0.53	0.479	5	4.033	0.69	0.0114	0.7
Fluorene	(mg/kg)	0.07	0.386	0.16	0.093	2.4	1.654	0.4	0.0114	0.6
Anthracene	(mg/kg)	0.1	0.454	0.69	0.449	9.3	0.58	2.5	0.0114	2.6
Fluoranthene	(mg/kg)	3.5	3.636	9.7	2.256	5.7	3.04	3.1	0.026	44
Phenanthrene	(mg/kg)	3.1	4.227	5.6	2.075	83	16.662	11	0.0068	8.8
Benzo(a)anthracene	(mg/kg)	3	1.045	3.3	0.436	37	9.188	15	0.0034	22
Benzo(b)fluoranthene	(mg/kg)	3.6	0.614	7.1	0.603	66	1.159	24	0.0227	410
Benzo(k)fluoranthene	(mg/kg)	NA	0.159	NA	0.899	NA	4.907	NA	0.0227	NA
Pyrene	(mg/kg)	4.8	4.363	12	2.628	160	3.21	78	0.0455	110
Chrysene	(mg/kg)	2	1.205	3.5	0.644	63	15.365	25	0.0034	39
Benzo(a)pyrene	(mg/kg)	3.6	0.915	5	0.562	100	3.9	37	0.0227	60
Dibenzo(a,h)anthracene	(mg/kg)	3.1	0.909	11	0.899	6	1.159	23	0.0227	35
Indeno(1,2,3-c,d)pyrene	(mg/kg)	9.2	0.909	3.8	0.899	90	2.298	56	0.0227	90
Benzo(g,h,i)perylene	(mg/kg)	11	0.909	4.9	0.899	220	1.159	83	0.0227	130
Dibenzo(a,e)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,h)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,i)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,l)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenz(a,j)acridine	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total PAHs	(mg/kg)	47.34	20.936	67.42	14.27	848.17	68.894	359.09	0.2669	953.3
Total PAHs	%	0.004734	0.0020936	0.006742	0.001427	0.084817	0.0068894	0.035909	0.00002669	0.09533

NOTES:
NA - Not Analyzed
For RCL DRF-REQ

Table 1 PAH Concentrations in Soil—Gas Works Park (Continued)

Constituent	Site: / Sample ID: / Date: / Depth (ft): / Result Type:	EPA15 193 4/18/84 3 Primary	EPA16 170 4/18/84 0.5 Primary	EPA16 194 4/18/84 3 Primary	EPA17 171 4/19/84 0.5 Primary	EPA17 195 4/19/84 3 Primary	EPA18 172 4/19/84 0.5 Primary	EPA18 196 4/19/84 3 Primary	EPA19 173 4/19/84 0.5 Primary
Starting Depth	(feet)	2.75	0	2.75	0	2.75	0	2.75	0
Ending Depth	(feet)	3.25	0.5	3.25	0.5	3.25	0.5	3.25	0.5
Acenaphthene	(mg/kg)	0.023	0.02	1.255	0.096	0.0106	0.6	0.022	1.8
Acenaphthylene	(mg/kg)	0.023	0.05	0.765	0.51	0.0106	1.3	0.042	51
Fluorene	(mg/kg)	0.023	0.02	3.1	0.29	0.0106	0.6	0.021	1.8
Anthracene	(mg/kg)	0.023	0.02	0.44	0.91	0.0106	0.6	0.022	15
Fluoranthene	(mg/kg)	0.028	0.34	20.604	4.9	0.0106	11	0.152	48
Phenanthrene	(mg/kg)	0.0186	0.51	9.771	6	0.0106	11	0.091	48
Benzo(a)anthracene	(mg/kg)	0.0105	0.42	16.209	5.6	0.0106	9.8	0.07	42
Benzo(b)fluoranthene	(mg/kg)	0.046	0.43	11.774	9.6	0.0213	27	0.044	92
Benzo(k)fluoranthene	(mg/kg)	0.046	NA	26.137	NA	0.0213	NA	0.044	NA
Pyrene	(mg/kg)	0.0605	0.58	23.901	14	0.0048	50	0.218	110
Chrysene	(mg/kg)	0.0105	0.32	34.674	11	0.0106	22	0.08	100
Benzo(a)pyrene	(mg/kg)	0.046	0.88	62.951	17	0.0213	23	0.044	190
Dibenzo(a,h)anthracene	(mg/kg)	0.046	0.58	0.879	12	0.0213	6	0.044	1.8
Indeno(1,2,3-c,d)pyrene	(mg/kg)	0.046	1.3	0.879	28	0.0213	100	0.044	450
Benzo(g,h,i)perylene	(mg/kg)	0.046	2.2	0.879	38	0.0213	150	0.044	570
Dibenzo(a,e)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,h)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,i)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,l)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA
Dibenz(a,j)acridine	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA
Total PAHs	(mg/kg)	0.4961	7.67	214.218	147.906	0.2174	412.9	0.982	1721.4
Total PAHs	%	0.00004961	0.000767	0.0214218	0.0147906	0.00002174	0.04129	0.0000982	0.17214

NOTES:

NA - Not Analyzed

For RCL DRF-REQ

Table 1 PAH Concentrations in Soil—Gas Works Park (Continued)

Constituent	Site: / Sample ID: / Date: / Depth (ft): / Result Type:	EPA19 197 4/19/84 3 Primary	EPA2 156 4/17/84 0.5 Primary	EPA2 180 4/17/84 3 Primary	EPA20 174 4/19/84 0.5 Primary	EPA20 198 4/19/84 3 Primary	EPA21 175 4/19/84 0.5 Primary	EPA21 199 4/19/84 3 Primary	EPA22 176 4/19/84 0.5 Primary
Starting Depth	(feet)	2.75	0	2.75	0	2.75	0	2.75	0
Ending Depth	(feet)	3.25	0.5	3.25	0.5	3.25	0.5	3.25	0.5
Acenaphthene	(mg/kg)	0.0014	1	0.364	0.97	0.021	1.8	0.023	0.55
Acenaphthylene	(mg/kg)	0.0108	0.73	0.014	0.87	0.021	83	0.015	3.5
Fluorene	(mg/kg)	0.0036	1.2	0.0357	1.6	0.021	11	0.023	1.6
Anthracene	(mg/kg)	0.0108	7.8	0.176	3.5	0.021	17	0.023	6.9
Fluoranthene	(mg/kg)	0.29	15	0.506	18	0.054	400	0.045	26
Phenanthrene	(mg/kg)	0.112	29	0.0357	38	0.056	620	0.057	45
Benzo(a)anthracene	(mg/kg)	0.172	18	0.1	9	0.023	61	0.013	17
Benzo(b)fluoranthene	(mg/kg)	0.186	11	0.0714	8.1	0.029	150	0.046	20
Benzo(k)fluoranthene	(mg/kg)	0.048	NA	0.0714	NA	0.042	NA	0.046	NA
Pyrene	(mg/kg)	0.399	35	0.617	30	0.07	460	0.081	56
Chrysene	(mg/kg)	0.217	13	0.069	16	0.021	96	0.0116	26
Benzo(a)pyrene	(mg/kg)	0.127	16	0.0714	20	0.042	150	0.046	46
Dibenzo(a,h)anthracene	(mg/kg)	0.048	22	0.0714	8.8	0.042	12	0.046	16
Indeno(1,2,3-c,d)pyrene	(mg/kg)	0.048	43	0.0714	13	0.042	88	0.046	47
Benzo(g,h,i)perylene	(mg/kg)	0.022	1.6	0.0714	27	0.042	150	0.046	65
Dibenzo(a,e)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,h)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,i)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,l)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA
Dibenz(a,j)acridine	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA
Total PAHs	(mg/kg)	1.6956	214.33	2.3458	194.84	0.547	2299.8	0.5676	376.55
Total PAHs	%	0.00016956	0.021433	0.00023458	0.019484	0.0000547	0.22998	0.00005676	0.037655

