Groundwater Pump and Treat Interim Action SMC/Cadet Commingled Plume DRAFT Work Plan

Prepared for

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CERTIFICATION

The technical material and data contained in this document were prepared under the supervision and direction of the undersigned, whose seal, as a professional hydrogeologist licensed to practice as such, is affixed below.

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1. INTRODUCTION

On behalf of the Port of Vancouver, U.S.A. (the Port), Parametrix has prepared this Groundwater Pump and Treat Interim Action Work Plan for the former Building 2220 site (a.k.a. the Swan Manufacturing Company site or the SMC site) and the Cadet Manufacturing Company (Cadet) site. The SMC site is adjacent to and west of the intersection of Fourth Plain Boulevard and Mill Plain Boulevard in Vancouver, Washington (Figure 1-1). The Cadet site is located at 2500 Fourth Plain Boulevard, approximately 1,000 feet northwest of the SMC site (Figure 1-2). The Port acquired the Cadet site on May 29, 2006, as part of a settlement agreement under which the Port assumed responsibility for cleanup. The interim action will be designed to capture commingled dissolved volatile organic compound (VOC) plumes sourced from the SMC site and the Cadet site, and to reduce the concentrations of VOCs in groundwater in the project area.

Since 1998, the Port has been conducting a remedial investigation and feasibility study (RI/FS) in the SMC site project area to address trichloroethylene (TCE) and other related VOCs in soil and groundwater. The project area, including the SMC and Cadet sites, is shown on Figure 1-2. In 2007, the Port submitted a Final RI Report for the SMC site (Parametrix 2007b) to the Washington Department of Ecology (Ecology). The history of the SMC site and the nature and extent of the commingled dissolved VOC plumes sourced from the SMC and Cadet sites are documented in the Final RI Report.

The term “TCE-impacted” in this document is intended to be inclusive of other chemicals that are generally found to be associated with TCE from the SMC and Cadet sites. These other chemicals include, but are not limited to, tetrachloroethene (PCE), cis-1,2-dichloroethene (cis-1,2,-DCE), 1,1-dichloroethene (1,1-DCE), and 1,1-dichloroethane (1,1-DCA).

1.1 PURPOSE

The purpose of this Groundwater Pump and Treat Interim Action Work Plan (Work Plan) is to summarize the selection of the interim action technology, present a conceptual design of the interim action, and outline the engineering design and permitting process elements that will be required prior to implementation of the action. This Work Plan contains some preliminary design elements sufficient to describe the interim action. However, it should be noted that the design is in the conceptual stages and is subject to change. Detailed design elements will be presented in the Design Engineering Report currently being prepared (30% and 90% Design Engineering Reports to be submitted to Ecology for review).

It is expected that the interim action will be incorporated into a final remedy for the SMC and Cadet sites, which will be selected during completion of the feasibility study. The groundwater pump and treat system will be designed so that it can be modified based on data collected after implementation and future project needs.

The Port has elected to implement this interim action to expedite cleanup of the sites and to offset potential impacts from pumping at the Clark Public Utilities (CPU) wellfield. CPU is in the process of developing a wellfield in the area to provide a public water source. Extraction of groundwater at the CPU wellfield has the potential to impact the current groundwater flow direction (and VOC migration) in the project area. The interim action will be implemented prior to the CPU development and be operated in a manner that manages potential impacts of the CPU wellfield on the dissolved-phase groundwater plume.

1.2 REGULATORY FRAMEWORK

The regulatory framework of the interim action and discussions of how it applies to the ongoing remedial investigations of the SMC and Cadet sites are presented in the following sections.

1.2.1 Model Toxics Control Act (MTCA)

Washington's Model Toxics Control Act (MTCA) defines procedures for the investigation and cleanup of contaminated sites that ensure that the quality of cleanup and protection of human health and the environment are not compromised. The RI/FS projects at the SMC and Cadet sites are being conducted in accordance with MTCA requirements summarized in Washington Administrative Code (WAC) 173-340-350.

The Groundwater Pump and Treat Interim Action is being conducted in accordance with MTCA requirements summarized in WAC 173-340-430. Specific requirements of WAC 173-340-430 that apply to this action are summarized below:

- The interim action meets the definition included in WAC 173-340-430(1)(a): *An interim action is a remedial action that is technically necessary to reduce a threat to human health or the environment by eliminating or substantially reducing one or more pathways for exposure to a hazardous substance at a facility*.
- The interim action meets general requirement WAC 173-340-430(2)(b): *Provide a partial cleanup, that is, clean up hazardous substances from all or part of the site, but not achieve cleanup standards*.
- The relationship of the interim action to the final cleanup action meets requirement WAC 173-340-430(3)(b): *If the cleanup action is not known, the interim action shall not foreclose reasonable alternatives for the cleanup action. This is not meant to preclude the destruction or removal of hazardous substances*.
- The timing of the interim action complies with requirement WAC 173-340-430(4)(a): *Interim actions may occur anytime during the cleanup process. Interim actions shall not be used to delay or supplant the cleanup process. An interim action may be done before or in conjunction with a site hazard assessment and hazard ranking. However, sufficient technical information must be available regarding the facility to ensure the interim action is appropriate and warranted*.

As required by WAC 173-340-430(6), public participation activities will be completed prior to implementing the interim action.

1.2.2 Agreed Orders

An Agreed Order is a legally binding, administrative order issued by ecology and agreed to by the potentially liable person (PLP). Agreed orders are available for remedial investigations, interim actions, feasibility studies, and final cleanups. The Port has entered into two Agreed Orders with Ecology for the SMC site. Prior to the Port acquiring the Cadet site on May 29, 2006, as part of a settlement agreement, Cadet entered into an Agreed Order with Ecology for the Cadet Site. Ecology is in the process of preparing a new Agreed Order for future work, including the Groundwater Pump and Treat Interim Action. The new Agreed Order will name the Port as the PLP for both the SMC and Cadet sites. The existing SMC and Cadet Agreed Orders are summarized below.

1.2.2.1 SMC Site Agreed Orders

The Port has entered into two Agreed Orders with Ecology for the SMC site. The first Agreed Order (No. 98TC-S337), issued in November 1998, included requirements to perform an RI/FS to define the extent of soil and groundwater contamination and to conduct soil interim actions. The Agreed Order also included a requirement to conduct an interim action for the stockpiled vadose zone TCE-impacted soil.

The second Agreed Order (No. 01TCPVA-3257), issued in October 2001, required the Port to complete the remaining parts of the original Agreed Order (i.e., the groundwater RI/FS for groundwater impacts) and to implement groundwater interim actions to reduce risk in the groundwater source area. Additional requirements of the second Agreed Order included a Groundwater Interim Action Work Plan, Final Work Plan Implementation, and Interim Action Report. All of these requirements were completed by 2004.

1.2.2.2 Cadet Site Agreed Order

In January 2000, Cadet entered into an Agreed Order (No. 00TCPVA-847) with Ecology to conduct investigations and interim remedial actions for VOCs in the subsurface at the Cadet site. Cadet conducted RI and interim action activities through May 2006, when the Port acquired the Cadet site.

2. SITE DESCRIPTION AND HISTORY

The following sections provide a brief description of the location and history of the SMC and Cadet sites, a summary of how the releases occurred at the SMC and Cadet sites, and a summary of contaminant issues on the ST Services site, all of which contribute to the commingled plume in the project area. The Port acquired the Cadet property on May 29, 2006, as part of a settlement agreement.

2.1 SITE LOCATION

The SMC site is adjacent to and west of the intersection of Fourth Plain Boulevard and Mill Plain Boulevard in Vancouver, Washington (Figure 1-2). The southern portion of the SMC site is currently being used as a staging area for metal rebar products. The remainder of the site is unoccupied, except for a portion covered by Mill Plain Boulevard. The Cadet facility is located approximately 1,000 feet northwest of the SMC site, at 2500 Fourth Plain Blvd (Figure 1-2). The Cadet site is currently occupied by an electric heater manufacturing facility. The sites are located in the southwest quarter of Section 21, Township 2 North, Range 1 East.

Current land use zoning in the vicinity of the SMC and Cadet sites is predominately Heavy and Light Industry. There is Single Family Residential land use zoning north and east of the SMC and Cadet sites, respectively. Future land use in the vicinity of the SMC and Cadet sites includes an increase in Light Manufacturing north of Fourth Plain Boulevard. Port property is zoned for continued use as Heavy and Light Manufacturing; these designations are not expected to change. Low Density Residential land use is anticipated to continue to the north and east of the SMC and Cadet sites (i.e., the North and South Fruit Valley Neighborhoods) (Clark County 2005).

2.2 DEFINITION OF SITE

The Port's Agreed Orders define the SMC site as follows:

> *The Port of Vancouver/Building 2220 Site, also known as the former Swan Manufacturing Site, is located between 2001 and 2501 West Fourth Plain, near the southwest corner of Fourth Plain and Kotobuki Way, in an industrial-zoned area at the Port of Vancouver.*

For the purposes of this Work Plan, the term "project area" is used to describe the area around the SMC and Cadet sites that includes Port-owned property and property owned by others. Figure 1-2 shows the SMC site, Cadet site, and the project area. Information about the project area has been used to define the physical characteristics, including geology and hydrogeology, that influence the migration of contaminants in the subsurface and to develop a numerical groundwater flow model.

The project area includes an extensive monitoring well network to evaluate the groundwater flow and groundwater quality. Figure 2-1 shows the current groundwater monitoring well network in the project area.

2.3 SUMMARY OF SMC AND CADET SITE HISTORIES

A comprehensive history of the SMC and Cadet sites is presented in the Final RI Report for the SMC site (Parametrix 2007b). The following summarizes the history of these sites.

2.3.1 Swan Manufacturing Company Site

From 1956 to 1964, electric heaters were manufactured by SMC at the site. Sheet metal was formed, cleaned, painted, and assembled into heaters. The sheet metal parts were cleaned using a TCE vapor degreasing tank prior to painting. According to a former employee of SMC, the degreasing operation consisted of a vapor degreasing tank and two rinse tanks. The degreasing tank was set into a concrete pit in the floor of the building. TCE in the tank was heated, and metal parts were suspended in the TCE vapors over the degreasing tank. The TCE condensed on the colder metal and dripped back into the tank (along with oil and dirt on the metal). After degreasing, the metal parts were transferred to the two rinse tanks, where the parts were rinsed to remove any remaining TCE. The parts were then dried and painted.

TCE in the degreaser was recycled every six months by transferring the TCE to a separator where dirt and oil were removed. Accumulated sludge was removed from the sides and bottom of the tank, placed in drums, and stored outside along the south side of the SMC facility. In some cases, the drums did not have lids. The drums were stored in this manner until they were removed for disposal. The frequency of disposal is unknown.

Occasionally, TCE was spilled while the degreasing tank was being refilled. This spilled TCE would accumulate in a sump below the degreasing tank. In order to remove the spilled TCE, water was added to the sump, and the mixture of water and TCE was pumped into barrels. These uncovered barrels were also stored outside, along the south side of the building.

In 1964, SMC transferred its operations to a new facility at 2500 Fourth Plain Boulevard, discontinuing operations at the SMC site. Cadet purchased SMC in 1972 and continues its operations at the 2500 Fourth Plain facility.

TCE at the SMC site was first discovered by the City of Vancouver (the City) in 1997, during the Mill Plain Boulevard Extension Project (Mill Plain project). The Mill Plain project involved the extension and rerouting of Mill Plain Boulevard, a major arterial road in Vancouver, Washington. The former SMC building was demolished by the Port in 1986, 11 years prior to the contaminant discovery. Additional historical information for the SMC site is included in the Final RI Report (Parametrix 2007b).

2.3.2 Cadet Manufacturing Company Site

The Cadet site is located at 2500 Fourth Plain Blvd (Figure 1-2). As previously discussed, SMC transferred its operations to the Cadet site in 1964. The Cadet site is a known source of VOCs in the groundwater beneath the facility and the adjacent North Fruit Valley Neighborhood (NFVN). Contamination from this source has commingled with the plume of VOC contamination originating from the SMC site in the Port area to the east of the SMC site. Figure 2-1 shows the groundwater monitoring well network in the vicinity of the Cadet site.

In January 2000, Cadet entered into an Agreed Order with Ecology to conduct investigations and interim remedial actions for VOCs in the subsurface at the Cadet site. Cadet documented its investigations in a Draft Remedial Investigation Report (AMEC 2003) and a Remedial Investigation Update Report (AMEC 2005). Contaminants detected in groundwater samples collected during Cadet's investigations include TCE, PCE, chloromethane, chloroform, 1,1-dichloroethene (1,1-DCE), cis-1,2-dichloroethene (cis-1,2-DCE), 1,1,1-trichloroethane (1,1,1-TCA), 1,1-dichloroethane (1,1-DCA), methylene chloride, 1,1,2-trichloroethene (1,1,2-TCE), 1,3-dichlorobenzene, and 1,4-dichlorobenzene. TCE and PCE were detected in groundwater samples at maximum concentrations of 78,000 µg/L and 70,000 µg/L, respectively. These concentrations were detected prior to Cadet's implementation of interim remedial actions to reduce contaminant concentrations in groundwater. Interim remedial actions implemented by Cadet include the installation of an air sparging and soil vapor extraction (AS/SVE) system under Cadet's manufacturing building, which has been operating since October 2003. In 2004 and 2005, Cadet also installed seven recirculating groundwater remediation wells (RGRWs) at the Cadet facility and in the NFVN to treat impacted groundwater beneath the area. In addition, Cadet installed in-home soil vapor vacuum (SVV) systems in six houses in the NFVN to mitigate VOCs detected in indoor air.

The Port acquired the Cadet property on May 29, 2006, as part of a settlement agreement under which the Port has assumed responsibility for cleanup.

2.4 ST SERVICES SITE SUMMARY

The ST Services site is located on Port property (Figure 1-2). The ST Services terminal, leased from the Port by NuStar, has been in continuous operation as a bulk storage and chemical handling facility (including by GATX, prior to ST Services) since approximately 1960.

In 1998, ST Services entered into an Agreed Order (No. 98-TC-5338) with Ecology to conduct investigation and cleanup of the site. Several phases of investigation and remedial activities (some prior to the Agreed Order) have been conducted at the site between 1991 and 2007. Investigation activities included soil borings, a soil gas survey, aquifer evaluation, and the collection of soil and groundwater samples. A network of groundwater monitoring wells has been installed at the site, including multi-level groundwater monitoring wells interim action pilot study wells, interim remedial action measure system wells, and one well located near the former Carborundum site. Groundwater monitoring has been conducted at the site since 1993.

Prior to 1994, the facility handled chlorinated solvents, including PCE, methylene chloride, and 1,1,1-trichloroethane (TCA) (SECOR 2001). Historical handling practices at the facility are reportedly responsible for chlorinated solvents in soil and groundwater beneath the site. The primary chlorinated solvent constituent detected in groundwater at the site is PCE. However, other VOCs detected at the site include TCE, 1,1-DCA, cis-1,2-DCE, 1,1,1-TCA, and vinyl chloride. In general, the highest concentrations of VOCs in groundwater have been detected in the shallow zone, between 35 and 45 feet below ground surface (bgs).

Based on the findings of an Interim Action Analysis prepared for the ST Services site in November 2006 (Ash Creek 2006), enhanced bioremediation and soil vapor extraction are recommended as an interim action for the source area located between two on-site buildings, Warehouses 13 and 15. This interim action will be focused on addressing the potential migration of vapors to breathing spaces of on-site workers and reducing the relatively high concentrations of VOCs that could migrate to the Columbia River (Ash Creek 2006).

2.5 OTHER WELLFIELDS IN PROJECT AREA

The unconsolidated sedimentary aquifer (USA) is a highly productive aquifer that underlies the project area. Due to the presence of this productive aquifer at a fairly shallow depth, a number of industries requiring large quantities of water located their facilities in the project area, near or adjacent to the Columbia River. Municipal water supply wellfields are also located east of the project area.

Over time there has been a decline in industrial pumping, but an increase in municipal pumping in the project area. More recently, a number of new wellfields have been proposed in the Vancouver Lake area to meet the projected municipal water supply demand.

To help develop an understanding of the hydrogeology in the project, including the effect of wellfields in the project area, a groundwater model was constructed using the three-dimensional finite difference groundwater flow U.S. Geological Survey code MODFLOW (McDonald and Harbaugh 1988). This groundwater model is presented in the Groundwater Model Summary Report (Parametrix 2004b). This model was also used to evaluate interim action alternatives by developing several pumping scenarios. The use of this groundwater model is discussed further in Section 7.2.1. Wellfields currently included in the groundwater model to evaluate the interim action are described in this section. Further information on the wellfields (including abandoned or discontinued systems) can be found in the Groundwater Model Summary Report (Parametrix 2004b).

