STATE OF WASHINGTON
KING COUNTY SUPERIOR COURT

STATE OF WASHINGTON, DEPARTMENT OF ECOLOGY, Plaintiff, v. CITY OF SEATTLE and PUGET SOUND ENERGY, Defendant.	No. 99-2-52532-9 SEA **AMENDMENT NO. 1 TO CONSENT DECREE (GAS WORKS UPLANDS)**

This amendment to Consent Decree No. 99-2-52532-9 is issued pursuant to the authority of RCW 70.105D, the Model Toxics Control Act (MTCA).

STATEMENT OF CURRENT CONDITIONS

A. Consent Decree No. 99-2-52532-9 was signed by the Court and filed on December 23, 1999. The Decree was a negotiated settlement between the Washington State Department of Ecology ("Ecology") and the City of Seattle ("City") and Puget Sound Energy, Inc. (PSE) (collectively the City and PSE are referred to herein as Defendants).

B. Exhibit B to the Consent Decree is the Cleanup Action Plan (CAP), dated June 18, 1999, and approved by Ecology on June 18, 1999.

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C. Improvements to the City of Seattle's Gas Works Park and MTCA remedial actions to the Gas Works Uplands as set out in the Exhibit B CAP were completed under the supervision of Ecology in 2001.

D. Some areas of Gas Works Park were left undeveloped and subject to institutional controls such as fencing and walls to prevent public access. The City of Seattle intended to develop these areas of the Park when funding became available for Park improvements and any necessary extension of MTCA remedial actions to address cleanup in accordance with the proposed cleanup standards and actions described in the CAP.

E. Ecology determined that the CAP needs to be revised to allow for substitution of remedial actions and different institutional controls in areas of the Gas Works Uplands specified as subject to fencing under the 1999 CAP. The City of Seattle requested revisions to the CAP to allow for extension of the remedial actions into the undeveloped areas of the Park and the substitution of institutional controls in accordance with the cleanup standards and cleanup action components described in the CAP and approval of Ecology.

F. Ecology has approved revisions to the CAP and provided for appropriate notice and public comment.

G. This amendment to the Consent Decree is for the purpose of integrating all remedies set forth in the revised CAP for the Site into the existing Consent Decree.

AMENDMENT TO CONSENT DECREE

Based on the foregoing, the parties stipulate and agree that the Consent Decree should be amended, pursuant to the provisions of Section XV. AMENDMENT OF CONSENT DECREE, as follows:

A. All of the terms of the Consent Decree remain in effect unless expressly amended herein.

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B. The Exhibit B Cleanup Action Plan, dated June 18, 1999, attached to the 1999 Consent Decree, shall be entirely replaced by the Revised Exhibit B Cleanup Action Plan, dated March, 2005, attached to this Amendment No. 1 to the Consent Decree. All of the Appendices to the 1999 Cleanup Action Plan remain the same and are not changed.

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY

_____
JAMES J. PENDOWSKI
Program Manager
Toxics Cleanup Program

Date: _____

STATE OF WASHINGTON
ATTORNEY GENERAL
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KENNETH R. BOUNDS
Superintendent
City of Seattle Department of Parks & Recreation

Date: _____

SEATTLE CITY ATTORNEY
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MARYA J. SILVERNALE, WSBA #14525
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Attorney for Defendant City of Seattle

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DATED this _____ day of _____, 2005.

_____
JUDGE/COMMISSIONER
King County Superior Court

ATTACHED EXHIBIT:

REVISED EXHIBIT B – Cleanup Action Plan [Revised – March 2005]

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REVISED EXHIBIT B - CLEANUP ACTION PLAN (REVISED MARCH 2005)

VOLUME 4

GAS WORKS PARK ENVIRONMENTAL CLEANUP

CLEANUP ACTION PLAN (REVISED)

Prepared for

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June 18, 1999

Revised by

CITY OF SEATTLE
DEPARTMENT OF PARKS & RECREATION

March 1, 2005

DECLARATIVE STATEMENT

TABLE OF CONTENTS

APPENDICES

LIST OF FIGURES

LIST OF TABLES

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
Θ = 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 that cannot be used on site and subsequently covered as specified in Section 4.1.2 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.

Figure

Figure

4-2 Proposed Air Sparging System Detail

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

4-3 Proposed Soil Cover and SVE System Detail

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~~))beginning with the north-central and southeastern portions (((~~(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 or geogrid.

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 or a geogrid layer will be placed over the existing Park deposits before soil placement. The geotextile or geogrid will physically separate the existing soils from the overlying vegetative soil layer, and thus eliminate commingling of these soils. The geotextile or geogrid will also provide a visual barrier that will alert maintenance workers or others if the vegetative soil layer has been compromised. The geotextile or geogrid 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 or geogrid 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 that cannot be used on site and subsequently covered as specified in Section 4.1.2 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. Contaminated ~~S~~soil generated during any future Park construction projects that cannot be used on site (for example, as fill) and subsequently covered as specified in Section 4.1.2 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, Use Restrictions, Maintenance Requirements and Educational Programs

- Maintenance and improvement (as necessary) of existing or revised fencing around the cracking towers ((~~and the northwest area of the Park~~)) until such time as these areas may be developed and either meet clean up levels or install alternative institutional controls, such as a vegetated soil cover consistent with section 4.1.2;

- Inspection and maintenance of the entire soil cover system;((~~and~~))

- Changes in use of park lands or changes to physical barriers or other structures, such as fences or pavement, may be made subject to written authorization by Ecology so long as appropriate cleanup actions occur in accordance with this Cleanup Action Plan or an approved revised Cleanup Action Plan in accordance with Chapter 173-340 WAC; and

- Ecology approval of a soils management plan for future park development or construction projects that disturb the soil cover or provide for development, including open area access, to areas formerly fenced or separated by other physical barriers (e.g., pavement);

- 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. Additional signs may be necessary in areas where changes of use or changes to physical barriers are made. Signs relating to Lake Union will be removed when Ecology determines that they are no longer necessary to protect public Health.

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 of contaminated soils that are accessible with a vegetated soil cover (described in Section 4.1.2) and development of 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 are 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 , 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. As described in Section 7, one type of containment measure may be substituted with another type with the written permission of Ecology.

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