NOTES:
NA - Not Analyzed
For RCL DRF-REQ

Table 1 PAH Concentrations in Soil—Gas Works Park (Continued)

Constituent	Site: / Sample ID: / Date: / Depth (ft): / Result Type:	EPA22 200 4/19/84 3 Primary	EPA23 177 4/19/84 0.5 Primary	EPA23 201 4/19/84 3 Primary	EPA24 178 4/19/84 0.5 Primary	EPA24 202 4/19/84 3 Primary	EPA3 157 4/17/84 0.5 Primary	EPA3 181 4/17/84 3 Primary	EPA4 158 4/17/84 0.5 Primary	EPA4 182 4/17/84 3 Primary
Starting Depth	(feet)	2.75	0	2.75	0	2.75	0	2.75	0	2.75
Ending Depth	(feet)	3.25	0.5	3.25	0.5	3.25	0.5	3.25	0.5	3.25
Acenaphthene	(mg/kg)	0.024	0.2	1.026	0.6	0.488	0.3	0.952	1.3	0.93
Acenaphthylene	(mg/kg)	0.065	0.77	1.077	2.1	0.415	0.14	0.413	2.8	2.465
Fluorene	(mg/kg)	0.013	0.21	0.244	0.97	0.088	0.21	0.952	4.1	0.419
Anthracene	(mg/kg)	0.024	1.4	1.026	1	0.488	0.44	0.952	12	0.93
Fluoranthene	(mg/kg)	0.108	16	21.59	12	11.158	3.5	4.136	66	5.07
Phenanthrene	(mg/kg)	0.171	14	6.821	11	2.341	4.9	0.964	160	5.349
Benzo(a)anthracene	(mg/kg)	0.045	3.7	17.897	5.2	6.098	4.7	1.517	44	1.302
Benzo(b)fluoranthene	(mg/kg)	0.041	17	8.667	16	3.195	4	5.561	55	1.86
Benzo(k)fluoranthene	(mg/kg)	0.047	NA	46.872	NA	9.463	NA	1.905	NA	1.86
Pyrene	(mg/kg)	0.149	39	29.077	19	15.268	9	7.354	180	7.256
Chrysene	(mg/kg)	0.034	16	38.41	6	13.17	3.5	1.562	72	1.349
Benzo(a)pyrene	(mg/kg)	0.047	30	61.436	10	16.927	5.1	1.905	130	1.86
Dibenzo(a,h)anthracene	(mg/kg)	0.047	20	2.051	12	0.976	2.2	1.905	60	1.86
Indeno(1,2,3-c,d)pyrene	(mg/kg)	0.047	47	37.692	6.6	0.976	9.6	1.905	100	1.86
Benzo(g,h,i)perylene	(mg/kg)	0.047	61	2.051	8.2	0.976	18	1.905	170	1.86
Dibenzo(a,e)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,h)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,i)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,l)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenz(a,j)acridine	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total PAHs	(mg/kg)	0.909	266.28	275.937	110.67	82.027	65.59	33.888	1057.2	36.23
Total PAHs	%	0.0000909	0.026628	0.0275937	0.011067	0.0082027	0.006559	0.0033888	0.10572	0.003623

NOTES:

NA - Not Analyzed

For RCL DRF-REQ

Table 1 PAH Concentrations in Soil—Gas Works Park (Continued)

Constituent	Site: / Sample ID: / Date: / Depth (ft): / Result Type:	EPA5 159 4/17/84 0.5 Primary	EPA5 183 4/17/84 3 Primary	EPA6 160 4/17/84 0.5 Primary	EPA6 184 4/17/84 3 Primary	EPA7 161 4/17/84 0.5 Primary	EPA7 185 4/17/84 3 Primary	EPA8 162 4/17/84 0.5 Primary	EPA8 186 4/17/84 3 Primary	EPA9 163 4/17/84 0.5 Primary
Starting Depth	(feet)	0	2.75	0	2.75	0	2.75	0	2.75	0
Ending Depth	(feet)	0.5	3.25	0.5	3.25	0.5	3.25	0.5	3.25	0.5
Acenaphthene	(mg/kg)	0.23	0.909	0.6	0.454	0.65	0.023	0.8	0.92	0.1
Acenaphthylene	(mg/kg)	1.1	1.66	1	2.851	5.7	0.008	10	6.069	0.44
Fluorene	(mg/kg)	0.17	0.244	0.6	0.17	0.67	0.023	3.5	0.506	0.15
Anthracene	(mg/kg)	1.8	0.909	0.65	0.454	11	0.023	4.9	0.92	0.84
Fluoranthene	(mg/kg)	8.3	5.509	8.7	14.386	75	0.076	35	6.759	6.9
Phenanthrene	(mg/kg)	9.2	3.295	3.2	2.916	43	0.0425	34	5.655	7.5
Benzo(a)anthracene	(mg/kg)	9.7	3.561	5.6	9.348	51	0.0184	25	1.793	4.4
Benzo(b)fluoranthene	(mg/kg)	20	2.841	14	0.909	83	0.023	41	1.333	7.3
Benzo(k)fluoranthene	(mg/kg)	NA	1.818	NA	0.909	NA	0.046	NA	1.839	NA
Pyrene	(mg/kg)	27	8.523	13	22.041	190	0.13	68	9.609	20
Chrysene	(mg/kg)	18	5.637	7.5	15.909	110	0.015	28	2.667	9
Benzo(a)pyrene	(mg/kg)	43	5.04	17	1.267	180	0.046	36	1.761	15
Dibenzo(a,h)anthracene	(mg/kg)	28	1.818	6	0.909	110	0.046	86	1.839	1.2
Indeno(1,2,3-c,d)pyrene	(mg/kg)	46	1.818	16	0.909	430	0.046	34	1.839	24
Benzo(g,h,i)perylene	(mg/kg)	84	1.818	20	0.909	520	0.046	61	1.839	30
Dibenzo(a,e)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,h)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,i)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,l)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenz(a,j)acridine	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total PAHs	(mg/kg)	296.5	45.4	113.85	74.341	1810.02	0.6119	467.2	45.348	126.83
Total PAHs	%	0.02965	0.00454	0.011385	0.0074341	0.181002	0.00006119	0.04672	0.0045348	0.012683

NOTES:
NA - Not Analyzed
For RCL DRF-REQ

Table 1 PAH Concentrations in Soil—Gas Works Park (Continued)