2.5.1 Great Western Malting

Great Western Malting (GWM), a tenant of the Port, has operated up to five water supply wells to provide water for its malting process. Generally, these wells operate on a continuous basis, cycling quickly on and off depending on the water level in the GWM facility’s water reservoir. Water produced from the wells is used for site operations, including washing and seeping sanitation. Depending on use, water used in the facility is discharged either to the Columbia River or to a wastewater lagoon, or is lost to the atmosphere as vapor.

Groundwater pumping at GWM began in 1937 with the installation of production Well 1. The last well installed was production Well 5 in 1977. Installation of water supply wells generally corresponded with facility expansions. Groundwater pumping at GWM reached a maximum rate of approximately 8,200 gallons per minute (gpm) on a continuous basis in 1978, following the installation of Well 5. This production rate began to decrease in the late 1990s as drum house operations were reduced (Hamachek 2003). Currently, GWM pumps at approximately 3,900 gpm under an agreement with the Port to maintain capture of the plume.

2.5.2 Port of Vancouver

The Port of Vancouver maintains three production wells located adjacent to the east side of the GWM leasehold. Wells 1 and 2 were constructed in 1929, with Well 2 reconstructed in 1962. Well 3 was constructed in 1950 to provide water to Fort Vancouver Plywood (Mundorff 1964). Historically, it is understood that Wells 1, 2, and 3 operated on a continuous basis, producing at a rate of 1,200 to 1,500 gpm, to provide water to Port tenants and Fort Vancouver Plywood (Mundorff 1964; Port of Vancouver 1995). Production rates started to decrease in the mid-1980s when Wells 1 and 2 were no longer operated on a continuous basis. Pumping of Well 3 began to decrease in the early 1990s as mill operations were reduced. Fort Vancouver Plywood abandoned its facility in 1996, and Well 3 became a Port backup water supply well.

2.5.3 City of Vancouver Water Stations

The City of Vancouver operates nine wellfields that provide potable water for their service area. The wellfields (or water stations) in the active model area are Water Station 1, Water Station 3, and Water Station 4. Examination of the production history for the three water stations indicates that water demand is greatest during the summer months of July, August, and September.

2.5.3.1 City of Vancouver Water Station 1

City of Vancouver Water Station 1 is located along East Fourth Plain Boulevard, just east of Fort Vancouver Way in Waterworks Park. The water station is located approximately 2.2 miles from the SMC site. The wellfield currently consists of 12 wells, with a nominal capacity of 25,280 gpm (36.4 million gallons per day [mgd]), and is the highest producing of the City's nine wellfields (City of Vancouver 2003). The City's operation records also indicate that Water Station 1 has the greatest seasonal production history, with notably higher pumping rates during the summer months (May through September). Production rates generally decreased between 1991 and 2002 (to an average rate of 6.76 mgd), when an upward production trend occurred. Recent annual production rates continue to remain below those in the early 1990s (City of Vancouver Water Division 2004).

2.5.3.2 City of Vancouver Water Station 3

City of Vancouver Water Station 3, located along Northwest Washington Street at Northwest 43rd Street, consists of three wells, with a nominal production capacity of 5,800 gpm (8.35 mgd) (City of Vancouver 2003). Operation records indicate that annual water production rates have slowly increased over time. Since 1977, the lowest annual production rate was in 1984, with an average of 0.82 mgd. The station's annual production rate peaked in 2000, with an average of 3.58 mgd.

2.5.3.3 City of Vancouver Water Station 4

City of Vancouver Water Station 4 is located along Blandford Drive at East 5th Street. The water station consists of six wells. Annual production rates at Water Station 4 peaked in 1988 at 5.35 mgd (City of Vancouver 2004). Pumping of these wells ceased in the latter part of 1989 when VOCs (primarily PCE) where detected. Following the installation of an air stripping treatment facility, pumping at Water Station 4 resumed in 1992 (Gray & Osborne 1996). Since 1992, pumping at Water Station 4 has averaged 1.12 mgd (City of Vancouver 2004). The air stripping treatment facility has a total treatment capacity of 8,000 gpm. Currently, only one tower is used, and no more than 4,000 gpm are pumped at the station (City of Vancouver 2003).

2.5.4 Clark Public Utilities

CPU has proposed to develop a wellfield near the project area, specifically to the northwest of the site near La Frambois Road and Vancouver Lake. At this time, two wells have been completed for the purposes of pumping tests. CPU is developing the wellfield as a public water source. Based on information provided by CPU, the initial wellfield will be designed to extract groundwater from the Troutdale gravel aquifer (TGA). As demand for water increases and the capacity of the TGA to meet that demand is reached, CPU plans to develop wells within the shallower USA. At this time, pumping rates for the proposed CPU wellfield are not known. However, information supplied by CPU to the Port indicated that initial pumping rate projections could be on the order of 5 to 10 mgd, increasing over time.

Part of the decision for implementation of this interim action is the potential for the CPU wellfield to impact the project area by altering the current groundwater flow regime. The Port elected to expedite the cleanup of the sites to offset these potential impacts. The interim action will be designed to be implemented prior to the CPU development and will be operated in a manner that manages potential impacts of the CPU wellfield on the dissolved-phase groundwater plume.

3. PROJECT AREA GEOLOGY AND HYDROGEOLOGY

Information regarding geologic and hydrogeologic conditions in the project area has been obtained through the completion of borings and monitoring wells during the SMC, Cadet, and ST Services investigations and data collected to further refine the Port's groundwater model (Parametrix 2007b). The Final RI Report for the SMC site provides a description of the refinements that have been made over time regarding interpretation of geologic and hydrogeologic conditions in the project area.

This section presents a summary of the geologic and hydrogeologic conditions in the project area for purposes of understanding the implications of the interim action. Figure 3-1 presents a comparison of the regional and project area geologic and hydrogeologic units and their relationship. Two regional hydrogeologic units are present in the project area; the unconsolidated sedimentary aquifer (USA) and the Troutdale gravel aquifer (TGA). Three groundwater zones (shallow, intermediate, and deep) have been identified for the USA in the project area. These hydrogeologic zones reflect the different depositional units present.

Figure 3-1 also includes the hydrogeologic unit nomenclature used in more recent water supply studies completed in the Vancouver Lake lowlands area. Since future development of water supply wellfields in the region of the project area are underway, an understanding of the relationship between the hydrogeologic units applied in the project area and in Vancouver Lake lowlands water supply studies is an important element of remedial actions completed in the project area.

3.1 GEOLOGIC CONDITIONS

The regional geologic framework and associated groundwater system detailed in the Final RI Report is based on the geologic setting described and the nomenclature used in the U.S. Geological Survey (USGS) water resources investigation report, Description of the Hydrogeologic Units in the Portland Basin (Swanson et. al. 1993). The Groundwater Model Summary Report (Parametrix 2004b) presents a regional conceptual model and detailed discussion of geologic and hydrogeologic units in the region and their presence in the project area.

The Final RI Report (Parametrix 2007b) further refined the descriptions of the geologic and hydrogeologic conditions in the project area. The presence, distribution and permeability of the lithologic units have been found to differ significantly throughout the project area and can influence the distribution of contaminants in the area.

Three distinct geologic units have been encountered in investigative borings completed in the project area. From shallow to deep, these depositional units are Quaternary alluvium deposits, Pleistocene catastrophic flood deposits, and the Pleistocene Troutdale Formation. A brief description of these units, as used in the regional conceptual model and in the more recent Vancouver Lake lowland water supply investigations, is presented below.

3.1.1 Quaternary Alluvial Deposits

Quaternary alluvial deposits consist of very poorly consolidated silt, sand, and clay present in the Columbia River floodplains. In the Vancouver Lake lowlands area, these deposits are present from ground surface to depths typically ranging from 30 to 60 feet bgs. Two subunits are present: an upper subunit consisting predominantly of silt, and a lower subunit consisting predominantly of fine sand. These subunits are regionally extensive, but may be locally absent in some areas of the lowland (Pacific Groundwater Group 2002).

3.1.2 Catastrophic Flood Deposits

Underlying the Quaternary alluvial deposits are catastrophic flood deposits. Catastrophic flood deposits in the project area consist predominantly of medium- to coarse-grained sand with gravel. The gravel can be coarse, ranging up to cobbles 6 inches or greater in diameter. These deposits are associated with the Late Pleistocene catastrophic floods of the Columbia River, are present throughout the project area, and underlie the Quaternary alluvium. Due to the generally coarse nature of these deposits and the general lack of fines and lack of cementation, these deposits are highly transmissive.

As shown on Figure 3-1, three catastrophic flood deposit subunits have been identified in the project area; a detailed description of these subunits and their distribution in the project area is presented in the Final RI Report for the SMC site (Parametrix 2007b).

3.1.3 Troutdale Formation

The Pleistocene-aged Troutdale Formation sediments underlie the catastrophic flood deposits. The Pleistocene section of the Troutdale Formation generally consists of cemented basaltic gravel, with quartzite pebbles in a micaceous silty sand matrix that can contain silt or clay lenses.

The Troutdale Formation encountered at the site consists of well graded, cemented to semi-consolidated sandy gravel with varying amounts of sand, silt, and clay. The matrix usually consists of brown to green fine-grained silty sand with varying amounts of silt and clay, and is usually abundant with mica. The Troutdale Formation is distinguished from the catastrophic flood deposits by the presence of cementation, consolidation, quartzite clasts, and a silty matrix containing mica.

As shown on Figure 3-2, the elevation of the top of the Troutdale Formation varies substantially in the project area. Mapping the top of the Troutdale Formation in the project area has identified the presence of an erosional trough or low area beneath the SMC and Cadet sites. A description of the erosional surface of the Troutdale Formation in the project area is presented in the Final RI Report (Parametrix 2007b).

3.2 HYDROGEOLOGIC UNITS

Consistent with the USGS Portland Basin nomenclature (Swanson et. al. 1993), there are two regional hydrogeologic units in the project area; the unconsolidated sedimentary aquifer (USA) and the underlying Troutdale Gravel Aquifer (TGA). As shown on Figure 3-1, the USA occurs in the Quaternary alluvium and catastrophic flood deposits while the TGA occurs in the Pleistocene-aged Troutdale Formation. A description of these hydrogeologic units is presented below.

3.2.1 Unconsolidated Sedimentary Aquifer

As shown on Figure 3-1, the USA occurs in material associated with saturated portions of the Quaternary alluvium deposits and the Pleistocene-aged catastrophic flood deposits. The Quaternary alluvium deposits, which overlie the catastrophic flood deposits, consist of very poorly consolidated silt and sand. The alluvium deposits are partially saturated and have a lower permeability than the underling catastrophic flood deposits. The saturated portion of the alluvium deposits is considered to be part of the USA. Water supply studies completed in the Vancouver Lake lowlands area have referred to the saturated portion of the Quaternary alluvial deposits as the recent alluvial aquifer, while the Pleistocene catastrophic flood deposits are referred to as the Pleistocene alluvial aquifer (PAA). The recent alluvial aquifer and the PAA are subunits of the USA.

In the project area, three groundwater zones have been established for the USA, based on observed geologic conditions (Figure 3-1). The Intermediate and Deep USA groundwater zones correspond to the PAA. Characteristics of the three groundwater flow zones within the USA are discussed in the Final RI Report (Parametrix 2007b).

3.2.2 Troutdale Gravel Aquifer

The TGA is associated with the Troutdale Formation, which underlies the catastrophic flood deposits and alluvial deposits that make up the USA in the project area. The top of the Troutdale Formation varies noticeably, and the presence of an erosional trough has been identified (Figure 3-2). The permeability and the transmissivity of the TGA have been noted to be at least one order of magnitude lower than the USA (McFarland and Morgan 1996; Pacific Groundwater Group 2002). This difference in permeability and the unit’s overall transmissivity is due to the presence of more fines in the Troutdale Formation, along with lithification and cementation, which ranges from consolidated to semi-consolidated. The combination of lower permeability and lack of groundwater extraction from the TGA in the project area produces much lower flow rates in the aquifer than those in the overlying USA.

3.3 POTENTIOMETRIC CONDITIONS

The potentiometric surfaces of the USA and the TGA are flat in the project area. These flat potentiometric surfaces are caused by a combination of setting (the project area is situated in a topographically flat floodplain adjacent to a large river) and hydrogeologic conditions (presence of permeable unconsolidated and consolidated sedimentary deposits). Water levels from monitoring wells in the project area show an efficient response to river stage changes. The Columbia River stage is influenced by tidal fluctuations, dam releases, and seasonal changes. Water levels in the wells quickly rise and fall in response to corresponding changes in river stage. Consequently, the development of potentiometric maps based on manual water level measurements has the potential for error, which becomes greater as the time between measurements increases.

The distinction between the USA and the TGA is based on differences in the geologic units; specifically, the overall permeability of the USA is at least one order of magnitude greater than the permeability of the TGA (McFarland and Morgan 1996). Consequently, groundwater flow conditions in the USA differ from conditions in the TGA. In addition, groundwater flow conditions within the three zones of the USA differ due to permeability contrasts between the alluvium and the catastrophic flood deposits.

Based on water level measurements, the flow pattern in the TGA is variable. However, the groundwater flow model results indicate that the flow pattern in the TGA is similar to the flow pattern observed in the USA, toward the GWM production wells. The rate of groundwater flow is lower in the TGA due to its lower permeability and its relationship to withdrawal points (i.e., production wells).

Data collected during the RI indicate that determination of groundwater flow in the project area based on single sets of water-level measurements (particularly, those manually collected) may not be accurate and may potentially result in misinterpretation due to fluctuations of the Columbia River. Stage levels of the Columbia River change throughout the day in response to tidal fluctuations, dam releases, and regional precipitation. A transducer study was completed in the fall of 2006 to evaluate groundwater flow conditions in the Columbia River Lowlands with a focus on the project area. This data were used to calibrate the transmissivity of the groundwater flow model and to evaluate groundwater flow in the project area. The findings of the 2006 transducer study, groundwater flow conditions based on the transducer data, and use of the transducer data to refine the groundwater flow model are presented in the Final RI Report (Parametrix 2007b).

3.4 AQUIFER PROTECTION

In August 2006, the U.S. Environmental Protection Agency (EPA) designated the Troutdale aquifer system in Clark County as a sole source aquifer. A sole source aquifer is an underground water supply designated by the EPA as the “sole or principal” source of drinking water for an area. The sole source aquifer designation program was established under the Safe Drinking Water Act of 1974. Under the program, the major criteria considered by the EPA are whether the aquifer is the sole or principal source of drinking water and whether contamination of the aquifer would create a significant hazard to public health. To meet this designation, the aquifer must supply at least 50 percent of the drinking water consumed in the area overlying the aquifer, and there must be no alternative source or combination of alternative sources of drinking water which could physically, legally, and economically supply those dependent upon the aquifer. The aquifer also needs to be delineated based on acceptable science and available information.

The designated sole source Troutdale aquifer system is composed of all lacustrine and fluvial sediments of the upper and lower members of the Troutdale Formation, other consolidated sand and gravel aquifer units, and overlying unconsolidated alluvium and flood deposits. This material overlies volcanic and marine sedimentary deposits commonly referred to as the “older rocks” unit. Sedimentary units include the eight hydrogeologic units that make up the upper and lower sedimentary subsystems of the Portland Basin aquifer system (McFarland and Morgan 1996).

The aquifer system boundaries designated by the EPA as the Troutdale aquifer system are represented by rivers and the geologic boundary between the aquifer system and the older rocks unit. The SMC project area is located in this sole source aquifer area.

The implementation of the interim action is consistent with the protection of the sole source aquifer. The interim action is designed to hydraulically contain contaminants in the project area and reduce VOC concentrations in the aquifer.

4. NATURE AND EXTENT OF GROUNDWATER CONTAMINATION

The following sections describe the nature and extent of groundwater contamination in the project area. Other project area media (such as soil, soil gas, indoor air, etc.) are discussed in the Final RI Report for the SMC site (Parametrix 2007b) and are noted in this Work Plan, where applicable.

It should be noted that the Port completed an exhaustive review of other potential sources in the project area (Parametrix 2005). The purposes of the review were to identify potential sources that could have contributed to the dissolved-VOC groundwater plume, to identify other potential contaminants such as metals or petroleum, and to identify whether groundwater contaminants at nearby sites could impact potential remedial actions implemented in the project area (e.g., contaminants migrating to a pump and treat system). Based on this review, no significant sources other than SMC, Cadet and ST Services were identified. The groundwater interim action is not expected to be impacted by other potential sources.