Constituent	Site: / Sample ID: / Date: / Depth (ft): / Result Type:	EPA9 / 187 / 4/17/84 / 3 / Primary	F10 / 53 / 3/15/85 / 0.16 / Primary	F16 / 54 / 3/15/85 / 0.16 / Primary	F24 / 55 / 3/15/85 / 0.16 / Primary	G19 / 56 / 3/15/85 / 0.16 / Primary	G27 / 57 / 3/15/85 / 0.16 / Primary	H10 / 58 / 3/15/85 / 0.16 / Primary	H22 / 59 / 3/15/85 / 0.16 / Primary	H32 / 60 / 3/15/85 / 0.16 / Primary
Starting Depth	(feet)	2.75	0	0	0	0	0	0	0	0
Ending Depth	(feet)	3.25	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16
Acenaphthene	(mg/kg)	1.039	2	20	20	2	2	20	2	2
Acenaphthylene	(mg/kg)	2.961	1	1	10	1	1	10	1	1
Fluorene	(mg/kg)	0.571	0.34	1.9	2	0.2	1.3	4.6	0.47	0.2
Anthracene	(mg/kg)	1.039	0.072	0.28	0.91	0.02	0.19	2.2	0.14	0.074
Fluoranthene	(mg/kg)	6.442	1.2	4.7	7.9	0.53	1.8	22	1.6	1.1
Phenanthrene	(mg/kg)	7.688	0.56	1.8	5.2	0.16	1.2	12	0.92	0.7
Benzo(a)anthracene	(mg/kg)	1.61	0.66	2	4.8	0.25	1.1	12	1.2	0.57
Benzo(b)fluoranthene	(mg/kg)	0.779	0.88	2.3	4.5	0.34	1.3	11	1.5	0.53
Benzo(k)fluoranthene	(mg/kg)	2.078	0.38	1	1.8	0.14	0.57	4.5	0.57	0.23
Pyrene	(mg/kg)	8.468	2.2	7.8	15	0.84	3.2	38	3.3	1.9
Chrysene	(mg/kg)	2.286	0.87	2.6	5.9	0.37	1.2	15	1.5	0.79
Benzo(a)pyrene	(mg/kg)	1.234	1.1	2.9	6.2	0.33	1.3	13	1.9	0.59
Dibenzo(a,h)anthracene	(mg/kg)	2.078	0.4	0.48	4	0.4	0.4	4	0.4	0.4
Indeno(1,2,3-c,d)pyrene	(mg/kg)	2.078	1.4	2.6	8	0.43	1.3	14	2.8	1.2
Benzo(g,h,i)perylene	(mg/kg)	2.078	1.9	3.2	10	0.54	2.4	14	2.9	0.91
Dibenzo(a,e)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,h)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,i)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,l)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenz(a,j)acridine	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total PAHs	(mg/kg)	42.429	14.962	54.56	106.21	7.55	20.26	196.3	22.2	12.194
Total PAHs	%	0.0042429	0.0014962	0.005456	0.010621	0.000755	0.002026	0.01963	0.00222	0.0012194

NOTES:
NA - Not Analyzed
For RCL DRF-REQ

Table 1 PAH Concentrations in Soil—Gas Works Park (Continued)

Constituent	Site: / Sample ID: / Date: / Depth (ft): / Result Type:	I13 / 61 / 3/15/85 / 0.16 / Primary	I21 / 62 / 3/15/85 / 0.16 / Primary	I29 / 63 / 3/15/85 / 0.16 / Primary	J14 / 64 / 3/15/85 / 0.16 / Primary	J32 / 65 / 3/15/85 / 0.16 / Primary	K17 / 66 / 3/15/85 / 0.16 / Primary	K33 / 67 / 3/15/85 / 0.16 / Primary	L12 / 68 / 3/15/85 / 0.16 / Primary	L20 / 69 / 3/15/85 / 0.16 / Primary
Starting Depth	(feet)	0	0	0	0	0	0	0	0	0
Ending Depth	(feet)	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16
Acenaphthene	(mg/kg)	20	20	20	20	20	20	20	20	20
Acenaphthylene	(mg/kg)	10	10	10	10	10	10	10	10	10
Fluorene	(mg/kg)	2	2.9	4.4	4.7	2	2	2	2	20
Anthracene	(mg/kg)	0.81	2.1	3.9	3.4	2.7	0.3	0.2	1.9	10
Fluoranthene	(mg/kg)	10	19	44	27	42	4.4	4.6	2	65
Phenanthrene	(mg/kg)	4.1	14	35	21	9.7	3.2	2.5	11	79
Benzo(a)anthracene	(mg/kg)	5.4	12	19	15	13	1.2	2.7	11	27
Benzo(b)fluoranthene	(mg/kg)	6.4	11	15	12	12	2	3.2	11	17
Benzo(k)fluoranthene	(mg/kg)	2.6	5	6.9	5.3	5.7	0.8	1.2	4.4	8
Pyrene	(mg/kg)	16	34	63	47	56	6.8	6.7	36	100
Chrysene	(mg/kg)	7.1	15	22	17	16	2.8	3.3	14	29
Benzo(a)pyrene	(mg/kg)	7.1	15	19	16	14	2.4	3.3	13	23
Dibenzo(a,h)anthracene	(mg/kg)	4	4	4	4	4	4	4	4	4
Indeno(1,2,3-c,d)pyrene	(mg/kg)	9.1	15	18	15	14	3.4	4.8	16	20
Benzo(g,h,i)perylene	(mg/kg)	9.4	21	24	20	7.3	3.6	4.9	16	18
Dibenzo(a,e)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,h)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,i)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,l)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenz(a,j)acridine	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total PAHs	(mg/kg)	114.01	200	308.2	237.4	228.4	66.9	73.4	172.3	450
Total PAHs	%	0.011401	0.02	0.03082	0.02374	0.02284	0.00669	0.00734	0.01723	0.045

NOTES:

NA - Not Analyzed

For RCL DRF-REQ

Table 1 PAH Concentrations in Soil—Gas Works Park (Continued)

Constituent	Site: / Sample ID: / Date: / Depth (ft): / Result Type:	L28 70 3/15/85 0.16 Primary	M10 71 3/15/85 0.16 Primary	M17 72 3/15/85 0.16 Primary	M31 73 3/15/85 0.16 Primary	MW1 116 2/11/87 58 Primary	MW10 123 2/11/87 3.4 Primary	MW12 124 2/11/87 3.3 Primary	MW14 125 2/11/87 6 Primary	MW3 117 2/11/87 4.3 Primary
Starting Depth	(feet)	0	0	0	0	57.5	3	3	5.5	4
Ending Depth	(feet)	0.16	0.16	0.16	0.16	58.5	3.5	3.5	6.5	4.5
Acenaphthene	(mg/kg)	20	20	20	20	0.37	0.33	1.1	1.9	0.73
Acenaphthylene	(mg/kg)	1	10	10	1	0.37	0.33	1.4	0.065	0.73
Fluorene	(mg/kg)	2.2	2	2	1.6	0.37	0.33	6.4	0.34	0.73
Anthracene	(mg/kg)	0.21	2.8	1.6	0.36	0.37	0.33	3.4	0.28	0.73
Fluoranthene	(mg/kg)	1.9	57	24	6.8	0.37	0.054	13	0.74	0.73
Phenanthrene	(mg/kg)	1.2	14	9.4	2.2	0.37	0.053	23	0.23	0.73
Benzo(a)anthracene	(mg/kg)	1.1	32	12	3.5	0.37	0.33	5.8	0.037	0.73
Benzo(b)fluoranthene	(mg/kg)	1.3	28	13	3.7	0.37	0.04	10	0.037	0.73
Benzo(k)fluoranthene	(mg/kg)	0.59	13	5.4	1.7	0.37	0.04	10	0.037	0.73
Pyrene	(mg/kg)	3.2	100	41	11	0.37	0.11	20	1.1	0.73
Chrysene	(mg/kg)	1.5	27	16	4.2	0.37	0.033	8	0.051	0.73
Benzo(a)pyrene	(mg/kg)	1.6	35	16	4.7	0.37	0.33	5.3	0.37	0.73
Dibenzo(a,h)anthracene	(mg/kg)	0.4	4	4	3.1	0.37	0.33	1.5	0.37	0.73
Indeno(1,2,3-c,d)pyrene	(mg/kg)	1.9	29	19	5.3	0.37	0.33	5.5	0.37	0.73
Benzo(g,h,i)perylene	(mg/kg)	2.6	27	24	5.6	0.37	0.33	5.6	0.37	0.73
Dibenzo(a,e)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,h)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,i)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,l)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenz(a,j)acridine	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total PAHs	(mg/kg)	40.7	400.8	217.4	74.76	5.55	3.3	120	6.297	10.95
Total PAHs	%	0.00407	0.04008	0.02174	0.007476	0.000555	0.00033	0.012	0.0006297	0.001095

NOTES:
NA - Not Analyzed
For RCL DRF-REQ

Table 1 PAH Concentrations in Soil—Gas Works Park (Continued)

Constituent	Site: / Sample ID: / Date: / Depth (ft): / Result Type:	MW4 118 2/11/87 3.7 Primary	MW6 119 2/11/87 5.8 Primary	MW7 126 2/11/87 8 Primary	MW9 121 2/11/87 2.5 Primary	MW9 122 2/11/87 5.7 Primary	N18 74 3/15/85 0.16 Primary	N26 75 3/15/85 0.16 Primary	P19 76 3/15/85 0.16 Primary	S-1 S-1 10/23/97 0 Primary
Starting Depth	(feet)	3.5	5.5	7.5	2.25	5.5	0	0	0	0
Ending Depth	(feet)	4	6	8.5	2.75	6	0.16	0.16	0.16	0
Acenaphthene	(mg/kg)	1.1	1.8	0.46	0.33	0.22	20	20	20	<0.2
Acenaphthylene	(mg/kg)	1.6	1.9	0.46	3	0.5	10	10	10	1.97
Fluorene	(mg/kg)	6.5	2.1	0.46	1.3	0.39	2	2	2	0.365
Anthracene	(mg/kg)	1	3.1	0.46	2.4	0.54	0.21	2.8	2.6	1.66
Fluoranthene	(mg/kg)	11	26	0.46	26	4.3	2.8	19	36	13.5
Phenanthrene	(mg/kg)	19	18	0.46	26	3.3	1.5	5.4	15	5.16
Benzo(a)anthracene	(mg/kg)	6.6	8.5	0.46	8.6	3.4	1.4	5.8	11	8.13
Benzo(b)fluoranthene	(mg/kg)	11	16	0.46	19	4.1	2	4.9	12	12.7
Benzo(k)fluoranthene	(mg/kg)	11	16	0.46	19	4.1	0.79	2.1	5.5	3.55
Pyrene	(mg/kg)	19	33	0.46	43	5.9	4.5	26	48	29.8
Chrysene	(mg/kg)	6.2	9.4	0.46	12	2.5	1.8	7.8	14	9.15
Benzo(a)pyrene	(mg/kg)	5.5	13	0.46	15	2.9	1.9	4.2	16	11
Dibenzo(a,h)anthracene	(mg/kg)	1.6	1.8	0.46	2	0.57	4	4	4	1.64
Indeno(1,2,3-c,d)pyrene	(mg/kg)	5.3	12	0.46	13	1.8	3.5	8.4	14	11.3
Benzo(g,h,i)perylene	(mg/kg)	6.1	14	0.46	16	1.9	4.4	10	15	13.4
Dibenzo(a,e)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,h)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,i)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,l)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenz(a,j)acridine	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total PAHs	(mg/kg)	112.5	176.6	6.9	206.63	36.42	60.8	132.4	225.1	123.325
Total PAHs	%	0.01125	0.01766	0.00069	0.020663	0.003642	0.00608	0.01324	0.02251	0.0123325

NOTES:

NA - Not Analyzed

For RCL DRF-REQ

Table 1 PAH Concentrations in Soil—Gas Works Park (Continued)

Constituent	Site: / Sample ID: / Date: / Depth (ft): / Result Type:	S-10 / S-10 / 10/23/97 / 0 / Primary	S-2 / S-2 / 10/23/97 / 0 / Primary	S-3 / S-3 / 10/23/97 / 0 / Primary	S-4 / S-4 / 10/23/97 / 0 / Primary	S-5 / S-5 / 10/23/97 / 0 / Primary	S-6 / S-6 / 10/23/97 / 0 / Primary	S-7 / S-7 / 10/23/97 / 0 / Primary	S-8 / S-8 / 10/23/97 / 0 / Primary
Starting Depth	(feet)	0	0	0	0	0	0	0	0
Ending Depth	(feet)	0	0	0	0	0	0	0	0
Acenaphthene	(mg/kg)	<0.01	<0.2	<0.2	<0.1	<0.5	0.214	0.2	<0.1
Acenaphthylene	(mg/kg)	<0.01	2.74	1.43	0.739	9.46	4.2	4.67	1.02
Fluorene	(mg/kg)	<0.01	0.443	<0.2	0.134	1.98	1.01	0.704	<0.1
Anthracene	(mg/kg)	<0.01	1.76	0.869	0.627	7.11	2.18	2.75	0.566
Fluoranthene	(mg/kg)	0.0508	9.92	5.86	4.13	62.5	7.11	10.4	2.22
Phenanthrene	(mg/kg)	0.0538	6.83	1.91	2.07	37.3	6.29	8.52	0.871
Benzo(a)anthracene	(mg/kg)	0.0254	5.56	3.55	1.87	23.3	5.03	6.51	1.73
Benzo(b)fluoranthene	(mg/kg)	0.0308	9.42	6.18	3.18	35.4	7.45	11.4	3.89
Benzo(k)fluoranthene	(mg/kg)	0.01	2.77	2.14	0.97	12	2.32	3.69	1.11
Pyrene	(mg/kg)	0.0831	17.3	11.2	7.34	102	13.6	20.3	4.65
Chrysene	(mg/kg)	0.0315	7.61	4.36	2.2	27.7	5.93	7.59	2.32
Benzo(a)pyrene	(mg/kg)	0.0269	7.55	5.94	2.71	36	8.67	11.8	4.12
Dibenzo(a,h)anthracene	(mg/kg)	<0.01	1.45	1.11	0.522	5.57	1.58	2.27	0.729
Indeno(1,2,3-c,d)pyrene	(mg/kg)	0.0269	10.5	8.02	3.9	44.4	10.2	16.9	5.72
Benzo(g,h,i)perylene	(mg/kg)	0.0254	11.7	9.05	4.47	53.7	12	20.4	7.08
Dibenzo(a,e)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,h)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,i)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,l)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA
Dibenz(a,j)acridine	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA
Total PAHs	(mg/kg)	0.3646	95.553	61.619	34.862	458.42	87.784	128.104	36.026
Total PAHs	%	0.00003646	0.0095553	0.0061619	0.0034862	0.045842	0.0087784	0.0128104	0.0036026

NOTES:
NA - Not Analyzed
For RCL DRF-REQ

Table 1 PAH Concentrations in Soil—Gas Works Park (Continued)