4.1 CONTAMINANTS OF POTENTIAL CONCERN

As presented in the Final RI Report for the SMC site (Parametrix 2007b), contaminants of potential concern (COPC) in groundwater were identified by using information related to the site history, analytical results from the Pre-RI and RI phases, and a review of MTCA regulations (WAC 173-340-703). Analysis of chemical concentrations from all groundwater zones indicated that the following chemicals were detected above a frequency of detection (FOD) of 5% and that at least one sample exceeded the relevant MTCA Method B cleanup standards for groundwater:

- trichloroethene
- tetrachloroethene
- 1,1-dichloroethene
- 1,2-dichloroethane
- bromodichloromethane
- carbon tetrachloride
- cis-1,2-dichloroethene
- dibromochloromethane
- methylene chloride.

These chemicals were carried forward through the risk assessment for groundwater presented in the Final RI Report. 1,1-dichloroethane was also evaluated in the risk assessment, since this chemical is a known TCE degradation by-product (EPA 2001). Other chemicals exceeding a FOD of 5% but not exceeding MTCA Method B cleanup levels and not considered COPCs include: chloroform, trans-1,2-dichloroethene, and trichlorofluoromethane. These three chemicals are considered to be minor contributors to potential risks.

4.2 EXTENT OF CONTAMINATION SUMMARY

The nature and extent of contamination in the project area were determined based on the following:

- Data collected during the RI completed for the SMC site
- Geologic and hydrogeologic understanding for the project area
- Interim action findings completed for the SMC site
- Data collected during the RI and interim actions completed at the Cadet and ST Services sites
- Groundwater flow and transport models
- Stable isotope investigation.

Since TCE is the most prevalent contaminant in the project area, a discussion of the distribution of TCE provides an understanding of the extent of groundwater contamination. This discussion focuses on the TCE plumes originating from the SMC and Cadets sites, which have commingled and have reached the GWM production wells. However, it should be noted that the plume emanating from the ST Services site needs to be considered to provide a complete understanding of distribution of groundwater contamination in the project area.

Based on groundwater data, groundwater flow and transport models, and stable isotope data, the extent of contamination in the project area is in relative equilibrium. The configuration of the commingled contaminant plume is not significantly changing, and the concentrations of contaminants are decreasing over time. This equilibrium in the configuration of the commingled contaminant plume is due to historic and current operation of production wells at the GWM facility that are located in the southeastern corner of the project area.

The two plumes originating separately from the SMC and Cadet site source areas migrate to the east and south (i.e., down-gradient) in response to pumping at the wastewater reclamation facility (WWRF) well and the GWM/Port wellfield. This has resulted in a commingled TCE plume with an east-southeast orientation that is pulled to the south primarily by pumping at the GWM wells which are equipped with air stripping towers. Due to pumping at GWM, TCE from the SMC and Cadet sites does not reach the Columbia River. Figures 4-1 and 4-2 show groundwater TCE isoconcentrations in the project area. As the plumes migrate laterally near the surface of the water table, they also migrate vertically through the USA (Figures 4-4 and 4-5). The downward migration of the plumes is primarily in response to pumping at the GWM pumping wells, which have intake screens set between 80 and 120 feet bgs. The extent of downward migration is limited by the less permeable Troutdale Formation and the depth of the GWM well screens. The SMC and Cadet plumes merge on Port property near Kotobuki Way, and can be characterized as a single plume to the east of the SMC site source area (Figures 4-1 and 4-2).

The following sections provide further information regarding the migration and distribution of TCE in the project area.

4.2.1 Contaminants in the USA

The distribution of contaminants in the USA is influenced by hydrogeologic conditions in the project area. The presence of an erosional trough containing channel sands and re-worked Troutdale Formation material, the heterogeneous nature of the USA, the interconnectivity of the USA and the Columbia River, and the influence of various pumping wells in the area create a complex flow path from the source areas to the GWM wellfield. This has resulted in a three-dimensional contaminant distribution across the project area. Three groundwater zones in the USA have been defined to evaluate and describe groundwater quality in the project area (Parametrix 2007b):

- Shallow USA zone – from ground surface to -10 feet mean sea level (MSL) (0 to 40 ft bgs)
- Intermediate USA zone – from -10 feet MSL to -100 feet MSL (40 to 140 ft bgs)
- Deep USA zone – below -100 feet MSL (below 140 ft bgs)

The shallow zone of the USA corresponds primarily to alluvial deposits, while the intermediate and deep zones of the USA correspond to catastrophic flood deposits.

The deep USA zone is primarily present in the area of the erosional trough, but it does extend to the river east of the ST Services site and south and east of the GWM site. However, in this part of the project area, the deep USA zone is generally less than 15 feet thick.

The distributions of contaminants detected in the shallow and intermediate USA zones are similar and are therefore discussed together. The specific sources and migration pathways of the contaminants detected in the deep USA zone are not completely understood and are therefore discussed separately.

4.2.1.1 Shallow and Intermediate USA Zones

The distribution of TCE in the shallow and intermediate USA zones is shown on Figures 4-1 and 4-2, respectively. The shallow zone of the USA corresponds to the alluvial deposits, while the intermediate zone corresponds to the catastrophic flood deposits.

Dissolved TCE plumes originating from the SMC, Cadet, and ST Services sites have migrated to the GWM wells, which are fitted with air strippers. TCE released to groundwater at the SMC and Cadet source areas has migrated to the east and south in response to groundwater withdrawal, primarily at the GWM wellfield. TCE released to groundwater at the ST Services site has migrated to the north and northeast and eventually to the southeast in response to these same pumping stresses.

Due to the differences in the hydrogeologic conditions (e.g., hydraulic conductivity) between the shallow and intermediate groundwater zones of the USA, there is some difference in the distribution of contaminants between the two zones. This difference is due in part because the rate of groundwater movement in the intermediate USA zone is greater than in the shallow USA zone. The higher rate of groundwater movement in the intermediate zone is due to a combination of the intermediate zone’s higher transmissivity and the withdrawal of groundwater from the intermediate zone at GWM. These conditions and the proximity of the shallow USA zone to the source areas result in higher contaminant concentrations in the shallow USA zone.

As shown on Figures 4-1 and 4-2, the TCE plume sourced from the SMC site has migrated in the shallow USA zone, while at the same time it has been drawn down into the more transmissive intermediate USA zone due to pumping. The resulting plume from the SMC site is relatively long and narrow in the shallow zone, with a centerline trending approximately 20 degrees south of east. A few hundred feet east of the SMC site source area, there is a bend in the plume, which is more defined in the intermediate zone, where it turns to the south. Contaminants migrating toward the GWM wellfield are generally not present in the shallow

USA zone south of NE 20th Street, because the greatest groundwater movement occurs in the intermediate USA zone due to its higher transmissivity and to pumping from the zone at the GWM wellfield. This diving behavior of the plume as it migrates away from the SMC source is shown on Figure 4-4. Figure 4-5 shows the vertical distribution of contaminants migrating away from the ST Services site. As contaminants migrate to the north away from the ST Services source area, they become more vertically dispersed as they follow the USA, which becomes thicker in this area. As shown on Figures 4-4 and 4-5, the vertical migration of contaminants is limited by the underlying lower permeability of the Troutdale Formation.

The maximum southern extent of the plume in the USA is GWM Well 4, where the plume is captured by operation of the production wells. Figure 4-4 shows how contaminants are captured by production Wells 4 and 5. Well 5, the most northerly GWM production well, has captured the majority of the commingled plume originating from the SMC, Cadet, and ST Services sites.

All production wells in the GWM/Port wellfield, including the WWRF production well, are screened in the intermediate zone of the USA. TCE concentrations less than 5 µg/L have been detected in Port and WWRF wells. As shown on Figures 4-1 and 4-2, the contamination from the ST Services site has migrated to the north and northeast, where it has commingled with contamination sourced from the SMC site and the Cadet facility.

4.2.1.2 Deep USA Zone

The extent of the deep USA zone is shown on Figure 4-6. The deep USA zone is thickest in the Troutdale Formation erosional trough located beneath the SMC and Cadet sites. The deep USA zone contamination includes low concentrations of TCE, with lesser amounts of PCE, cis-1,2-DCE, 1,1,1-TCA, 1,1-DCE, 1,1-DCA, and traces of trichlorofluoromethane (TCFM). VOC contamination in the deep USA zone is limited to the erosional trough area (Figure 4-6).

Based on the hydrogeologic information and the -100 feet MSL criteria used to define the deep USA zone, the zone extends from the north to the river in the area between the ST Services site and the former Fort Vancouver Plywood site, and to the area east of Northwest Packing. However, the thickness of the deep USA near the river is less than 15 feet.

Concentrations of TCE detected in deep USA zone wells are generally less than 15 µg/L. As shown on Figure 4-6, the deep USA zone underlying the SMC and Cadet site source areas has slightly higher concentrations of TCE (approximately 30 µg/L).

4.2.2 Contaminants in the TGA

The Troutdale Formation has an undulating surface in the project area (Figure 3-2). The elevation of the top of the TGA in the project area ranges from -59 feet MSL to more than -229 feet MSL. With a couple of exceptions, VOCs are not detected in wells screened in the TGA and were generally not detected in depth-specific groundwater samples collected from the TGA. The only SMC monitoring well screened in the TGA where TCE (and cis-1,2-DCE) was detected is intermediate well MW-15i, with a TCE concentration of approximately 2 µg/L. VOCs were also detected at deep sample ports of ST Services wells MGMS-2 and MGMS-3, which appear to be screened in the TGA. Low concentrations of TCE and PCE were also found in Cadet well MW-29TGA, in the northeast part of the North Fruit Valley Neighborhood. The TCE concentration in TGA wells is shown on Figure 4-7.

4.3 PREVIOUS/ACTIVE INTERIM ACTIONS

Several previous and/or active interim actions have been implemented at the SMC and Cadet sites. This section briefly summarizes interim actions that were designed to mitigate source areas and/or groundwater contamination.

4.3.1 Actions Completed

Interim actions completed at the SMC and Cadet sites include source area control, an AS/SVE system, and recirculating groundwater wells.

4.3.1.1 Soil Interim Action – SMC Site

A soil interim action was completed at the SMC site in April 1998. The soil interim action involved excavating TCE-impacted soil and ex situ treatment of the stockpiled soil in the vicinity of Building 2220. Soil interim actions were performed with oversight from Ecology and in accordance with MTCA's Independent Remedial Action Program (IRAP) requirements. Soil cleanup activities included:

- Excavating and stockpiling TCE-impacted soil with concentrations greater than 500 µg/kg (MTCA Method A cleanup standard for TCE in soil).
- Treating the stockpiled soil using Enhanced Soil Vapor Extraction (ESVE) until TCE concentrations in the soil were below the MTCA Method A cleanup standard.

Excavation was completed in an expedited manner to allow construction of the Mill Plain Boulevard Extension project. In 1999, after evaluating treatment alternatives for the stockpiled soil, treatment was completed (Parametrix 1999). Additional information on the soil interim action is described in the Final RI Report (Parametrix 2007b).

4.3.1.2 Source Control Interim Action – SMC Site

A source control groundwater interim action was implemented in January 2002. It consisted of injecting Fenton's Reagent and potassium permanganate into the groundwater source area to destroy residual TCE. Groundwater interim actions and evaluation were documented in the Final Groundwater Interim Action Report (Parametrix 2004a). In addition, several additional treatment and verification sampling events were completed after submitting the Final Groundwater Interim Action Report.

The treatment program consisted of injecting Fenton's Reagent below the water table using a combination of injection wells and temporary direct-push injection points. The remedial action objective for the interim action was to destroy, to the extent possible, residual TCE in the SMC groundwater source area. Thus, dissolved TCE concentrations in the source area of less than 10,000 µg/L were deemed indicative of successful treatment and achievement of the remedial action objective. Based on the results of the treatments, the groundwater interim action met the remedial action objectives and is now considered complete, and no further interim actions for source control are expected. Further information on the source control interim action is included in the Final RI Report (Parametrix 2007b).

4.3.1.3 AS/SVE System – Cadet Site

A soil vapor extraction (SVE) system was first installed at the Cadet site in May 2002 to remove soil vapors from beneath the building. An expanded AS/SVE system was installed in October 2003 to remediate VOCs in source area soil and groundwater and to prevent additional migration of dissolved-phase VOCs to the NFVN. The AS/SVE system is comprised of 73 AS wells and 39 SVE wells beneath the Cadet building and in the northern and eastern parking lot areas of the Cadet site.

The AS and SVE wells are interconnected through a network of underground piping. AS wells are connected to two blowers and one compressor that inject air into the subsurface. The SVE wells are connected to four SVE blowers that extract air from the SVE wells. The extracted air is treated using granular activated carbon prior to discharge to the atmosphere.

The Cadet 2005 Remedial Investigation Update Report (RI Update) (AMEC 2005) indicates that groundwater monitoring results from July 2004, October 2004, and January 2005 groundwater sampling events did not show evidence of rebounding dissolved-phase VOC concentrations after the AS/SVE system was pulsed. The AS/SVE system is currently being evaluated by the Port in accordance with the Final AS/SVE Evaluation Plan (Parametrix 2007d).

4.3.1.4 RGRWs – Cadet Site and North Fruit Valley Neighborhood

Recirculating groundwater wells (RGRWs) are one of the remedial action measures implemented by Cadet to reduce concentrations of VOCs originating from a source area located under the Cadet building (AMEC 2005). The RGRWs were installed in the NFVN to mitigate VOCs in groundwater, which is the suspected primary source of VOCs detected in the indoor air of homes located in the NFVN.

Between February 2004 and July 2005, eight RGRWs were installed by Cadet in the vicinity of the Cadet facility and the NFVN. The eight RGRWs include seven operable wells (RGRW-1A and RGRW-2 through RGRW-7) and one decommissioned well (RGRW-1). Each of the RGRWs is constructed with an upper screen located in the shallow levels of the USA and a deeper screen located in the intermediate levels of the USA. Each RGRW includes a submersible pump and a packer located between the two well screens. In addition, the vault for each RGRW includes chemical tanks, a chemical feed pump, and a compressor. The RGRW withdraws groundwater from the intermediate USA, injects sodium permanganate (a strong oxidant that facilitates the breakdown of VOCs into innocuous by-products), then discharges the treated water into the shallow USA through the upper well screen. Additional information on the RGRWs is included in the Final RGRW Evaluation Plan (Parametrix 2007c).

4.3.2 Effectiveness in Reducing VOC Concentrations in Groundwater

As a result of the various interim actions completed on the SMC and Cadets sites, as well as natural attenuation, VOCs in the project area have generally decreased over time. Figures 4-9, 4-10, and 4-11 show the extent of the commingled Cadet and SMC plume in the shallow USA zone in 2002, 2004, and 2006. As shown on these figures, the concentrations of TCE in the shallow USA zone have decreased significantly since 2002. The most significant TCE concentration reductions have occurred in the shallow USA zone east of the Cadet facility, in the NFVN, where the RGRWs have been intermittently operating since 2004. The decrease in TCE concentrations in the project area occurred after interim actions were initiated at the SMC and Cadet sites. However, residual dissolved phase contaminants that require remediation exist in groundwater in the project area.

4.4 RISK ASSESSMENT SUMMARY

A risk assessment was conducted as part of the RI to evaluate the potential risk associated with the SMC site (Parametrix 2007b). The potential human health risks from the release of VOCs at the SMC site were examined by evaluating soil, soil gas, groundwater and indoor air data collected within the project area. An exposure assessment, toxicity assessment, and risk characterization were completed for all of the identified potential exposure pathways.

Ecology and the Washington Department of Health (Health) requested that the Port prepare a Comprehensive Vapor Intrusion and Indoor Air Evaluation Plan (CAMP) (Parametrix 2007a), which includes a discussion of the indoor air data collected at the site and provides recommendations for evaluating indoor air results. The purpose of the CAMP is to provide context for the indoor air results. The CAMP also includes recommended screening levels and mitigation levels for site contaminants, and provides a basis for further indoor air monitoring.

The goals of the risk assessment were to identify potential risks to on-site and off-site Port workers, excavation/construction workers, and off-site residents from chemicals found in soil, soil gas, groundwater, and indoor air. A brief summary of the conclusions of the risk assessment for each medium is included below.

Groundwater: The potential risk associated with ingestion and dermal contact of groundwater was evaluated for source area and project area workers, an excavation worker, and an SFVN resident. While previous remedial actions have significantly reduced groundwater concentrations, current concentrations are still at levels that suggest potential elevated risks to human health for all receptors and exposure pathways evaluated. The results indicate that remedial actions are necessary to reduce groundwater concentrations to levels that are protective of potential future receptors. Use of groundwater within the project area, in areas of contamination at levels evaluated in the risk assessment, should continue to be restricted until contaminant concentrations do not exceed cleanup goals. This interim action will be designed to hydraulically contain groundwater and treat dissolved-phase VOCs in the project area.

Soil: The potential risk associated with soil was evaluated for a source area worker and an excavation worker. Based on the human health risk assessment, the current risk associated with COPCs in soil in the source area is within the acceptable risk range. Further remediation of soil is not warranted based on the potential receptor scenarios evaluated. However, reduction of COPCs in source material may be evaluated in the feasibility study to supplement the groundwater remedial efforts.

Indoor Air: The potential risk associated with indoor air was evaluated for source area workers and SFVN residents. Current measured concentrations of VOCs at all SFVN residences indicate elevated cancer risks (i.e., above $1\text{x}10^{-6}$) from chronic exposure to indoor air (Excess Lifetime Cancer Risks [ELCRs] ranging from $7\text{x}10^{-6}$ to $2\text{x}10^{-4}$). However, background air conditions should be considered when evaluating the indoor air results. Based on data collected to date, the background (outdoor) air concentrations appear to be within the levels observed nationally and may have some impact on indoor air concentrations. The CAMP was prepared to provide recommendations for evaluating indoor air data and includes recommended screening and mitigation levels for all of the COPCs. It should be noted that remedial efforts to mitigate indoor air concentrations may be required and are likely to include the reduction of TCE in groundwater, which will reduce volatilization to indoor air.

Outdoor Air: The risk from outdoor air was evaluated for a source area worker and an SFVN resident (child and adult). Based on the human health risk assessment, the current risk associated with COPCs in outdoor air is within the acceptable risk range. Outdoor air was evaluated because it is a complete exposure pathway at the site. However, it should be noted that the source of the outdoor air concentrations is unknown and could be sourced from the groundwater plume, local facility emissions, and/or other sources.

For the purposes of this Work Plan, the risk associated with groundwater at the SMC and Cadet sites indicate an elevated risk if used as a drinking water source. Therefore, the Port has elected to implement an interim action to facilitate cleanup of the contaminated aquifer. Additional actions may be necessary to achieve cleanup levels for other media at the site.

5. INTERIM ACTION OBJECTIVES AND POINTS OF COMPLIANCE/MONITORING

This section provides the remedial action objectives and the current understanding of performance monitoring and discharge limits.

5.1 GROUNDWATER INTERIM REMEDIAL ACTION OBJECTIVES

Remedial action objectives (RAO) describe the overall goals of an interim action. For an interim action, the goals do not necessarily include final cleanup of a site, but must be consistent with final cleanup objectives (WAC 173-340-430(3)(b)). Validation that the objectives are attained is determined through performance monitoring. The RAOs identified for this interim action are:

- Achieve hydraulic containment of the SMC/Cadet dissolved-phase VOC plume.
- Remove dissolved-phase VOCs in groundwater.

Hydraulic containment of the plume is essential to prevent further migration of contaminants in the aquifer and possible impacts to drinking water wells in the vicinity. The plume, for purposes of the interim action, is defined by TCE concentrations greater than 5 µg/L (Figures 4-1 and 4-2). Removal of the dissolved-phase VOCs will provide cleanup and potential future use of the aquifer. The location of the interim action in the immediate vicinity of the SMC site (see Section 7) has the additional benefit of removing the most highly contaminated groundwater within the plume. The implementation of the interim action is consistent with the protection of the sole source aquifer designated by the EPA.

5.2 INTERIM ACTION MONITORING

All interim action alternatives considered include performance monitoring during the remedial action to evaluate the effectiveness of the treatment and to determine that the cleanup performance standard has been met. For the selected interim action, performance monitoring will include:

- Monitoring of the extraction and groundwater treatment system, including sampling of treated groundwater and air discharges, to ensure proper performance.
- Regular monitoring of groundwater through sampling of monitoring wells to evaluate groundwater concentrations and to observe the dissolved plume configuration. In addition, sampling of other media (i.e., soil gas, indoor air) may be required to correlate whether the interim action has impacted other media concentrations.
- Monitoring of transducer data and application of the groundwater model to determine hydraulic containment.

A preliminary performance monitoring program has been developed and is presented in Section 7.3. It is expected that the Port will continue to work with Ecology to further refine the expectations of the monitoring program, specific performance criteria, sampling methods, and the relationship of the interim action to the various media (groundwater, soil gas, indoor air) at the site.

5.3 TREATMENT PLANT DISCHARGE LIMITS (WATER AND AIR)

The following sections describe the current understanding of discharge standards for water and air from the treatment system.

5.3.1 Discharge Standards for Water

Discharge standards for the treatment system will be developed and issued in the National Pollutant Discharge Elimination System (NPDES) permit. It is currently anticipated that water from the treatment system will be discharged through an existing bank outfall on the Columbia River. Accordingly, state surface water standards will be applicable. MTCA lists Washington State Surface Water Quality Standards in WAC 173-201a as potential Applicable or Relevant and Appropriate Requirements (ARARs). The state standards do not contain specific numeric standards for TCE and other chemicals, but do include antidegradation restrictions and requirements for application of All Known, Available, and Reasonable Methods of Treatment (AKART) for removal of toxic pollutants.

Although specific discharge standards have not yet been developed (this will be determined by Ecology and provided in the NPDES permit), it is expected that the preferred treatment technology (air stripping) will be capable of meeting potential surface water discharge standards. Air stripping is capable of removing TCE and other risk driver chemicals to below detection limits of 0.1 µg/L. TCE is the driver for design of the treatment system because it has the highest concentration in groundwater and is the least volatile of the risk driver chemicals. Table 5-1 provides a comparison of Henry’s Law constants for risk driver chemicals. The Henry’s Law constant is indicative of the removal performance provided by air stripping (compounds with higher Henry’s Law constants are easier to remove). As shown in the table, TCE has the lowest Henry’s Law constant among the risk driver chemicals but is nonetheless highly volatile and readily removed by air stripping.

Table 5-1. Comparison of Henry’s Law Constants for Risk Driver Compounds

Compound	Henry’s Law Constant @ 10C (unitless)
TCE	0.23
PCE	0.36
1,1-DCE	0.66

Because VOCs are the only COPCs in groundwater, their removal will result in discharge water quality that meets surface water standards. The treated groundwater will contain background concentrations of elements and minerals that are part of the natural groundwater aquifer matrix. It is anticipated that these natural materials such as metals or suspended solids will not require treatment in order to meet surface water discharge standards. Further information will be developed during the NPDES permit application process.

5.3.2 Discharge Standards for Air

Emissions from air stripping towers are regulated under state and local air pollution control requirements. The Southwest Clean Air Agency (SWCAA) will be the lead regulatory agency. At this point in time, it has not been determined whether treatment of the air emissions will be required. Treatment requirements, if any, will be determined by SWCAA in the air permit and will be based on meeting concentration limits for VOCs (discussed below) as well as on results of a Best Available Control Technology (BACT) analysis. The BACT analysis presents an evaluation of available control technologies and considers feasibility, effectiveness, economics, and other factors. The BACT analysis and an Air Discharge Application are submitted to SWCAA for review. The application is also submitted for public review.

Air quality regulations under WAC 173-460-110 include Acceptable Source Impact Levels (ASILs) for toxic air pollutants such as TCE and PCE. Emissions from the proposed air strippers were modeled with EPA Screen, a conservative dispersion model developed by EPA, to provide preliminary estimates of air pollutant concentrations. Modeling was based on the predicted maximum concentrations of TCE (200 µg/L) in extracted groundwater. Results of the dispersion modeling show that the ASIL standard for TCE is achieved without treatment of off-gases. Application of off-gas treatment using granular activated carbon (GAC) is expected to reduce these emission levels by approximately 90 percent.

Compared to other risk driver chemicals, TCE has the most stringent ASIL standard (Table 5-2). By meeting air quality standards for TCE, the standards for other risk driver chemicals will also be achieved. However, as indicated earlier, the requirements for treatment of air emissions will be based on the BACT analysis and review by SWCAA.

Table 5-2. Discharge Standards and Estimated Air Emissions without Off-Gas Treatment

	TCE	PCE	1,1-DCA	1,1-DCE	1,2-DCE	1,1,1-TCA
Groundwater Concentration (ug/L)	200	160	20	1	80	20
Mass Emitted[1] (lbs/year)	2,017	1,613	202	10	807	202
Dispersion Model[2] (ug/m^3)	0.3	0.241	0.181	0.009	0.72	0.181
ASIL2 (ug/m^3)	0.59	1.10	2,700	67	2,600	6,400

Notes:

[1] Using mass balance from groundwater analytical data and an assumed flow of 2,300 gpm.

[2] Annual averaging time for TCE and PCE; 24-hour averaging time for 1,1,1-TCA, 1,1-DCA, 1,1 DCE, and 1,2-DCE.

ASIL - Acceptable Source Impact Level (WAC 173-460-150 (2) & (3)).

Dispersion Model - SCREEN 3 model output (assumes 65 foot stack height, 1 foot diameter stack, with building downwash and overpass receptor height).

6. EVALUATION OF INTERIM CLEANUP ACTIONS

This section discusses treatment technologies and the selection of the groundwater interim action. The interim action was selected in accordance with MTCA requirements summarized in WAC 173-340-430.

6.1 CRITERIA FOR SELECTION OF INTERIM CLEANUP ACTIONS

The primary criteria for selection of the groundwater interim action is achievement of the RAOs established in Section 5.1:

- Achieve hydraulic containment of the SMC/Cadet dissolved-phase VOC plume.
- Remove dissolved-phase VOCs in groundwater.

The following sections describe the selection of interim action alternatives.

6.1.1 Containment/Capture of Groundwater Plume

There are a limited number of technology options available to meet the hydraulic containment RAO, specifically for large plumes such as the SMC- and Cadet-sourced plumes. Hydraulic containment is generally limited to extraction of groundwater to create a capture zone, limiting the potential for plume migration. Other technologies include interceptor walls for treatment, recirculating wells, and sheet piling to restrict groundwater movement. However, given the lateral and vertical extent of the commingled plume, technologies such as interceptor walls and sheet piling were deemed not feasible due to costs and logistical considerations and were not considered further. Recirculating wells located on the perimeter of the plume could theoretically be used to provide cleanup. While recirculating wells would not provide hydraulic containment, they would provide cleanup at the far edge of the plume. However, the cost to construct and maintain a large number of recirculating wells is very high, and cleanup would be limited to the rate at which groundwater flows to the wells naturally (i.e., no control of groundwater flow). Therefore, in order to meet the hydraulic containment RAO, groundwater pumping and treatment was deemed the only feasible alternative for the interim action.

There are three options available to maintain capture of the groundwater plume:

1. Extraction at the downgradient edge of the plume; this is the current GWM pumping well scenario, operating at approximately 3,900 gpm.
2. Extraction at the downgradient edge of the plume, enhanced with circulating wells within the plume.
3. Extraction at the source area of the plume.

The location of extraction equipment is a key variable that differentiates potential remedial alternatives. Currently the GWM wells are operating at the downstream edge of the plume, and have historically pulled the plume toward the wells. Extraction wells closer to the source of contamination would encounter higher contaminant concentrations and should remove larger quantities of mass over shorter periods of time.

In order to analyze the effectiveness of a pump and treat interim action, a groundwater model was used to evaluate the interim action alternatives. The model was constructed using the three-dimensional finite difference groundwater flow U.S. Geological Survey code MODFLOW (McDonald and Harbaugh 1988).

The model was applied to the interim action alternative by establishing an extraction well location, screen interval and pump rate in the model. The model was then applied to steady-state, average conditions for river stage and recharge to predict groundwater flow patterns in the model area. The effectiveness of an interim action well was evaluated using particle tracking simulations to illustrate whether or not the capture zone of a well configuration encompassed the SMC/Cadet plume.

Based on the consideration of the three scenarios, model simulations and results, and the RAO for hydraulic containment, extraction within the SMC site location was selected as the most viable alternative. Reduction of VOC concentrations in groundwater is an RAO (discussed in Section 6.1.2), but continued operation of the GWM wells alone will not achieve the objectives of the site. Circulating wells are also not acceptable because they do little to control hydraulic migration. While providing some cleanup of groundwater concentrations (the RGRWs in the NFVN have dramatically reduced concentrations near the RGRWs), circulating wells primarily function as interceptors of groundwater. Therefore, placement of an extraction well at the SMC site and treatment of extracted groundwater will achieve the RAOs for the site.

Figure 6-1 shows the results of the groundwater model with the extraction well located in the SMC source area. The capture zone encompasses the commingled plume originating from the SMC and Cadet sites. The groundwater model will be a key element in evaluating hydraulic containment (see Section 7.3.1.2). Achievement of the second RAO, treatment of VOCs, is discussed below.

6.1.2 Reduction of VOC Concentrations in Groundwater

As discussed in Section 5.1, the second RAO is to remove dissolved-phase VOCs in groundwater. Treatment of the contaminants in groundwater will provide future value to the aquifer as a potential drinking water source and is consistent with the sole source aquifer designation by the EPA. Based on current and known future use, the aquifer near the project area is important as a public water alternative. A number of facilities or public entities have used or are currently using water within the existing aquifer near the project area (see Section 2.5); however, no drinking water wells are located within the groundwater contamination plume (SMC and Cadet commingled plume). It is expected that future use of the aquifer within the project area will be needed to meet water demands. Therefore, cleanup of dissolved-phase VOCs needs to be completed to reduce the risks to human health and the environment.

As discussed above, the extraction well will be located at the SMC site. This location was selected because it will treat the most highly contaminated groundwater within the plume, and the capture zone created by the well will include the entire commingled plume (Figure 6-1).

Reduction of VOC concentrations in groundwater will be achieved by extracting water and treating it at an aboveground facility. Treatment alternatives have been identified and are evaluated in the following section.

6.2 EVALUATION OF EX-SITU TREATMENT ALTERNATIVES

Presumptive technologies for ex-situ treatment of contaminated groundwater are set forth in the EPA guidance document Presumptive Response Strategy and Treatment Technologies for Contaminated Ground Water at CERCLA Sites (USEPA 1996). Presumptive technologies are preferred technologies based on historical patterns of remedy selection and EPA's evaluation of technology performance data. EPA guidance constitutes the development and screening stages for the ex-situ treatment component of the groundwater pump and treat cleanup action. Presumptive remedies for ex-situ treatment of VOCs are:

- Air Stripping
- Granular Activated Carbon
- Chemical/UV oxidation
- Aerobic Biological Reactors

Of these presumptive remedies, air stripping and activated carbon are the most frequently used technologies for treatment of groundwater contaminated with TCE. The EPA report Treatment Technologies for Site Cleanup: Annual Status Report (11th Edition) (USEPA 2004) tracks the status of pump and treat technologies used to clean up contaminated groundwater at Superfund sites across the United States. Based on 171 pump and treat projects using 224 treatment technologies, more than half of the systems are using air stripping to successfully remove VOCs from groundwater. Carbon adsorption is the second most frequently used pump and treat technology. The report also shows that TCE and PCE are the most common groundwater contaminants treated by the pump and treat technologies.

Remedial technology alternatives were assembled and evaluated to select those most suitable for the interim action. The remedial technologies were screened using the following criteria:

- **Effectiveness** – The potential effectiveness of the technology to (1) address site-specific conditions, including applicability to treat dissolved TCE and other VOCs; (2) ability to reliably meet discharge standards; (3) minimize human health and environmental impacts during implementation; and (4) provide proven and reliable remediation under the conditions observed at the SMC site.
- **Implementability** – The technical and administrative feasibility of implementing a technology. Technical considerations cover site-specific factors that could prevent successful use of a technology, such as physical interferences or constraints, practical limitations of a technology, conflicting schedules, and land use compatibility. Administrative considerations include the ability to obtain permits and the availability of qualified contractors, equipment, and disposal services.
- **Cost** – The capital and operation and maintenance costs associated with the technology. Costs that are excessive compared to the overall effectiveness of the technology may be considered as one of several factors used to eliminate technologies. Technologies providing effectiveness and implementability similar to that of another technology by employing a similar method of treatment or engineering control, but at greater cost, may be eliminated.

The assembled ex-situ treatment technologies are evaluated in the following sections.

6.2.1 Biological Treatment

Biological treatment (or bioremediation) involves the destruction of contaminants by biological mechanisms, including microorganisms (e.g., yeast, fungi, or bacteria), in contaminated soil and water. Microorganisms eat and digest organic substances for nutrients and energy. Certain microorganisms can digest organic substances such as fuels or solvents into harmless products such as carbon dioxide and water. Once the contaminants are degraded, the microorganism population dies off, having consumed their entire food source. Certain microorganisms are capable of detoxifying TCE and other chlorinated hydrocarbons by a process known as anaerobic reductive dechlorination. Biological dechlorination requires that the necessary microorganisms are present or are introduced as part of the treatment. The dechlorination is typically limited by the availability of food and nutrients for microbial growth. Ex-situ bioremediation of chlorinated solvents is usually carried out in aboveground fluidized beds or fixed bed reactors.

6.2.1.1 Evaluation

The results of the evaluation for the established criteria are summarized below.