Constituent	Site: / Sample ID: / Date: / Depth (ft): / Result Type:	S-9 / S-9 / 10/23/97 / 0 / Primary	S-9 / S-9 / 10/23/97 / 0 / Duplicate 1	UW1 / 77 / 5/24/84 / 0.08 / Primary	UW10 / 86 / 5/24/84 / 0.08 / Primary	UW11 / 87 / 5/24/84 / 0.08 / Primary	UW12 / 88 / 5/24/84 / 0.08 / Primary	UW13 / 89 / 5/24/84 / 0.08 / Primary	UW14 / 90 / 5/24/84 / 0.08 / Primary	UW15 / 91 / 5/24/84 / 0.08 / Primary
Starting Depth	(feet)	0	0	0	0	0	0	0	0	0
Ending Depth	(feet)	0	0	0.08	0.08	0.08	0.08	0.08	0.08	0.08
Acenaphthene	(mg/kg)	3.99	3.88	NA	0.99	NA	0.48	NA	NA	NA
Acenaphthylene	(mg/kg)	7.64	7.76	NA	19.6	NA	2.61	NA	NA	NA
Fluorene	(mg/kg)	7.48	7.87	NA	7.36	NA	0.94	NA	NA	NA
Anthracene	(mg/kg)	10.5	12.1	NA	5.72	NA	1.68	NA	NA	NA
Fluoranthene	(mg/kg)	43.1	48.9	NA	93.1	NA	9.53	NA	NA	NA
Phenanthrene	(mg/kg)	40.5	47.6	NA	79.2	NA	14.8	NA	NA	NA
Benzo(a)anthracene	(mg/kg)	19.3	18.2	NA	51.3	NA	4.84	NA	NA	NA
Benzo(b)fluoranthene	(mg/kg)	29.1	29.6	NA	44.6	NA	6.19	NA	NA	NA
Benzo(k)fluoranthene	(mg/kg)	8.71	9.18	NA	NA	NA	NA	NA	NA	NA
Pyrene	(mg/kg)	74.4	81.2	NA	98.4	NA	17.8	NA	NA	NA
Chrysene	(mg/kg)	22.4	23	NA	59.4	NA	6.21	NA	NA	NA
Benzo(a)pyrene	(mg/kg)	30.9	31.6	0.94	NA	0.034	NA	1.04	0.52	1.64
Dibenzo(a,h)anthracene	(mg/kg)	4.67	5.26	NA	36.7	NA	7.75	NA	NA	NA
Indeno(1,2,3-c,d)pyrene	(mg/kg)	32.8	36.7	NA	31.8	NA	2.82	NA	NA	NA
Benzo(g,h,i)perylene	(mg/kg)	39	42.9	NA	31.5	NA	10	NA	NA	NA
Dibenzo(a,e)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,h)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,i)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,l)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenz(a,j)acridine	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total PAHs	(mg/kg)	374.49	405.75	0.94	559.67	0.034	85.65	1.04	0.52	1.64
Total PAHs	%	0.037449	0.040575	0.000094	0.055967	0.0000034	0.008565	0.000104	0.000052	0.000164

NOTES:

NA - Not Analyzed

For RCL DRF-REQ

Table 1 PAH Concentrations in Soil—Gas Works Park (Continued)

Constituent	Site: / Sample ID: / Date: / Depth (ft): / Result Type:	UW16 92 5/24/84 0.08 Primary	UW17 93 5/24/84 0.08 Primary	UW18 94 5/24/84 0.08 Primary	UW19 95 5/24/84 0.08 Primary	UW2 78 5/24/84 0.08 Primary	UW20 96 5/24/84 0.08 Primary	UW21 97 5/24/84 0.08 Primary	UW22 98 5/24/84 0.08 Primary	UW24 99 5/24/84 0.08 Primary
Starting Depth	(feet)	0	0	0	0	0	0	0	0	0
Ending Depth	(feet)	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
Acenaphthene	(mg/kg)	NA	NA	NA	NA	NA	NA	0.1	NA	NA
Acenaphthylene	(mg/kg)	NA	NA	NA	NA	NA	NA	3.79	NA	NA
Fluorene	(mg/kg)	NA	NA	NA	NA	NA	NA	0.26	NA	NA
Anthracene	(mg/kg)	NA	NA	NA	NA	NA	NA	0.8	NA	NA
Fluoranthene	(mg/kg)	NA	NA	NA	NA	NA	NA	14.9	NA	NA
Phenanthrene	(mg/kg)	NA	NA	NA	NA	NA	NA	8.46	NA	NA
Benzo(a)anthracene	(mg/kg)	NA	NA	NA	NA	NA	NA	9.98	NA	NA
Benzo(b)fluoranthene	(mg/kg)	NA	NA	NA	NA	NA	NA	11.9	NA	NA
Benzo(k)fluoranthene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	24.3	NA	NA
Chrysene	(mg/kg)	NA	NA	NA	NA	NA	NA	10.6	NA	NA
Benzo(a)pyrene	(mg/kg)	2.79	7.86	5.68	22.2	0.99	22.2	NA	11.8	14.8
Dibenzo(a,h)anthracene	(mg/kg)	NA	NA	NA	NA	NA	NA	13.6	NA	NA
Indeno(1,2,3-c,d)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	3.1	NA	NA
Benzo(g,h,i)perylene	(mg/kg)	NA	NA	NA	NA	NA	NA	17.5	NA	NA
Dibenzo(a,e)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,h)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,i)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,l)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenz(a,j)acridine	(mg/kg)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total PAHs	(mg/kg)	2.79	7.86	5.68	22.2	0.99	22.2	119.29	11.8	14.8
Total PAHs	%	0.000279	0.000786	0.000568	0.00222	0.000099	0.00222	0.011929	0.00118	0.00148

NOTES:

NA - Not Analyzed

For RCL DRF-REQ

Table 1 PAH Concentrations in Soil—Gas Works Park (Continued)

Constituent	Site: / Sample ID: / Date: / Depth (ft): / Result Type:	UW3 79 5/24/84 0.08 Primary	UW4 80 5/24/84 0.08 Primary	UW5 81 5/24/84 0.08 Primary	UW6 82 5/24/84 0.08 Primary	UW7 83 5/24/84 0.08 Primary	UW8 84 5/24/84 0.08 Primary	UW9 85 5/24/84 0.08 Primary
Starting Depth	(feet)	0	0	0	0	0	0	0
Ending Depth	(feet)	0.08	0.08	0.08	0.08	0.08	0.08	0.08
Acenaphthene	(mg/kg)	NA	NA	NA	0.79	NA	NA	0.58
Acenaphthylene	(mg/kg)	NA	NA	NA	4.66	NA	NA	5.77
Fluorene	(mg/kg)	NA	NA	NA	1.09	NA	NA	1.28
Anthracene	(mg/kg)	NA	NA	NA	1.94	NA	NA	2.5
Fluoranthene	(mg/kg)	NA	NA	NA	8.4	NA	NA	34.8
Phenanthrene	(mg/kg)	NA	NA	NA	11	NA	NA	23.7
Benzo(a)anthracene	(mg/kg)	NA	NA	NA	8	NA	NA	17.6
Benzo(b)fluoranthene	(mg/kg)	NA	NA	NA	11.8	NA	NA	23.2
Benzo(k)fluoranthene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA
Pyrene	(mg/kg)	NA	NA	NA	14.2	NA	NA	51.6
Chrysene	(mg/kg)	NA	NA	NA	10	NA	NA	28
Benzo(a)pyrene	(mg/kg)	5.23	1.48	18.4	NA	3.22	5.53	NA
Dibenzo(a,h)anthracene	(mg/kg)	NA	NA	NA	11.1	NA	NA	18.6
Indeno(1,2,3-c,d)pyrene	(mg/kg)	NA	NA	NA	3.1	NA	NA	4.12
Benzo(g,h,i)perylene	(mg/kg)	NA	NA	NA	14	NA	NA	17.5
Dibenzo(a,e)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,h)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,i)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA
Dibenzo(a,l)pyrene	(mg/kg)	NA	NA	NA	NA	NA	NA	NA
Dibenz(a,j)acridine	(mg/kg)	NA	NA	NA	NA	NA	NA	NA
Total PAHs	(mg/kg)	5.23	1.48	18.4	100.08	3.22	5.53	229.25
Total PAHs	%	0.000523	0.000148	0.00184	0.010008	0.000322	0.000553	0.022925