- **Effectiveness** – Effective treatment using bioremediation depends on the ability of native and/or imported organisms to degrade TCE. Effectiveness also depends on availability of food and nutrients, which typically must be added to the system on a continual basis to maintain living organisms. The effectiveness and reliability of this technology to meet stringent discharge limits for VOCs and to process high volumes of groundwater is questionable and is not as well proven as other presumptive technologies. Pilot studies to demonstrate effectiveness and operational performance would be required prior to design.
- **Implementation** – Bioremediation is technically implementable; however, the reactors and other associated equipment would be much larger than what has typically been used in other systems. As with other technologies, permits for discharge of treated effluent would be required. An additional permit for disposal of sludges from the treatment process would likely be required. Other permits such as outfall permits and building permits would be the same as other alternatives.
- **Cost** – The capital cost of this alternative would be comparable to others. However, operating costs, particularly those costs associated with power and disposal of residuals, could potentially be lower than other alternatives.

Summary of Advantages

- Potential to completely degrade and destroy contaminants.
- Energy consumption and operating costs are potentially lower than other alternatives.

Summary of Disadvantages

- There is the potential to form toxic intermediate degradation products such as vinyl chloride. Operation would have to be closely monitored and maintained to ensure complete degradation of contaminants.
- The effectiveness and reliability of this technology to meet stringent discharge limits for VOCs and to process high volumes of groundwater is questionable and is not as well proven as other presumptive technologies. Literature review indicates that most

applications are limited to relatively low flow conditions. Pilot studies to demonstrate effectiveness and operational performance would be required prior to design.

- The preferred degradation pathway for TCE and daughter products is anaerobic (i.e., without oxygen). Anaerobic processes are not widely used for ex-situ groundwater treatment (USEPA 1996). Furthermore, EPA recommends that while aerobic processes are presumptive, anaerobic processes are not, for the following reasons: 1) anaerobic processes have not been widely used for groundwater treatment; 2) reaction rates are slower than for aerobic processes; and 3) such reactors have a greater sensitivity to process upsets, especially where flow and contaminant concentrations vary over time.
- Bioremediation requires the addition of food and nutrients. Because the native groundwater contains very low concentrations of carbon source material and nutrients, these materials would need to be added to the process in considerable amounts to maintain biological degradation.
- Performance is temperature-sensitive, and removal rates could decline in cold winter months.

Based on this evaluation and the consideration of advantages and disadvantages, biological treatment was eliminated from further consideration. Of the presumptive ex-situ groundwater remedies researched by EPA, this technology is used at only 4% of the sites. The effectiveness of this technology is less proven than other technologies.

6.2.2 Chemical/UV Oxidation Processes

When used as part of a pump and treat system, captured contaminated groundwater is treated using advanced oxidation processes – such as ultraviolet (UV) radiation, ozone, or hydrogen peroxide – to destroy organic contaminants as water flows into a treatment tank. If ozone is used as the oxidizer, an ozone destruction unit is used to treat collected off-gases from the treatment tank and downstream units where ozone gas may collect or escape.

6.2.2.1 Evaluation

The results of the evaluation for the established criteria are summarized below.

- **Effectiveness** – Advanced oxidation would be expected to perform well in removing and destroying contaminants. Formation of toxic intermediate compounds is a concern, and treatment of effluent by GAC may be required. The effectiveness and reliability of this technology to meet stringent discharge limits for VOCs and to process high volumes of groundwater is questionable and is not as well proven as other presumptive technologies. Pilot studies to demonstrate effectiveness and operational performance would be required prior to design.
- **Implementation** – This alternative has many of the same implementation requirements as other alternatives. Large quantities of chemicals would have to be handled and stored, and the system would be labor-intensive, requiring frequent refills of chemical feed tanks and monitoring of reactant feed rates and effluent quality.
- **Cost** – The cost of this alternative would be comparable or higher than others due to the frequent maintenance and large quantities of chemicals required.

Summary of Advantages

- Destroys organic contaminants as part of the treatment process instead of transferring them to other media, which reduces the quantity of hazardous treatment residuals (e.g., spent carbon) that will require further treatment.

Summary of Disadvantages

- The aqueous stream being treated must provide for good transmission of UV light (high turbidity causes interference). This factor can be more critical for UV/H_2O_2 than UV/O_3 (turbidity does not affect direct chemical oxidation of the contaminant by H_2O_2 or O_3).
- Costs may be higher than those for competing technologies because of energy requirements and oxidant demand. For example, Alexander and Modak (2006) showed that treatment of groundwater TCE by GAC is less costly than UV/Oxidation.
- Pretreatment of the aqueous stream may be required to minimize ongoing cleaning and maintenance of UV reactor and quartz sleeves.
- Handling and storage of oxidizers require special safety precautions.
- There is the potential to form toxic, unreacted intermediate compounds. In some applications, GAC treatment is required downstream of the oxidation unit to remove un-reacted intermediate compounds.

Based on this evaluation and consideration of advantages and disadvantages, Chemical/UV Oxidation treatment was eliminated from further consideration. Of the presumptive ex-situ groundwater remedies researched by EPA, this technology is used at only 1% of the sites. The effectiveness of this technology is less proven than other technologies. The degree of maintenance and associated costs is relatively high compared to other alternatives.

6.2.3 Air Stripping

When used as part of pump and treat system, captured groundwater is remediated using air stripping, a well-understood technology in which volatile organics are partitioned from groundwater by greatly increasing the surface area of the contaminated water exposed to air. Types of aeration methods include packed towers, diffused aeration, tray aeration, and spray aeration.

Air stripping involves the mass transfer of volatile contaminants from water to air. For groundwater remediation, this process is typically conducted in a packed tower or an aeration tank. The typical packed tower air stripper includes a spray nozzle at the top of the tower to distribute contaminated water over the packing in the column, a fan to force air countercurrent to the water flow, and a sump at the bottom of the tower to collect decontaminated water. Auxiliary equipment that can be added to the basic air stripper includes an air heater to improve off-gas removal efficiencies; automated control systems with sump level switches and safety features, such as differential pressure monitors, high sump level switches, and explosion-proof components; and air emission control and treatment systems, such as activated carbon units, catalytic oxidizers, or thermal oxidizers. Large-scale packed tower air strippers are usually installed on concrete pads.

6.2.3.1 Evaluation

The results of the evaluation for the established criteria are summarized below.

- **Effectiveness** – Air stripping is a well-established technology that has shown high removal efficiencies. Based on process modeling and actual case study examples, air stripping is capable of removing TCE and other risk driver chemicals to below detection limits of 0.1 µg/L.
- **Implementation** – This alternative is readily implementable. Local suppliers of air stripping towers and associated equipment are available in the area. Local suppliers are also available for providing GAC and associated equipment for off-gas treatment. As with other technologies, permits for discharge of treated effluent would be required. An additional permit for discharge of air emissions will be required. Other permits such as outfall permits and building permits would be the same as for other alternatives. All permits are expected to be obtainable for this alternative.
- **Cost** – The capital and operating costs for this alternative are similar to other alternatives. Potential significant cost savings may be realized in later years of operation when groundwater VOCs decline to such low levels that off-gas treatment can be eliminated.

Summary of Advantages

- Air stripping is a highly proven and reliable technology. Discharge standards are readily obtainable.
- The process has a long history of success and has been used at many other sites under similar high flow rates and groundwater VOC concentrations.
- The same technology has been used successfully at GWM, and has maintained compliance there with NPDES discharge standards on the Columbia River.
- The technology is highly adaptable to changing flow rates and influent chemical concentrations.

Summary of Disadvantages

- The potential exists for scaling and biofouling of packing material. Air strippers can become fouled by mineral deposits such as calcium, iron, and manganese. In addition, biological growth can occur on the packing material restricting the flow of air and water through the tower. In situations where groundwater contains high concentrations of minerals or biologically active materials, cleaning materials and equipment can be incorporated into the air stripping tower design to periodically remove buildup of materials.
- Contaminants are transferred from one medium to another. However, with the addition of GAC for treatment of off-gasses, contaminants are destroyed during thermal reactivation of the carbon.

6.2.4 Granular Activated Carbon

When used as part of a pump and treat system, groundwater is pumped through a series of canisters or columns containing activated carbon to which dissolved organic contaminants adsorb. Liquid phase carbon adsorption is a full-scale technology in which groundwater is pumped through one or more vessels containing activated carbon to which dissolved organic contaminants adsorb. Periodic replacement or regeneration of saturated carbon is required. The principal form of activated carbon used for groundwater treatment and treatment of off-gasses from air strippers is granular activated carbon (GAC). GAC is an excellent sorbent due to its large surface area, which generally ranges from 500 to 2,000 square meters per gram.

Adsorption by activated carbon has a long history of use as a treatment for municipal, industrial, and hazardous waste streams. The concepts, theory, and engineering aspects of the technology are well developed. It is a proven technology with documented performance data. Carbon adsorption is a relatively nonspecific adsorbent and is effective for removing many organic, explosive, and some inorganic contaminants from liquid and gaseous streams.

6.2.4.1 Evaluation

The results of the evaluation for the established criteria are summarized below.

- **Effectiveness** – Pump and treat with GAC filtration is one of the most common water treatments for a variety of contaminants and has been used successfully all over the world. Because of its success in reducing VOC concentrations, it is also the most popular technology for treatment of emissions from air strippers, air sparging systems, and similar remedial technologies, and is considered to be Best Available Control Technology (BACT) by EPA and local air quality agencies.
- **Implementation** – This alternative is readily implementable. Local suppliers of GAC and associated equipment are available in the area. As with other technologies, permits for discharge of treated effluent would be required. Other permits such as outfall permits and building permits would be the same as other alternatives. All permits are expected to be obtainable for this alternative.
- **Cost** – Capital costs for this alternative are comparable to other alternatives. Operating costs can be relatively high, depending on the replacement frequency of carbon. A preliminary evaluation suggests that operating costs of this alternative would be higher than the costs for air stripping with off-gas GAC treatment.

Summary of Advantages

- This is a highly proven and reliable technology. Discharge standards are readily obtainable.
- The process has a long history of success and has been used at many other sites under similar high flow rates and groundwater VOC concentrations.
- The technology is highly adaptable to changing flow rates and chemical concentrations.
- Due to the dilute concentrations of VOCs in the air stream, GAC is preferred over other technologies such as catalytic combustion for control of air stripper emissions.

Summary of Disadvantages

- The presence of multiple contaminants can impact process performance. Single component isotherms may not be applicable for mixtures. Bench tests may be conducted to estimate carbon usage for mixtures.

- Carbon use rate is highly influenced by the concentration of natural organic matter (NOM) in the groundwater. Natural dissolved organic material competes with contaminants for adsorption sites on the carbon.
- Streams with high concentrations of suspended solids (> 50 mg/L) and oil and grease (> 10 mg/L) may cause fouling of the carbon and may require frequent treatment. In such cases, pretreatment is generally required.
- Costs may be high if this technology is used as the primary treatment of waste streams with high contaminant concentration levels.
- Type, pore size, and quality of the carbon, as well as the operating temperature, will impact process performance. Vendors with expertise in carbon selection should be consulted.

6.3 SUMMARY OF INTERIM CLEANUP ACTION ALTERNATIVES

Table 6-1 presents the interim action cleanup alternatives and a summary of the evaluation for each criterion.

Table 6-1. Summary of Interim Action Alternatives Evaluated

Alternative	Treatment	Effectiveness	Implementability	Cost
Extraction Well	Air Stripping	Well established technology; can achieve 99% efficiency.	Readily available from vendors; permit required for air emissions.	Capital costs similar; may reduce costs in later years as VOCs lower.
Extraction Well	GAC	Established technology; more effective for air than water.	Readily available from vendors; more effective for air than water.	Capital costs similar to other alternatives; relatively high O&M costs.
Extraction Well	Chem/UV Oxidation	May be effective, but may create additional compounds that must be treated.	Requires large chemical amounts and high O&M.	High O&M costs.
Extraction Well	Biological	Effectiveness for high volumes of water is questionable.	Implementable; large equipment vessels required.	O&M costs may be lower.

Air stripping is currently being used successfully by other facilities to treat similar flow rates and VOC concentrations. It is the most popular presumptive remedy for ex-situ treatment of TCE and PCE, and performance is highly predictable and reliable. No further pre-design studies such as pilot or bench-scale studies are required, and effluent discharge standards are readily attainable. GAC may also be used for treatment of air emissions (depending on requirements of the air permit to be issued by SWCAA). Although GAC is also applicable for treatment of groundwater, air stripping with off-gas treatment is expected to be more economical overall.

Based on the RAOs and the selection criteria, the interim action alternative will consist of a pump and treat system designed to extract contaminated groundwater, which will be treated using air stripping technology. GAC may be used to remove VOCs from air stripper off-gas emissions.

7. SELECTED INTERIM CLEANUP ACTION

The following sections describe the selected interim action, the predicted effectiveness, and performance monitoring. It should be noted that information presented in this section is based on a conceptual level design. Information including equipment sizing, flows, performance requirements, and other information may change or be refined as the design progresses to a more detailed level.

7.1 DESCRIPTION OF SELECTED INTERIM CLEANUP ACTION

The preferred alternative involves pumping groundwater from the project area and treating the groundwater through an air stripping process. The groundwater extraction well will be located at the former SMC site. The treatment plant will be located on Port property, next to the Trimac building (Port Building number 2601). This area is owned and controlled by the Port and is already supplied with ample utilities. The conceptualized locations for the pumping well and treatment system are shown on Figure 7-1. Figures 7-2 and 7-3 present the conceptual layout of the extraction/treatment system and process schematic. Figure 7-4 presents the conceptual air stripper tower design.

The Port is currently conducting pre-design studies, which include evaluating conveyance alternatives and establishing the final treatment plant location and pipe alignments. Upon agency approval of the Work Plan, the Port will prepare a 30% Design Engineering Report, which will include specifics and refinement of the interim action design. The 30% Design Engineering Report will be submitted to Ecology for review and approval. Upon approval of the 30% Design, a 90% Design Engineering Report will then be prepared and submitted to Ecology for review and approval. The 90% Design Engineering Report will be used to refine adjustments to the final design, prior to developing the bid documents for selection of a contractor for construction.

The following sections provide the conceptual design for the interim action, including groundwater pumping, air stripping towers, off-gas treatment, and groundwater discharge.

7.1.1 Groundwater Pump and Treatment

The interim action pumping system will include one groundwater extraction well located on the former SMC site (Figure 7-1). The well will be designed to produce a maximum groundwater extraction rate of up to approximately 3,900 gpm. The average flow rate from the well during the interim action is anticipated to be approximately 2,500 gpm. The flow rate from the well will be variable and will be controlled manually with adjustment valves located at the treatment plant. A flow meter will be installed on the well’s discharge line to continuously monitor and record flow. Design of the well and pump will allow for future addition of automated controls to adjust flow rates automatically in response to pumping effects of other wellfields (i.e. GWM, the City, and CPU). As a means of energy conservation, the well motor will be equipped with a variable speed drive.

Pumping rates needed to contain the contaminant plume and offset effects of the CPU wellfield were predicted with the hydrogeologic model and are included in Table 7-1. The table also shows maximum predicted TCE/PCE concentrations and required removal rates by the treatment system. As shown, the maximum required pumping rate initially (Year 1) is expected to be approximately 2,226 gpm. The average annual flow rate during the first year of operation is expected to be approximately 1,400 gpm. Initially, TCE/PCE concentrations are anticipated to be approximately 200 µg/L. As shown in the table, the concentration of TCE/PCE in the extracted water is expected to decline steadily as extraction progresses through subsequent years of operation. The pump rate will be increased to draw contaminants from farther away and to offset the expected increased pumping at CPU (discussed in Section 2.5.4). After approximately 25 years, the rate of decline of VOCs is expected to be asymptotic (Table 7-1).

Specifications for the extraction well will be determined during remedial design. Preliminary design indicates that the extraction well diameter and depth will be approximately 24 inches and 130 feet, respectively. The well pump will likely be vertical turbine, with a power output of approximately 150 horsepower (hp). The well motor will be variable speed to accommodate the anticipated variations in pumping rate. The well head and associated piping will be located in a well house. All piping and electrical conduits will run underground from the well house to the treatment plant. Flow from each well will be measured and monitored with an electronic flow meter installed on the discharge piping leading from the well to the treatment plant. The flow rate will be monitored and controlled locally by the treatment plant operator from a control screen located in the control room next to the treatment plant.

Liquid chlorine (sodium hypochlorite) will be injected at the well head at a controlled rate to prevent accumulation of biological growth (e.g., algae and bacteria) in the air stripping towers. The chlorine injection rate will be controlled automatically (paced with flow rate) to maintain a chlorine residual of approximately 1 part per million. Chlorine injection will occur upon discharge from the pumping well to allow adequate time for mixing before the groundwater enters the air strippers. Chlorine will be stored on site within a double-walled containment tank (e.g., dike tank) with a volume of approximately 2,000 gallons.

Piping from the extraction well to the treatment plant will be a combination of ductile iron and C-900 PVC (pressure rated). The piping will run underground at an approximate depth of 3 feet bgs, but may vary to avoid existing utilities or other structures.

7.1.2 Air Stripping Towers

The air stripping tower design was evaluated with a computer model to simulate process performance. The computer model is based on a two-phase resistance theory (gas and liquid phase) and uses empirically derived Onada Correlations (Onada et al. 1968). This model has been verified in the field for groundwater TCE removal (Ball and Edwards 1992). The key design elements that affect TCE removal performance are:

- Packing Height
- Air/Water Ratio (v/v)
- Water and Air Temperature
- Pressure Drop and Fan Size

Figure 7-4 shows the conceptual design of the air stripping towers. The design includes two air strippers. The overall tower height would be approximately 65 feet, and the diameter is approximately 10 feet. The treatment system design is based on removing TCE from an estimated maximum concentration of 200 µg/L down to the analytical detection limit of 0.1 µg/L. In addition, each air stripping tower will be designed for a maximum flow of approximately 3,900 gpm. Actual flows and concentrations from the groundwater extraction system are expected to vary over time and are shown in Table 7-1 for the first 25 years of operation. Beyond year 25, average flows are expected to remain steady at approximately

3,900 gpm, and TCE concentrations are expected to continue to decline exponentially. As shown in Table 7-1, the treatment system design will be capable of removing TCE to 0.1 µg/L at all anticipated flows and concentrations. Actual removal rates and discharge criteria for TCE will be determined in the NPDES permit. As previously discussed in Section 5.3, TCE has the highest concentration and is the most difficult compound to strip relative to other risk driver chemicals. Therefore, removing TCE to required discharge standards will result in attainment of discharge standards for other risk driver chemicals.

In certain situations, natural constituents in groundwater are present at sufficiently high concentrations to require water pretreatment or periodic cleaning of towers to avoid accumulation of unwanted scale or mineral deposits within the air stripper packing material. A manganese dioxide filter will be used to remove naturally occurring iron and manganese from extracted groundwater. The water will flow through the filter bed at a flux rate of approximately 12 gpm per square foot. The manganese dioxide filter requires daily backwashing to maintain the effectiveness of the media for oxidizing and removing iron and manganese. The backwash water concentrated with iron and manganese will be discharged to the sanitary sewer.

7.1.3 Off-Gas Treatment System

Off-gases from the air strippers may require treatment. Treatment requirements, if any, will be determined by SWCAA in the air permit and will be based on meeting concentration limits for VOCs as well as results of a BACT analysis. A BACT analysis presents an evaluation of available control technologies and considers feasibility, effectiveness, economics, and other factors. If treatment of off-gases is required, activated carbon would most likely be the technology of choice for this application. The information below presents conceptual design information for activated carbon.

The off-gases from the air strippers will be routed through ducting to air heaters to increase air temperature and decrease relative humidity for efficient carbon adsorption. Air heaters would be powered by either electricity or natural gas, both which are available with adequate capacity via existing utility lines near the treatment plant location. Each of two carbon adsorber units would contain approximately 36,000 lbs of granular activated carbon. The adsorbers would be skid-mounted, portable units for easy removal and replacement. Upon depletion of carbon in the adsorber unit, a new adsorber containing fresh carbon would replace the old adsorber. Depleted carbon would be transported to a permitted offsite facility for regeneration. Services are readily available in the area for supply and replacement of activated carbon. Carbon use rates and replacement frequency for carbon adsorption units would be determined during design.

7.1.4 Treatment Plant Discharge

Treated discharge water from the air strippers will gravity-flow into a wet-well located below ground at the treatment facility. The wet-well is a concrete-lined, below-ground sump and will be sized for sufficient capacity and retention time for dechlorination. Dechlorination will be provided by adding sodium metabisulfite to react with and remove all remaining residual chlorine in the water.

Discharge pumps will be located in the wet-well and will convey treated water through the PVC discharge line. The discharge line from the treatment system will be routed as shown on Figure 7-1 and will connect to an existing 36-inch HDPE storm drain. The flow will then travel by gravity through the existing 36-inch storm drain which runs beneath the rail spur and the Port Terminal 2 area. The 36-inch storm drain discharges though a bank outfall beneath the Terminal 2 dock (Figure 7-1). The outfall is typically located beneath the water surface during normal flow periods of the Columbia River.

The portion of the existing 36-inch storm drain which runs beneath the rail spur is owned by the City of Vancouver. The portion of the existing 36-inch storm drain which runs beneath Port Terminal 2 area is owned by the Port. This line was originally designed with a significant amount of surplus flow capacity. Parametrix has performed a hydraulic analysis on this line as well as the drainage areas and storm volumes that currently discharge through it. This analysis has indicated that the 36-inch line has more than sufficient capacity to convey the treated discharge water, plus any stormwater. The analysis indicates that only on rare occasions (e.g., 25-year, 1-hour storm flow) would the line reach full flow capacity. Under these rare conditions, discharge of treated water will be momentarily delayed until after peak storm flows have subsided. Based on hydraulic modeling, this situation would only occur for less than one hour per year, on average. Level sensors will be included in the discharge line/36-inch line connection to automatically turn flows off from the extraction/treatment system during these rare peak flow events.

7.2 TECHNICAL JUSTIFICATION OF SELECTED INTERIM CLEANUP ACTION

The following section discusses the results of the groundwater model used to select the interim action and the potential options for modifying the interim action in the future.

7.2.1 Groundwater Model Summary/Predicted Effectiveness

The effectiveness of groundwater extraction for containment of contaminant plumes is well documented in the scientific literature. Similarly, the use of groundwater flow models to delineate the capture zone of extraction wells is presented in the scientific literature.

In order to analyze the effectiveness of a pump and treat interim action at the SMC site, a groundwater model was used to evaluate the interim action alternative. The model was constructed using the three-dimensional finite difference groundwater flow U.S. Geological Survey code MODFLOW (McDonald and Harbaugh 1988).

The model area is rectangular, approximately 11 miles northwest to southeast, and six miles northeast to southwest. It covers an area of approximately 48 square miles that includes most of the Columbia River lowlands of the Vancouver Lake region and most of the Vancouver area west and south of Interstate 205. The model area is described in the Groundwater Model Summary Report (Parametrix 2004b).

The active area of the model is bounded by the Columbia River on its southern and western sides and covers approximately 29 square miles. The northern boundary runs approximately one-half mile north of Burnt Bridge Creek, the north side of Vancouver Lake, and Lake River. The eastern boundary of the active area is situated near NE Andresen Road, and the northwestern boundary lies along a line that would be formed if Salmon Creek’s western drainage were extended straight out to the Columbia River. The model boundaries coincide with physical (hydraulic) boundaries to the extent possible. Burnt Bridge Creek and the Columbia River form the area’s northern, western and southern boundaries, respectively. The eastern boundary was extended to the approximate eastern edge of the lower flood terrace deposits.

The top of the groundwater model was selected to correspond to the water table and extends vertically to the bottom of the TGA. The vertical extent of the model includes the shallow alluvium aquifers in this portion of the Portland basin, which consists of the USA and the TGA. The USA is further divided into the shallow silty alluvium, the sandy alluvium and the Columbia River catastrophic flood deposits (CFD). The aquifers are represented in the model as layers. The layers in the USA were designed to represent the silty and sandy alluvium and the CFD. The CFD consists of up to nine layers to allow for distribution of contaminants with depth and evaluation of well completion interval on containment and removal of the SMC/Cadet plume.

The model was applied to the interim action alternative by establishing an extraction well location, screen interval and pump rate in the model. The model was then applied to steady-state, average conditions for river stage and recharge to predict groundwater flow patterns in the model area. The effectiveness of an interim action well was evaluated using particle tracking simulations to determine whether or not the capture zone of a well configuration encompassed the SMC/Cadet plume.

The capture zone for the interim action extraction well is shown in Figure 6-1, which also includes capture zones for other production wells in the project area. The extraction well provides capture from the vicinity of Great Western Malting to north of the Cadet site, which is sufficient to achieve the objective of this interim remedial action: hydraulic capture of the plume. As described in Section 7.3.1.2, water level transducer data will be used to refine and further calibrate the groundwater model to delineate the actual capture zone produced by the interim action.

The predicted effectiveness of the groundwater cleanup was also developed using the groundwater model. Table 7-1 shows the expected influent concentration during the course of the interim action. As shown, the expected concentration decreases dramatically after the first 10 years of operation, from an initial concentration of 200 µg/L to approximately 30 µg/L. Verification of the groundwater concentrations will be conducted through performance monitoring (Section 7.3).

7.2.2 Flexibility to Modify Alternative to Offset Changes in Current and Proposed Wellfields in Project Area

The proposed interim remedial action is capable of achieving the objectives outlined in Section 5. However, this interim action can be easily modified after installation in the event that the objectives are not being met. Changes that can be made to enhance the pump rate, if necessary, include:

- Increase pump rate with no change to the well. The well will have a maximum capacity of 3,900 gpm.
- Add a second well to the extraction system.

In addition, the present action can be modified, if necessary, as part of a final action. The most likely change required to achieve containment in the final action would be to increase the pump rate in response to groundwater development in the Columbia River Lowlands. This would likely require installation of a second extraction well.

7.3 INTERIM ACTION MONITORING PLAN

Monitoring of the interim action will include performance monitoring to ensure that the RAOs are being met. The performance monitoring will include:

- Regular monitoring of groundwater through sampling of monitoring wells to evaluate groundwater concentrations and to observe the dissolved plume configuration. In addition, sampling of other media (soil gas, indoor air) may be required to correlate whether the interim action has impacted other media concentrations.
- Monitoring of transducer data and application of the groundwater model to determine hydraulic containment.
- Monitoring of the extraction and groundwater treatment system, including sampling of treated groundwater and air discharges, to ensure proper performance.

Monitoring completed during the interim action will primarily utilize the sampling schedule developed during implementation of the Multi-Media Monitoring Plan, which has been used to guide recent monitoring activities for the SMC and Cadet sites. The monitoring schedule presented in the Multi-Media Monitoring Plan identifies monitoring locations and frequency of sampling for various media (groundwater, soil gas, indoor air, and outdoor air). Depending on groundwater conditions, the frequency of sampling varies from quarterly to annually.

The Multi-Media Monitoring Plan was modified to reflect data requirements for the interim action, and will be used as the tool to guide the evaluation of changes in the distribution of VOC concentrations in groundwater (Table 7-2). The proposed plan for monitoring the various media during operation of the interim action is presented below.

7.3.1 Groundwater Monitoring

Groundwater monitoring was designed to evaluate achievement of the RAOs, including reduction of VOC concentrations and to evaluate the effectiveness of hydraulic containment.

7.3.1.1 Effectiveness in Reducing VOC Concentrations in Groundwater

The objectives of the interim action are to contain VOC-contaminated groundwater from the SMC/Cadet site and remove VOCs from groundwater. Consequently, performance monitoring will be oriented toward documenting the change in the distribution of dissolved-phase VOCs in groundwater over time. This will be accomplished by routine monitoring of selected wells located in the SMC/Cadet VOC plume.

Prior to commencement of the pump and treat interim action, a comprehensive groundwater monitoring event will be completed. This event will establish groundwater quality conditions in the project area prior to extraction well pumping. Based on the current schedule, it is anticipated that this comprehensive event will be completed during the 2008 fourth-quarter sampling event (Table 7-2).

During the first year of extraction well operation, at a minimum, semi-annual sampling will be completed at most wells to document project area groundwater quality conditions. Table 7-2 presents a preliminary groundwater sampling schedule for the year 2009, which is anticipated to be the first year of the interim action system operation.

While most wells will be monitored to provide a comprehensive evaluation, the focus of specific performance monitoring will be on groundwater wells located at the edges of the plume and groundwater wells that historically have had higher TCE concentrations (50 µg/L and above). Data from the groundwater wells located at the edges of the plume (along with transducer data; discussed in Section 7.3.1.2) will indicate whether containment is being achieved. Evaluation of the groundwater wells with TCE above 50 µg/L will determine whether the main portion of the plume is expanding or has been reduced. It is not expected that TCE will be immediately reduced in all wells as a result of the interim action. Some wells may actually increase initially as the groundwater gradient is modified by pumping at SMC.

7.3.1.2 Effectiveness of Capture Zone/Hydraulic Containment

The extent of capture will be determined by a combination of water level measurements and groundwater modeling. Due to the potentiometric conditions described in Section 3.3, water level measurements will be taken at selected wells using water level transducers.

A network of 12 water level transducers is currently in place and is being used to evaluate groundwater level conditions and the potentiometric surface in the project area. These locations were selected to provide a distribution and spacing of measurement points throughout the project area. Locations were also selected to examine the influence of pumping at GWM and to provide data to further refine and calibrate the groundwater model.

Water level transducers have been deployed in USA intermediate zone wells, with the exception of monitoring well MW-13d, which is a deep USA monitoring well. Intermediate screened wells are used for water level transducer locations because the intermediate zone of the USA is the highly permeable portion of the USA and accounts for most of the transmissivity in the Columbia River lowlands. Water produced from the extraction well during the interim action will primarily come from the USA intermediate zone.

The current set of water level transducers will be slightly reconfigured and increased to obtain data to delineate a capture zone for the interim action. Figure 7-5 shows the location of wells equipped with water level transducers and proposed additional locations. Water level data from these pressure transducers will be used to further calibrate the site groundwater flow model, which will then be used to delineate a capture zone for the interim action. At the completion of the interim action construction, a transducer monitoring plan will be developed and submitted to Ecology for review and approval.

7.3.2 Soil Gas Monitoring

Soil gas monitoring is an important aspect in evaluating the interim action. The Port and Cadet have collected soil gas data throughout the project area since approximately 2004. Soil gas monitoring will be used as an additional data set to evaluate the impact of the interim action on groundwater concentrations. Soil gas monitoring will be conducted in accordance with the modified Multi-Media Monitoring Plan schedule included in Table 7-2.

7.3.3 Treatment System Monitoring

Treatment system monitoring will be conducted in accordance with the NPDES permit. The details of the monitoring will be determined by Ecology through the NPDES permit process. It is expected that monitoring will include sampling of influent and effluent at the treatment system. This data will be used to document the rate of removal of dissolved-phase VOCs and change in concentration in the extraction well discharge over time. The influent sample will be collected at the extraction well, prior to influent entering the treatment system. Effluent sampling will be completed in the discharge line, just prior to the wet-well. The effluent sample monitoring will include all parameters outlined in the NPDES permit.

Air emissions will be regulated by SWCAA under an air emission permit. Air sampling will be required to ensure that the permit conditions are being met. Monitoring of the air strippers is expected to be completed at the treatment discharge. Monitoring schedule, parameters, and sampling methods will be conducted in accordance with the pending SWCAA air emission permit.

7.3.4 Process to Develop Indoor Air Monitoring Plan

Indoor air monitoring has been conducted in the NFVN since approximately 2002 and in the SFVN since approximately 2006. Indoor air data continues to be collected and evaluated. A draft monitoring plan (the CAMP) was prepared in January 2007 for Ecology and Health review (Parametrix 2007a). Comments on the draft CAMP were used to develop further indoor air monitoring to document condition in the NFVN in September 2007.

The groundwater interim action is expected to reduce groundwater contamination in the project area, including contamination beneath residential areas. This is expected to reduce soil gas concentrations of VOCs and indoor air concentrations over time. However, the correlation between groundwater concentrations and indoor air are not completely understood.

The Port will continue to work with Ecology and Health to develop the indoor air monitoring plan. It is expected that further monitoring will be required to evaluate indoor air concentrations in the Fruit Valley Neighborhood. A revised CAMP will be submitted to Ecology and Health in early 2008. The revised CAMP will include a summary of all indoor air data collected to date, proposed mitigation and cleanup levels, and recommendations for future indoor monitoring.

7.4 COMPLIANCE WITH MTCA AND OTHER REQUIREMENTS

The Groundwater Pump and Treat Interim Action is being conducted in accordance with MTCA requirements summarized in WAC 173-340-430. Specific requirements of WAC 173-340-430 that apply are summarized below:

- The interim action meets the definition included in WAC 173-340-430(1)(a): *An interim action is a remedial action that is technically necessary to reduce a threat to human health or the environment by eliminating or substantially reducing one or more pathways for exposure to a hazardous substance at a facility*.
- The interim action meets general requirement WAC 173-340-430(2)(b): *Provide a partial cleanup, that is, clean up hazardous substances from all or part of the site, but not achieve cleanup standards*.
- The relationship of the interim action to the final cleanup action meets requirement WAC 173-340-430(3)(b): *If the cleanup action is not known, the interim action shall not foreclose reasonable alternatives for the cleanup action. This is not meant to preclude the destruction or removal of hazardous substances*.
- The timing of the interim action complies with requirement WAC 173-340-430(4)(a): *Interim actions may occur anytime during the cleanup process. Interim actions shall not be used to delay or supplant the cleanup process. An interim action may be done before or in conjunction with a site hazard assessment and hazard ranking. However, sufficient technical information must be available regarding the facility to ensure the interim action is appropriate and warranted*.