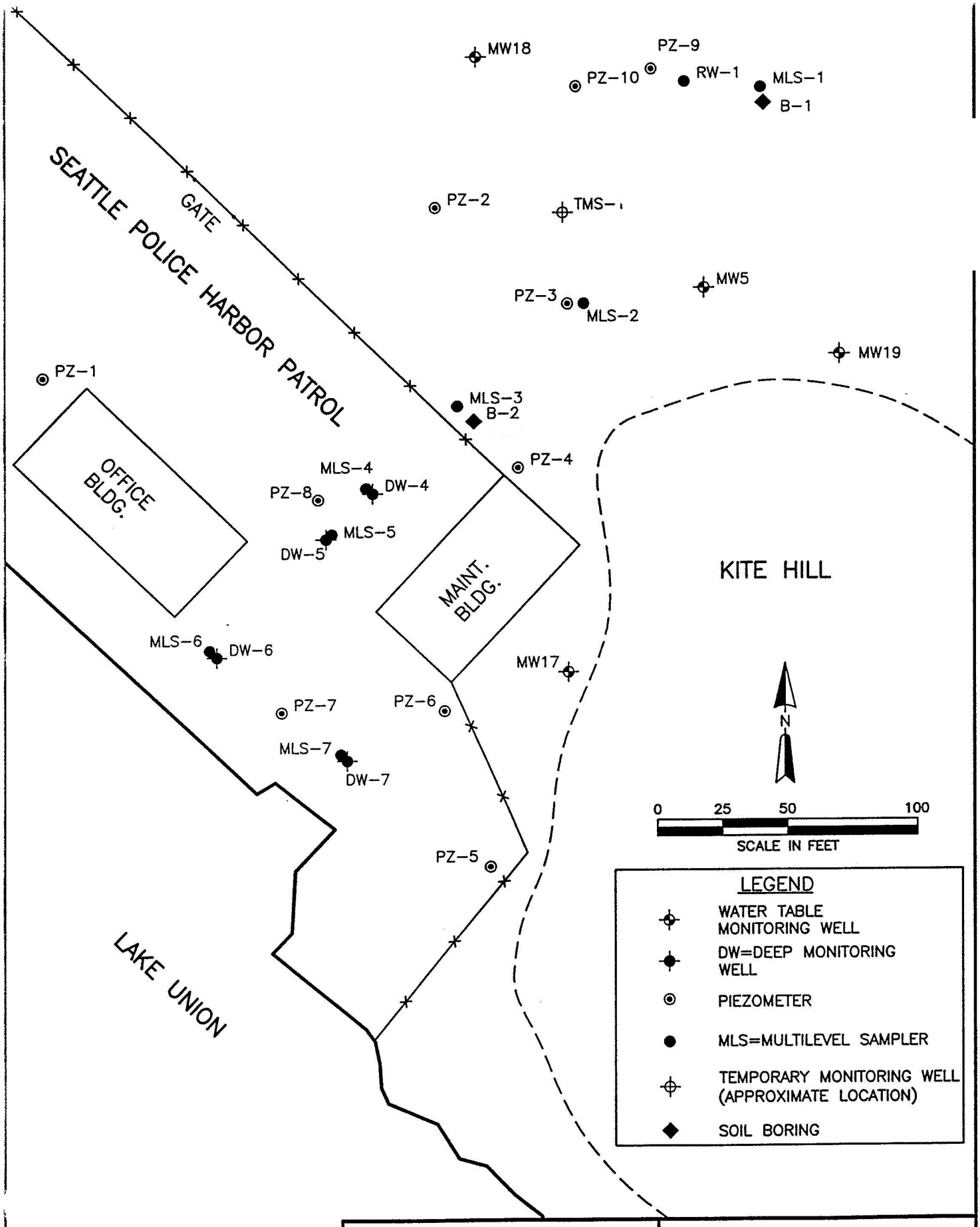
NOTES:
NA - Not Analyzed
For RCL DRF-REQ

Table 3-8 Soil and Aqueous-Phase PAH Concentrations

Location:	B-2	DW-5	DW-5	DW-7	MW-22	MW-23
Depth (ft):	16.5	7	27.5	15	3	3
Laboratory ID:	GW3	GW5	GW4	GW6	GW2	GW1
Soil Concentrations (mg/kg)						
Naphthalene	6,695	968	1,306	316	164	57
2-Naphthalene	2,896	314	567	160	9	13
1-Naphthalene	1,722	220	327	103	5	7
Acenaphthalene	436	58	105	11	21	28
Acenaphthlene	447	115	76	71	1	5
Fluorene	570	148	122	31	9	13
Phenanthrene	1,550	506	331	90	197	183
Anthracene	409	152	87	23	30	52
Fluoranthene	516	200	112	33	353	577
Pyrene	612	234	133	40	477	773
benz(a)anthracene	194	74	43	13	105	236
Chrysene	175	68	37	10	119	211
Benzo(a)pyrene	146	65	34	8	191	289
Sum	**16,369**	**3,121**	**3,281**	**908**	**1,681**	**2,445**
Aqueous-phase Concentrations (µg/kg)						
Naphthalene	19,809	6,515	13,853	110	1,000	6
2-Naphthalene	2,229	761	1,629	55	10	0.26
1-Naphthalene	1,442	560	1,159	156	10	7
Acenaphthalene	256	81	270	20	15	14
Acenaphthlene	151	170	155	246	3	7
Fluorene	108	109	118	76	5	8
Phenanthrene	102	122	119	120	65	33
Anthracene	24	11	3	21	5	6
Fluoranthene	5	7	7	12	12	21
Pyrene	0.3	7	0.05	11	18	23
benz(a)anthracene	0.1	0.02	0.3	0.4	0.6	0.6
Chrysene	0.03	0.05	0.2	0.1	0.4	0.2
Benzo(a)pyrene	0.01	0.03	0.1	0.04	0.04	0.1
Sum	**24,126**	**8,343**	**17,314**	**828**	**1,144**	**126**

NOTES:

Depths are in feet below ground surface.



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REMEDIATION TECHNOLOGIES INC

GAS WORKS PARK				WESTERN STUDY AREA MAP	
5-3434-300					
CURRENT DATE	7/2/98	CADD FILE	3434S035	DRAWING NO.	FIGURE 2-1

Figure 2-4
Site Map of Gas Works Park Showing Sampling Locations, 1984-1995

- Surface soil sample (EPA 1984)
- Surface soil and water sample (EPA 1984)
- 6 in. and 3 ft. soil sample (Ecology and Environment 1984)
- Surface soil sample (U. of Washington 1984)
- Surface soil sample (Tetra Tech 1985)
- Soil surface sample (HDR 1988)
- Soil and water sample (EPA 1995)
- Groundwater monitoring well (Tetra Tech 1987)
- Temporary groundwater monitoring well (HDR 1988)
- Groundwater monitoring well (HDR 1989)
- Contour interval (10 feet)
- Contour interval (2 feet)
- Sewer/drainage
- Shoreline
- Building

Location of the two pre-FFS soil samples with >1% PAH

NOTE: Both locations were subsequently excavated and covered with clean fill.

N

Feet

0 60 120 180

Vertical Datum = NAVD 1988

BASE DATA PROVIDED BY:

Prepared by Parametrix, Inc. File: gasworks/ri_report/sampling.gra Date: November 03, 1998 *Parametrix, Inc. expressly disclaims any guarantee of accuracy of any depiction of the base data.*

DRAFT

Table 13-5a. Life-cycle cost estimate for Alternative 5: excavation of all soils exceeding MTCA Method B Cleanup Lev to the MTCA point of complaince depth of 15 feet.