WAC 173-340-700(3)(c) defines other regulatory requirements as those “that apply to the site because of a type of action and/or location of the site” (“applicable state and federal laws”). WAC 173-340-710 discusses applicable state and federal laws, specifically noting in WAC

173-340-710(7) that all cleanup actions shall comply with applicable state and federal laws. Examples of required compliance relevant to the potential remedial actions relate to water discharges, air emission standards, and interim actions.

7.4.1 Relationship to Other Cleanup Actions

As discussed earlier in this report, Cadet installed RGRWs in the NFVN in 2002, and several of the RGRWs have been operating since that time (see RGRW Evaluation Plan, Parametrix 2007c). The RGRWs have been effective in reducing groundwater concentrations in the NFVN (Figure 4-1). At a minimum, specific RGRWs will be operated by the Port until the interim action is constructed and running. An evaluation of the operational status of the RGRWs, and the effects of the RGRWs on the interim action, will be completed at that time. It is expected that the RGRWs will be used in coordination with the interim action to maximize the effectiveness of cleanup in the project area. Evaluation of the operational status of the RGRWs will be completed on a continuous basis as groundwater data and the effects of capture by the interim action well are received.

Investigation and cleanup actions are ongoing at the ST Services site to the southwest of SMC and Cadet. NuStar (current tenant on the ST Services site) is in the process of initiating an enhanced bioremediation and soil vapor extraction system in the source areas at the site. The ST Services interim action will focus on addressing the potential migration of vapors to the breathing spaces and reducing the relatively high concentrations of VOCs that could migrate to the Columbia River (Ash Creek 2006). As shown on Figure 6-1, the capture zone expected by the Port's interim action includes the ST Services area. The Port's interim action will not adversely impact the interim action at the ST Services site source areas. However, it is anticipated that groundwater contaminated with VOCs from ST Services will continue to migrate north to the proposed extraction well at the SMC site. The air strippers proposed as part of the Port's interim action will treat VOCs migrating from the ST Services site. Cleanup of source areas on the ST Services site will eventually reduce the potential for migration of ST Services-sourced contaminants towards the Port's extraction well. This should reduce the cleanup timeframe for the commingled plume in the project area.

8. IMPLEMENTATION OF SELECTED INTERIM ACTION

This section summarizes the activities to be conducted as part of implementation of the selected interim action.

8.1 PREDESIGN

The interim action described in this Work Plan is conceptual in nature. Predesign studies have been completed by the Port to facilitate the development of this Work Plan and the final selection of the groundwater interim action alternative. As previously discussed, a 30% Design Engineering Report is currently being developed and will be submitted to Ecology for review and approval. The 30% Design Engineering Report will include specifics of the design and refinement of the interim action. Upon approval of the 30% Design, a 90% Design Engineering Report will then be prepared and submitted to Ecology for review. The 90% Design Engineering Report will be used to refine adjustments to the final design, prior to developing the bid documents for selection of a contractor for construction of the interim action.

8.2 PERMITTING

As part of the construction and operation of the interim action, several permits and approvals are required from various agencies. The Port is conducting the interim action under an Agreed Order with Ecology and is required to meet the substantive requirements of MTCA. In addition, the Port will meet all local, state, and federal requirements. It should be noted that the Port has determined that several permits previously discussed with Ecology are not required for this interim action. These include a shoreline permit, construction stormwater permit, hydraulic project approval, and grading permit. A brief summary of the current understanding of the required permits is presented below.

8.2.1 SEPA

A Washington State Environmental Policy Act (SEPA) checklist will be prepared. Ecology has been identified as the lead agency for review of the SEPA checklist.

8.2.2 Building, Utilities, and Grading

Building, utilities, and/or grading permits may be required by the City of Vancouver prior to construction of the interim action. The Port will obtain all required information and prepare permit application documents for submittal to the City of Vancouver prior to implementation of the interim action.

8.2.3 SWCAA

Emissions from air stripping towers are regulated under state and local air pollution control requirements. SWCAA will be the lead regulatory agency. At this point in time, it has not been determined whether treatment of the air emissions will be required. Treatment requirements, if any, will be determined by SWCAA in the air permit and will be based on meeting concentration limits for VOCs as well as results of a BACT analysis. The BACT analysis presents an evaluation of available control technologies and considers feasibility, effectiveness, economics, and other factors. The BACT analysis along with an Air Discharge Application is submitted to SWCAA for review. The application is also submitted for public review.

8.2.4 Wastewater Discharge

The air stripper media will be periodically backwashed for cleaning purposes. Backwash water from the treatment plant will be discharged to the publicly owned treatment works (POTW). A wastewater discharge permit (Title 14, Chapter 10, Section 120) will be required from the City of Vancouver. The Port will obtain all required information and prepare permit application documents for submittal to the City of Vancouver prior to implementation of the interim action.

8.2.5 NPDES

An NPDES permit is required to discharge treated groundwater to the Columbia River. Ecology is the lead agency for NPDES permits. The selected interim action includes treatment of extracted water in the project area and discharge to an existing 36-inch stormwater line with an outfall on the Columbia River. Accordingly, state surface water standards will be applicable. MTCA lists Washington State Surface Water Quality Standards in WAC 173-201a as potential ARAR. The state standards do not contain specific numeric standards for TCE and other risk driver chemicals, but do include antidegradation restrictions and requirements for application of AKARTs for removal of toxic pollutants. It is expected that the preferred treatment technology (air stripping) will be capable of meeting potential surface water discharge standards. Air stripping is capable of removing TCE and other risk driver chemicals to below detection limits of 0.1 µg/L.

The Port is currently preparing the NPDES permit application and will obtain an NPDES permit prior to any discharges to the Columbia River.

8.3 DESIGN DOCUMENTS AND CONTRACTOR SELECTION

The Port is currently preparing the 30% Design Engineering Report and will submit it to Ecology for review and approval. Upon approval of the 30% Design, a 90% Design Engineering Report will then be prepared and submitted to Ecology for review. The 90% Design Engineering Report will be used to refine adjustments to the final design, prior to developing the bid documents for selection of a contractor for construction of the interim action.

After final approval of the design, the Port will prepare bid documents for solicitation of qualified contractors.

8.4 CONSTRUCTION AND STARTUP

Based on the current schedule (see Appendix A), construction of the interim action is expected to commence in late 2008. Construction of the extraction well, treatment plant, and piping is expected to be completed by early 2009. Startup, testing, and performance evaluation of the interim action will be completed in early 2009.

8.5 PUBLIC INVOLVEMENT

As required by WAC 173-340-430(6), public participation will be completed prior to implementing the interim action. It is expected that the Work Plan will be available for public comment for a period of 30 days. The Port and Ecology will take into consideration reasonable public comments with respect to the interim action.

8.6 PROJECT SCHEDULE

The proposed project schedule is included in Appendix A.

8.7 HEALTH & SAFETY PLAN / SAMPLING AND ANALYSIS PLAN

A Health & Safety Plan (HASP) has been developed for this interim action and is included in Appendix B. A sampling and analysis plan (SAP) has been prepared for expected sampling activities during the interim action and is included in Appendix C.

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TABLES

Table 7-1. Summary of Predicted Flow Rates, Concentrations, and Removal Efficiencies

Year of Operation	Maximum Influent TCE + PCE Concentration (ug/L)	Maximum Flow Rate (gpm)	Annual Average Flow Rate (gpm)	Removal of TCE Provided by Air Stripping (%)	Discharge Concentration of TCE (µg/L)
1	200	2,226	1400	99.95	0.1
2	139	2,385	1500	99.92	0.1
3	112	2,624	1650	99.91	0.1
4	104	2,862	1800	99.90	0.1
5	91	3,101	1950	99.89	0.1
6	81	3,339	2100	99.87	0.1
7	68	3,578	2250	99.85	0.1
8	56	3,816	2400	99.82	0.1
9	40	4,055	2550	99.75	0.1
10	35	4,293	2700	99.71	0.1
11	27	4,532	2850	99.62	0.1
12	23	4,770	3000	99.56	0.1
13	19	4,770	3000	99.47	0.1
14	17	4,770	3000	99.41	0.1
15	15	4,770	3000	99.33	0.1
16	13	4,770	3000	99.23	0.1
17	12	4,770	3000	99.17	0.1
18	11	4,770	3000	99.10	0.1
19	10	4,770	3000	99.00	0.1
20	9	5,009	3150	98.89	0.1
21	8	5,247	3300	98.75	0.1
22	8	5,486	3450	98.75	0.1
23	7	5,724	3600	98.57	0.1
24	7	5,963	3750	98.57	0.1
25	7	6,200	3900	98.57	0.1

TCE – Trichloroethylene
PCE – Tetrachloroethylene
gpm – Gallons per minute
µg/L – Micrograms per liter