Item No.	Item Description		Quantity	Units	Unit Price	Extension
1	General Requirements	7%	1	LS	$1,127,600	$1,127,600
2	Mobilization	5%	1	LS	$1,739,500	$1,739,500
3	Demolition/Reconstruction of Play Barn		1	LS	$1,500,000	$1,500,000
4	Demolition of Cracking Towers		1	LS	$500,000	$500,000
5	Soils Excavation/Stockpile		384,780	CY	$20	$7,695,600
6	Soils Handling/Trans./Disp. (Non-DW)		543,411	TON	$45	$24,453,500
7	Soils Handling/Trans./Disp. (DW)		33,759	TON	$250	$8,439,800
8	Soils Handling/Trans./Disp. (EHW)		0	TON	$250	$0
9	Dewatering and Water Treatment		1	LS	$6,105,900	$6,105,900
10	Backfill Material and Placement		384,780	CY	$15.00	$5,771,700
11	Final Grading & Seed Prep.		15.9	AC	$1,000	$15,900
12	Irrigation System		15.9	AC	$30,500	$485,000
13	Hydroseed (seed/mulch/fert.)		15.9	AC	$2,500	$39,800
14	Surface Water Management		20.0	AC	$5,000	$100,000
	SUBTOTAL					**$57,974,300**
15	Contingency (on items 3 through 17)		15%			$8,266,100
16	Engineering (on items 3 through 16)		10%			$5,510,700
17	Construction Eng./Inspection (on items 3 through 16)		10%			$5,510,700
18	Construction Env. Monitoring (on items 3 through 16)		5%			$2,755,400
	TOTAL					**$80,017,200**

Budget Assumptions

General: Does not include park redevelopment. Construction estimates are based on complete installation by a private contractor.

1 Contractor's administrative costs, overhead, and profit (% based on similar projects).

2 Contractor's mobilization and demobilization costs (% based on similar projects).

3 Includes replacement of all contents of the Play Barn and Playground.

4 Assumes structures can be sold as clean scrap and will not be replaced.

5 Soils removed to depth of 15 ft over the acerages shown in Table 13-5b.

6 Estimated cost for non-Dangerous Waste soils handling, transport, and disposal in an eastern WA or OR landfill (without treatment).

7 Estimated cost for Dangerous Waste soils handling, transport, and disposal in an eastern OR landfill (without treatment).

8 Estimated cost for Extremely Hazardous Waste soils handling, transport, and disposal in an eastern OR landfill (without treatment).

9 See Table 13-5c.

10 Locally available, clean, pit-run gravel. Top 1 ft capable of sustaining turf grass and small shrub vegetation.

11 Estimated unit cost for raking and non-amendment soil preparation.

12 Estimated area and unit cost based on Parks Department estimates.

13 Estimated unit cost based on similar Parks Department projects.

14 Estimated unit cost for ditches, bioswales, and control structures. Also includes erosion control during construction.

15 Contingency based on similar clean-up projects with possible unknown limits of contamination.

16 Preparation of construction bid documents (plans, specifications, and engineer's estimate).

17 Third-party construction engineering, inspection, and construction quality assurance.

18 Third-party environmental monitoring during construction (air, water, and soil).

Payment of Washington State sales tax not required for remediation projects.

Table 1: Volume Estimates for Excavation and Disposal of Contaminated Alternative 5.

	Gas Works Park Site Area Designation	Approximate Area (acres)	Estimated Quantities of Soils Exceeding MTCA Method B Cleanup Levels						
			Non-DW		DW		EHW		Total
			%	Vol (cu yd)	%	Vol (cu yd)	%	Vol (cu yd)	Vol (cu yd)
	Area North of Old Railroad Grade								
1	NW Area	1.9	95%	43,681	5%	2,299	0%	0	45,980
2	Parking Lot	1.9	0%	0	0%	0	0%	0	0
	Area South of Old Railroad Grade								
3	American Tar Co. (ATCO)	0.6	95%	13,794	5%	726	0%	0	14,520
4	Kite Hill	2.2	0%	0	0%	0	0%	0	0
5	Cracking Towers	1.0	95%	22,990	5%	1,210	0%	0	24,200
6	Play Barn	3.1	95%	71,269	5%	3,751	0%	0	75,020
7	Benzene Source Area	0.3	50%	3,630	50%	3,630	0%	0	7,260
8	Benzene Plume Area (Less Source Area)	1.0	95%	22,990	5%	1,210	0%	0	24,200
9	Concrete Prow	0.2	0%	0	0%	0	0%	0	0
10	Trees/Vegetation	2.0	95%	45,980	5%	2,420	0%	0	48,400
11	All Other Areas	6.0	95%	137,940	5%	7,260	0%	0	145,200
		20.2		362,274		22,506		0	384,780
NOTES									
-	Waste Categories per WAC 173-303: DW = Dangerous Waste; EHW = Extremely Hazardous Waste								
-	Excavation Depth = 15 ft, the soil point of compliance specified by WAC 173-340-740(6)(c)								
1	Relative % of non-DW versus DW is based on characterization of drill cuttings during the FFS and on results in the site soil sampling database.								
2	No soil contamination was indicated in this area, which was north of the gas plant production area.								
3	See Note 1.								
4	Kite Hill is comprised of over 15 ft of clean glacial till fill imported from the Safeco Building excavation.								
5	See Note 1.								
6	See Note 1.								
7	Relative % of non-DW vs DW is based on soil sampling data from the benzene source area of the former Light Oil Plant.								
8	See Note 1.								
9	The Prow is a solid concrete structure with no underlying contaminated soil.								
10	See Note 1.								
11	See Note 1.								

Table 13-5c. Dewatering cost assumptions for Alternative 5.

Item No.	Item Description		Quantity	Units	Unit Price	Extension
1	General Requirements	7%	1	LS	$263,800	$263,800
2	Mobilization	5%	1	LS	$188,500	$188,500
3	Upland Sheetpile		84,500	SF	$20	$1,690,000
4	Shoreline Sheetpile		37,800	SF	$25	$945,000
5	Dewatering and Water Treatment		756,000	GAL	$1.50	$1,134,000
	SUBTOTAL					**$4,221,300**
6	Contingency (on items 3 through 17)		25%			$942,300
7	Engineering (on items 3 through 16)		10%			$376,900
8	Construction Eng./Inspection (on items 3 through 16)		10%			$376,900
9	Construction Env. Monitoring (on items 3 through 16)		5%			$188,500
	TOTAL					**$6,105,900**

Budget Assumptions

General: ***Does not include park redevelopment. Construction estimates are based on complete installation by a private contractor.***

1 Contractor's administrative costs, overhead, and profit (% based on similar projects).

2 Contractor's mobilization and demobilization costs (% based on similar projects).

3 Upland sheetpile to isolate excavation into 4 areas to reduce groundwater infiltration and discharge.

4 Shoreline sheetpile to isolate excavation from lake to reduce groundwater infiltration and discharge.

5 Estimated direct costs for dewatering and water treatment.

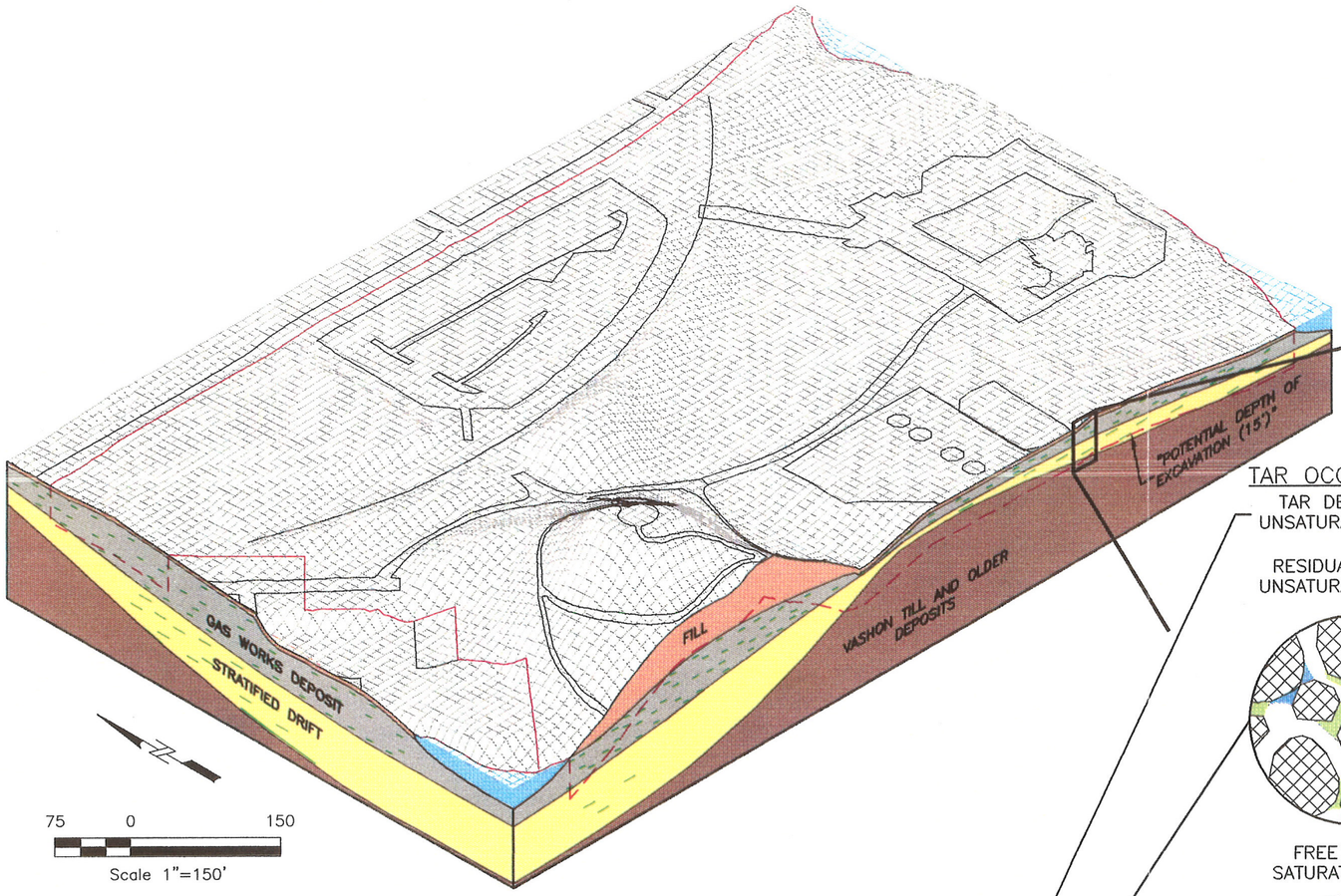
6 Contingency based on similar clean-up projects with possible unknown limits of contamination.

7 Preparation of construction bid documents (plans, specifications, and engineer's estimate).

8 Third-party construction engineering, inspection, and construction quality assurance.

9 Third-party environmental monitoring during construction (air, water, and soil).

Payment of Washington State sales tax not required for remediation projects.



75 0 150

Scale 1"=150'

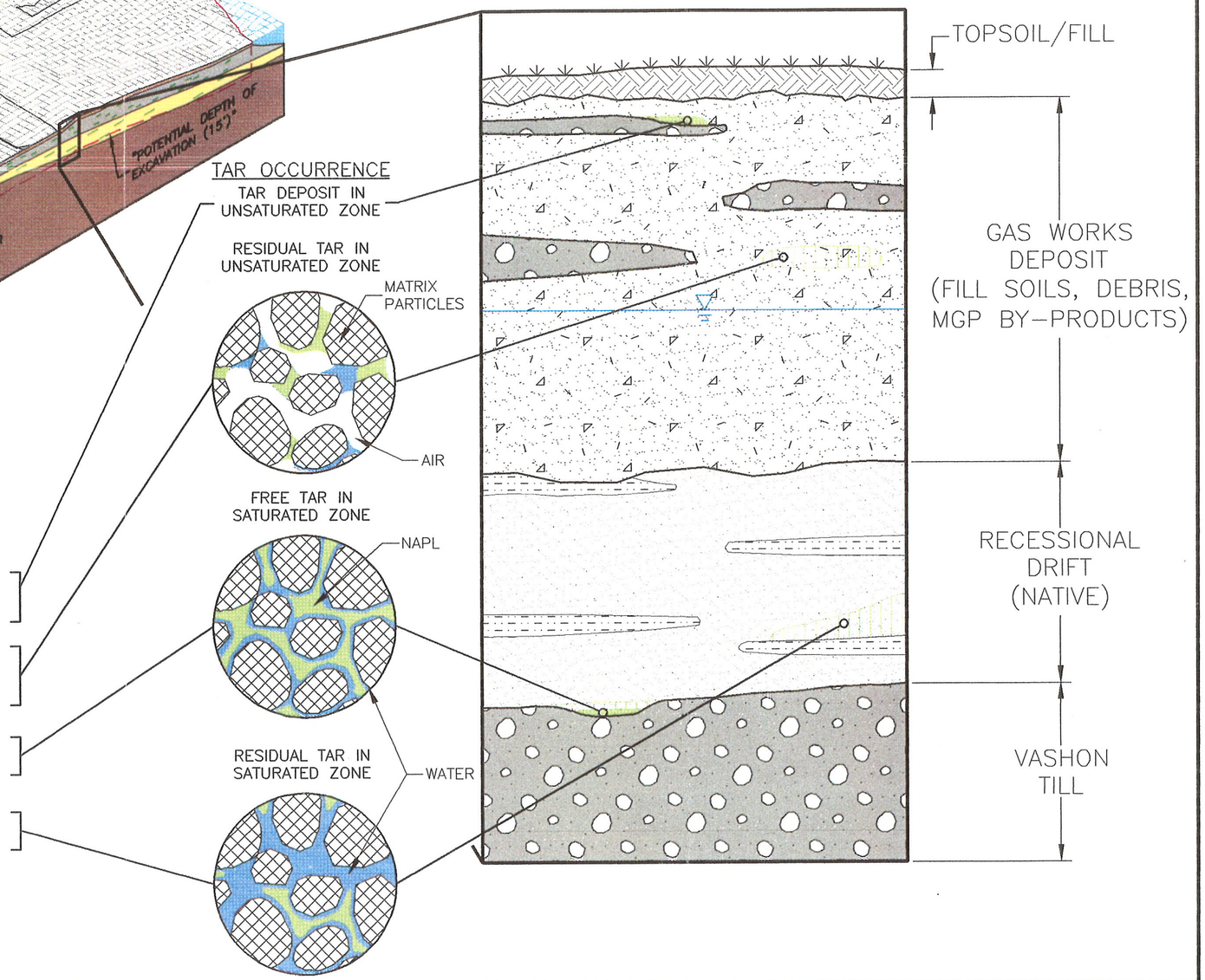
DOES TAR/TARRY SOIL EXCEED 1% TOTAL PAH?

TAR DEPOSITS IN UNSATURATED ZONE (E.G. TAR SEEPS) LIKELY EXCEED 1% PAH. ALL TAR AT SURFACE IDENTIFIED BY THE OCTOBER 1997 TEST PIT INVESTIGATION HAS BEEN REMOVED.

AREAS OF RESIDUAL TAR IN UNSATURATED ZONE DO NOT APPEAR TO EXCEED 1% PAH BASED ON TESTING DATA. ALL KNOWN AREAS OF TAR–SATURATED SOIL AT THE SURFACE HAVE BEEN REMOVED.

AREAS OF FREE TAR IN THE SATURATED ZONE MAY EXCEED 1% PAH. FREE TAR OCCURS AS ISOLATED LENSES OR POCKETS.

AREAS OF RESIDUAL TAR IN THE SATURATED ZONE DO NOT APPEAR TO EXCEED 1% PAH BASED ON TESTING DATA.



ThermoRetec

SEATTLE DEPARTMENT OF PARKS AND RECREATION & PUGET SOUND ENERGY 1-3916-900			SCHEMATIC BLOCK DIAGRAM OF TAR OCCURRENCE AT GAS WORKS PARK
CURRENT DATE 4/5/99	CADD FILE	3916s001	FIGURE 1