Table 7-2: Groundwater Quality Sampling Schedule - 2007 through 2009

Groundwater Interim Treatment Action Work Plan

Swan and Cadet Facility Sites

Well Name	Total Depth of Well (feet bgs)	Top of Well Screen (feet MSL)	Bottom of Well Screen (feet MSL)	Sample Location (feet MSL)	Water Quality Zone	Well Location	Sampling Point Function	Sampling Method	2006				2007				2008				2009				Notes	Interim Action Sample Schedule Rationale (for 2009)
									Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4		
Swan Site Monitoring Wells																										
MW-01	25.0	11.8	1.8	6.8	shallow	west of source area	Upgradient	Low Flow	X				X				X			X	X		X		Usually NDs	Outside of plume. Not expected to change.
MW-01d	221.0	-184.2	-194.2	-189.2	deep	west of source area	Upgradient	Low Flow	X	X	X		X		X		X		X	X	X		X		Regular fairly consistent detects. Deep USA well	Not expected to change rapidly. Deep well.
MW-02	30.0	10.4	0.4	5.4	shallow	east of source area	Plume monitoring	Low Flow	X		X		X		X		X		X	X	X	X	X	X	Regular detects. Downgradient of source area. > 50 ug/l.	Shallow well DG of source. Expected to change rapidly.
MW-02d	217.0	-176.4	-186.4	-181.4	deep	east of source area	Downgradient	Low Flow	X	X			X				X			X	X		X		Historically NDs. Deep USA well.	Deep well. Historcially ND. No expected change.
MW-03	23.0	14.2	4.2	9.2	shallow	south of source area	Source area	Low Flow	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	No longer sampled. Too shallow.	Inactive monitoring point.
MW-04	25.0	12.1	2.1	7.1	shallow	south of source area	Plume monitoring	Low Flow	X				X		X		X			X	X		X		Below 5 ppb or ND. SG POV-SG-2 adjacent to well.	Outside of plume. No expected change.
MW-04i	100.0	-61.3	-71.3	-66.3	intermediate	south of source area	Plume monitoring	Low Flow	X				X				X			X	X		X		Historically NDs	Outside of plume. No expected change.
MW-04d	232.0	-195.0	-205.0	-200.0	deep	south of source area	Plume monitoring	Low Flow	X	X			X				X			X	X		X		Historically NDs. Deep USA well	Deep well. Historically ND. No expected change.
MW-05	30.0	8.5	-1.5	3.5	shallow	source area	Source area	Low Flow	X		X		X		X		X		X	X	X	X	X	X	Source area. > 50 ug/l.	Shallow source area well. Expected to change rapidly.
MW-05i	100.0	-61.7	-71.7	-66.7	intermediate	source area	Source area	Low Flow	X		X		X		X		X		X	X	X	X	X	X	Historically NDs. Occasional detects. Recent daughter detects	Intermediate source area well. Expected to change rapidly.
MW-05d*****	227.0	-188.7	-198.7	-193.7	deep	source area	NA	Low Flow	X	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	Peaking variable behavior. Well decommissioned in 11/06.	Well decommissioned.
MW-05dR	226.0	-187.7	-197.7	-192.7	deep	source area	Source area	Low Flow					X	X	X	X	X	X	X	X	X	X	X		New replacement well for MW-5d.	Deep source area well. Possible slow improvement change.
MW-06	29.0	10.6	0.6	5.6	shallow	SE of source area	Plume monitoring	Low Flow	X		X		X		X		X		X	X	X	X	X	X	Regular fairly consistent detects. Fairly stable. < 50 ug/L.	Shallow well cross-gradient of source. Rapid change expected.
MW-07	30.0	11.2	1.2	6.2	shallow	east of source area	Plume monitoring	Low Flow	X		X		X		X		X		X	X	X	X	X	X	Regular fairly consistent detects. Stable. > 50 ug/l.	Shallow well DG of source. Expected to change rapidly.
MW-07i	90.0	-47.2	-57.2	-52.2	intermediate	east of source area	Plume monitoring	Low Flow	X		X		X		X		X		X	X	X	X	X	X	Regular fairly consistent detects. Possible declining trend.	Intermediate well DG of source. Rapid change expected.
MW-08	30.0	11.7	1.7	6.7	shallow	east of source area	Plume monitoring	Low Flow	X	X	X		X		X		X		X	X	X	X	X	X	Has been noisy. Recently declining. Near POV-SG-3. < 50 ug/l.	Shallow well cross-gradient of source. Moving to ND.
MW-08i	130.0	-88.4	-98.4	-93.4	intermediate	east of source area	Plume monitoring	Low Flow	X		X		X				X			X	X		X		Historically NDs. Near RGRW influence.	Intermediate well DG of source. Rapid change expected.
MW-09	32.0	12.0	2.0	7.0	shallow	east of source area	Plume monitoring	Low Flow	X	X	X	X	X		X		X		X	X	X	X	X		Has been noisy. Recently declining. POV-SG-7 well. < 5 ug/l.	Shallow well cross-gradient of source. Moving to ND.
MW-10	31.5	12.1	2.1	7.1	shallow	SE of source area	Plume monitoring	Low Flow	X		X	X	X	X	X		X		X	X	X	X	X	X	Has been noisy. Increasing trend. Adjacent POV-SG-8 well. ~200 ug/l.	Shallow well DG of source. Expected to change rapidly.
MW-11	26.0	9.4	-0.6	4.4	shallow	SW of source area	Plume monitoring	Low Flow	X	X	X		X		X		X		X	X	X	X	X		Has been noisy. Source uncertain. Adjacent POV-SG-1. < 10 ug/l.	South of SMC source. Use to check conditions of GW to the south.
MW-12	31.0	11.3	1.3	6.3	shallow	S of Cadet, W of source area	Upgradient	Low Flow	X				X				X			X	X		X		Historically NDs	Outside of plume. Not expected to change.
MW-12d	216.0	-173.4	-183.4	-178.4	deep	S of Cadet, W of source area	Upgradient TGA monitoring	Low Flow	X	X	X		X				X			X	X		X		Regular fairly consistent detects. Deep USA well	Deep well. Possible slow improvement change.
MW-13*	29.0	16.7	6.7	11.7	shallow	NW corner of Gen Chemical	Upgradient Outlier well	Low Flow	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	Not sampled. Perched gw zone well. NDs.	Inactive monitoring point.
MW-13d	262.0	-218.8	-228.8	-223.8	deep	NW corner of Gen Chemical	Upgradient Outlier well	Low Flow	X	X			X				X			X	X		X		Historically NDs	Outside of plume. Confirm no change is occurring.
MW-14d	221.0	-184.5	-194.5	-189.5	deep	N of Tesoro facility	TGA monitoring	Low Flow	X	X	X		X		X		X		X	X	X		X		Regular fairly consistent detects. Deep USA well	Deep well. Possible slow improvement change.
MW-15	33.0	8.1	-1.9	3.1	shallow	W of NW Packing facility	Downgradient outlier	Low Flow	X				X				X			X	X		X		Historically NDs	Outside of plume. No expected change.
MW-15i	139.0	-97.9	-107.9	-102.9	TGA	W of NW Packing facility	TGA monitoring	Low Flow	X	X	X		X				X			X	X			X	Regular below 5 ppb. TGA well.	TGA well. Possible slow improvement change.
MW-16	36.0	11.5	1.5	6.5	shallow	near 23rd & Thompson Ave	Plume monitoring	Low Flow	X	X	X	X	X	X	X		X		X	X	X	X	X	X	Noisy and declining. Some variability.	Shallow well DG of source. Expected to change rapidly.
MW-16d	230.0	-183.4	-193.4	-188.4	TGA	near 23rd & Thompson Ave	TGA monitoring	Low Flow	X	X			X				X			X	X		X		Historically NDs. TGA well	TGA well. Historically ND. Confirm no change.
MW-17	31.0	8.6	-1.4	3.6	shallow	near 20th & Mill Plain Blvd	Downgradient	Low Flow	X		X		X				X			X	X		X		Historically NDs	Outside of plume. Confirm no changes.
MW-17d	195.0	-155.2	-165.2	-160.2	TGA	near 20th & Mill Plain Blvd	TGA monitoring	Low Flow	X	X			X				X			X	X		X		Historically NDs. TGA well	TGA well. Historically ND. Confirm no change.
MW-18	38.0	4.0	-6.0	-1.0	shallow	near 16th & Simpson Ave	Downgradient	Low Flow	X				X				X			X	X		X		Historically below 5 ppb. Recent NDs.	Outside of plume. Confirm no changes.
MW-18i	130.0	-87.9	-97.9	-92.9	intermediate	near 16th & Simpson Ave	Plume monitoring	Low Flow	X		X		X		X		X		X	X	X		X		Regular detections. < 10 ug/l. Declining trend.	Low concentrations. Confirm changes. Potential GWM pump interference.
MW-19s	33.0	10.5	0.5	5.5	shallow	near GWM well #5	Plume monitoring	Low Flow	X	X			X				X			X	X		X		Historically below 5 ppb. Recent NDs.	Shallow well near GWM well. Now ND. Confirme no change.
MW-19i	130.0	-85.6	-95.6	-90.6	intermediate	near GWM well #5	Plume monitoring	Low Flow	X	X	X		X		X		X		X	X	X	X	X		Regular detections. Noisy. Possible declining trend. < 10 ug/l.	Low concentrations. Confirm changes. Potential GWM pump interference.
MW-20	57.0	9.4	-0.6	4.4	shallow	near 4th Plain Blvd & Roosevelt Ave	Plume monitoring	Low Flow	X	X	X		X		X		X		X	X	X	X	X	X	Historically variable. Recent notable decline. CM-SG-14 evaluation well.	Shallow well DG of source. Expected to move to ND.
MW-21	42.0	8.3	-1.7	3.3	shallow	near 23rd & Roosevelt Ave	Plume monitoring	Low Flow	X	X	X		X		X		X		X	X	X	X	X	X	Historically variable. Recent steady decline. CM-SG-16 evaluation well.	Shallow well DG of source. Expected to decline rapidly.
MW-22**	16.0	29.4	19.4	24.4	shallow	20th & Roosevelt Ave	NA	Low Flow	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	Well has been decommissioned.	Well decommissioned.
MW-23	45.0	11.4	1.4	6.4	shallow	under Mill Plain Blvd RR bridge	Outlier well	Low Flow	X				X				X			X	X		X		Usually NDs. Below 5 ppb.	Outside of plume? Confirm change to ND.
MW-24	62.0	8.7	-1.3	3.7	shallow	west end of NW 25th ST	Outlier well	Low Flow	X				X				X			X	X		X		Historically NDs.	Outside of plume. Confirm no change.
MW-24i	123.0	-51.9	-61.9	-56.9	intermediate	west end of NW 25th ST	Outlier well	Low Flow	X				X				X			X	X		X		Variable. Some NDs. Below 5 ppb.	Edge of plume. Confirm change to ND.
MW-25	85.0	5.3	-4.7	0.3	shallow	west end of NW 19th ST	Outlier well	Low Flow	X				X				X			X	X		X		Variable. Declining trend. Below 5 ppb.	Outside of plume. Confirm no change.
MW-26i	113.0	-20.7	-30.7	-25.7	intermediate	near NW 20th & Lincoln Ave	Outlier well	Low Flow	X				X				X			X	X		X		Variable. Some NDs. Below 5 ppb.	Edge of plume? Confirm change to ND.
MW-28s	29.0	10.2	0.2	5.2	shallow	near Mill Plain Blvd & Thompson Ave	Downgradient	Low Flow	X	X			X				X			X	X		X		One detection. Rest NDs.	Outside of plume. Confirm no change.
MW-28i	85.0	-43.9	-53.9	-48.9	intermediate	east of COV WWTF	Plume monitoring	Low Flow	X	X	X		X		X		X		X	X	X	X	X	X	Variable. Possible declining trend.	Medium concentrations. Confirm changes. Potential GWM pump interference
MW-29i	125.0	-83.7	-93.7	-88.7	intermediate	west of POV building 2185	Outlier well	Low Flow	X				X				X			X	X		X		Historically NDs.	Outside of plume. Confirm no changes.
MW-30i	85.0	-45.2	-55.2	-50.2	intermediate	NE area of former Carbo Pond area	Plume monitoring	Low Flow	X		X		X		X		X		X	X	X	X	X	X	Some variability. Possible declining trend.	DG of STS source. Potential concentration increase.
MW-31i	85.0	-43.4	-53.4	-48.4	intermediate	north area of former Carbo Pond area	Plume monitoring	Low Flow	X	X	X		X		X		X		X	X	X	X	X	X	Variable concentrations over time. Recent declining trend.	DG of STS source. Potential concentration increase.
MW-32s	33.0	11.5	1.5	6.5	shallow	south area of former Carbo Pond area	Cross-gradient	Low Flow	X	X			X				X			X	X	X	X	X	Historically NDs.	DG of STS source. Potential concentration increase.
MW-32i	70.0	-25.5	-35.5	-30.5	intermediate	south area of former Carbo Pond area	Plume monitoring	Low Flow	X	X	X		X		X		X		X	X	X	X	X	X	Variable concentrations over time. Recent declining trend.	DG of STS source. Potential concentration increase.
MW-33s	31.0	10.8	0.8	5.8	shallow	SW corner of POV building 2601	Plume monitoring	Low Flow	X	X	X		X				X			X	X	X	X	X	Historically NDs. Recent detection. Below 5 ppb.	DG of STS source. Potential concentration increase.
MW-33i	85.0	-43.4	-53.4	-48.4	intermediate	SW corner of POV building 2601	Plume monitoring	Low Flow	X	X	X		X		X		X		X	X	X	X	X	X	Variable concentrations over time. Recent declining trend.	DG of STS source. Potential concentration increase.
MW-34i	105.0	-62.1	-72.1	-67.1	intermediate	south of Tesoro facility	Plume monitoring	Low Flow	X	X	X		X		X		X		X	X	X	X	X		Some variability.	Edge of plume. Confirm change to ND.
MW-35s	32.5	12.1	2.1	7.1	shallow	near 16th & Simpson Ave	Downgradient	Low Flow	X	X			X				X			X	X		X		Historically NDs.	Outside of plume. Confirm no changes.
MW-35i	122.0	-77.4	-87.4	-82.4	intermediate	near 16th & Simpson Ave	Plume monitoring	Low Flow	X	X	X		X		X		X		X	X	X	X	X		Some variability. < 20 ppb.	Confirm changes. Potential GWM pump interference.
MW-36s	34.0	11.1	1.1	6.1	shallow	near 20th & Simpson Ave	Downgradient, low conc.	Low Flow	X	X	X		X				X			X	X		X		Some NDs. Below 5 ppb with one exception.	Outside of plume. Confirm no changes.
MW-36i	105.0	-59.9	-69.9	-64.9	intermediate	near 20th & Simpson Ave	Plume monitoring	Low Flow	X	X	X		X		X		X		X	X	X	X	X	X	Some variability. Possible declining trend.	Variable levels; possible declining trend. Semi-annual monitoring.
MW-37s	34.0	10.9	0.9	5.9	shallow	east of NW Packing near Port way	Downgradient	Low Flow	X	X			X				X			X	X		X		Historically NDs.	Outside of plume. Confirm no changes.
MW-37i	125.0	-80.3	-90.3	-85.3	intermediate	east of NW Packing near Port way	Plume monitoring	Low Flow	X	X	X		X		X		X		X	X	X	X	X	X	Fairly stable regular detections	Confirm changes. Potential GWM pump interference.
MW-38i	155.0	-100.5	-110.5	-105.5	deep	west side of Mill Plain Blvd RR bridge	Plume monitoring	Low Flow	X	X	X		X		X		X		X	X	X	X	X	X	Increasing TCE concentration trend.	Confirm changes. Potential GWM pump interference.
MW-39s	33.0	10.4	0.4	5.4	shallow	east side of POV building 2045	Downgradient	Low Flow	X	X			X				X			X	X		X		Historically NDs.	Outside of plume. Confirm no changes.
MW-E	34.1	7.1	-2.9	2.1	shallow	north area of former Carbo Pond area	Plume monitoring	Low Flow	X	X	X		X		X		X		X	X	X	X	X	X	Some variability. Possible increasing trend.	DG of STS source. Potential concentration increase.
MW-F	37.3	7.3	-2.7	2.3	shallow	SE area of former Carbo Pond area	Outlier well	Low Flow	X	X	X		X				X			X	X	X	X	X	Historically NDs. All below 5 ppb.	DG of STS source. Potential concentration increase.
MW-G	37.7	4.9	-5.1	-0.1	shallow	NE corner of former Carbo Pond area	Plume monitoring	Low Flow	X	X	X		X				X		X	X	X	X	X	X	Some variability.Possible increasing trend. Well currently buried.	DG of STS source. Potential concentration increase.
Cadet Site Monitoring Wells																										
CM-MW-01s	25.0	8.7	-1.3	3.7	shallow	Cadet east parking lot	Plume monitoring	Low Flow		X			X	X	X	X	X	X	X	X	X	X	X	X	Occasional use of peristaltic when WL is low. Noisy data.	Shallow well DG of source. Expected to change rapidly.
CM-MW-01i	91.0	-57.3	-67.3	-62.3	intermediate	Cadet east parking lot	Plume monitoring	Low Flow		X			X	X	X	X	X	X	X	X	X	X	X	X	Decreasing concentrations	Shallow well DG of source. Expected to change rapidly.
CM-MW-01d-040	40.0		NM		intermediate	Cadet east parking lot	Plume monitoring	Built-in Dedicated DVP		X	X		X		X		X		X	X	X	X	X	X	Decreasing to stable concentrations	Intermediate well DG of source. Expected to change rapidly.
CM-MW-01d-121	120.5		NM		intermediate	Cadet east parking lot	Plume monitoring	Built-in Dedicated DVP		X	X		X		X		X		X	X	X	X	X	X	Decreasing to stable concentrations	Intermediate well DG of source. Expected to change rapidly.
CM-MW-01d-161	161.0		NM		deep	Cadet east parking lot	Plume monitoring	Built-in Dedicated DVP		X	X		X		X		X		X	X	X	X	X	X	Slight increasing trend.	Deep well DG of source. Possible slow improvement change.
CM-MW-01d-194	193.5		NM		deep	Cadet east parking lot	Plume monitoring	Built-in Dedicated DVP		X	X		X		X		X		X	X	X	X	X	X	Fairly stable.	Deep well DG of source. Possible slow improvement change.
CM-MW-01d-224	224.0		NM		deep	Cadet east parking lot	Plume monitoring	Built-in Dedicated DVP		X	X		X		X		X		X	X	X	X	X	X	Slight increasing trend.	Deep well DG of source. Possible slow improvement change.
CM-MW-02s	20.0	10.2	0.1	5.2	shallow	West of Cadet facility	Upgradient	Low Flow					X				X			X	X		X		Has been NDs for several years.	Outside of plume. Confirm no changes.
CM-MW-02d	230.7	-193.6	-203.6	-198.6	deep	NW of Cadet facility	Plume monitoring	Low Flow		X	X		X				X			X	X		X		Fairly stable. Possible increasing trend.	Deep well. Possible slow improvement change.
CM-MW-03s	25.0	8.3	-1.7	3.3	shallow	Cadet east parking lot	Plume monitoring	Low Flow		X	X		X	X	X	X	X	X	X	X	X		X		Has been stable for several years at < 5 ppb.	Probable changes due to pumping.
CM-MW-03d-060	59.5		NM		intermediate	Cadet east parking lot	Plume monitoring	Built-in Dedicated DVP		X	X		X		X		X		X	X	X		X		Generally stable concentrations	Intermediate well. Changing conditions due to flow direction change.

Table 7-2: Groundwater Quality Sampling Schedule - 2007 through 2009
Groundwater Interim Treatment Action Work Plan
Swan and Cadet Facility Sites

Well Name	Total Depth of Well (feet bgs)	Top of Well Screen (feet MSL)	Bottom of Well Screen (feet MSL)	Sample Location (feet MSL)	Water Quality Zone	Well Location	Sampling Point Function	Sampling Method	2006				2007				2008				2009				Notes	Interim Action Sample Schedule Rationale (for 2009)
									Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4		
CM-MW-03d-100	100.0		NM		intermediate	Cadet east parking lot	Plume monitoring	Built-in Dedicated DVP		X	X		X		X		X		X	X	X		X		Somewhat noisy data	Intermediate well. Changing conditions due to flow direction change.
CM-MW-03d-141	140.5		NM		deep	Cadet east parking lot	Plume monitoring	Built-in Dedicated DVP		X	X		X		X		X		X	X	X		X		Slight variability but generally stable.	Deep well. Possible slow improvement change.
CM-MW-03d-181	181.0		NM		deep	Cadet east parking lot	Plume monitoring	Built-in Dedicated DVP		X	X		X		X		X		X	X	X		X		Slight variability but generally stable.	Deep well. Possible slow improvement change.
CM-MW-03d-227	226.5		NM		deep	Cadet east parking lot	Plume monitoring	Built-in Dedicated DVP		X	X		X		X		X		X	X	X		X		Slight variability but generally stable.	Deep well. Possible slow improvement change.
CM-MW-04s	30.0	15.2	0.2	7.7	shallow	NW 27th and Unander	Plume monitoring	Low Flow		X	X		X	X	X	X	X	X	X	X	X	X	X	X	Peristaltic when WL is low. Recent stable. RGRW influence.	Changing concentrations expected due to change in flow direction.
CM-MW-04i	95.0	-54.6	-64.6	-59.6	intermediate	NW 27th and Unander	Downgradient, low conc.	Low Flow					X		X		X			X	X	X	X	X	Generally stable and below 5 ppb. RGRW influence.	Changing concentrations expected due to change in flow direction.
CM-MW-05s	25.0	11.9	1.9	6.9	shallow	on Weigel btw 27th and 28th	Plume monitoring	Dedicated bladder pump		X			X	X	X	X	X	X	X	X	X	X	X	X	Occasional use of peristaltic when WL is low. Stabilizing.	Changing concentrations expected due to change in flow direction.
CM-MW-05i	95.0	-58.0	-68.0	-63.0	intermediate	on Weigel btw 27th and 28th	Plume monitoring	Low Flow		X	X		X		X		X		X	X	X	X	X	X	Fairly stable concentrations	Changing concentrations expected due to change in flow direction.
CM-MW-05d	217.0	-179.4	-189.4	-184.4	deep	NW 27th and Weigel	Plume monitoring	Low Flow		X	X				X		X		X	X	X		X		Slight variability but generally stable.	Deep well DG of source. Possible slow improvement change.
CM-MW-06s***	34.5	11.0	-4.0	3.5	shallow	NW 28th and Unander	Plume monitoring	Low Flow		X	X		X	X	X	X	X	X	X	X	X	X	X	X	Has declined notably. Appears to have stabilized. RGRW influence.	Changing concentrations expected due to change in flow direction.
CM-MW-07s	44.5	18.0	-2.0	8.0	shallow	NW 27th and Thompson	Plume monitoring	Low Flow		X	X		X	X	X	X	X	X	X	X	X	X	X	X	Has declined notably. Appears to have stabilized. RGRW influence.	Changing concentrations expected due to change in flow direction.
CM-MW-07i	109.0	-56.3	-66.3	-61.3	intermediate	NW 27th and Thompson	Plume monitoring	Low Flow			X		X		X		X		X	X	X	X	X	X	Stable concentrations. RGRW influence.	Changing concentrations expected due to change in flow direction.
CM-MW-07d	225.0	-171.4	-181.4	-176.4	deep	NW 27th and Thompson	Perimeter well	Low Flow		X			X				X			X	X		X		Declining trend. Below 5 ppb. Recently NDs.	Deep well DG of source. Possible slow improvement change.
CM-MW-08s	24.5	12.7	2.7	7.7	shallow	Weigel and Van Allman	Plume monitoring	Low Flow		X	X		X		X		X		X	X	X	X	X	X	Occasional use of peristaltic when WL is low. Fairly stable.	Changing concentrations expected due to change in flow direction.
CM-MW-09s	23.0	16.2	1.2	8.7	shallow	West of Cadet facility	Plume monitoring	Low Flow		X	X		X	X			X			X	X		X		Usually NDs.	Outside of plume. Confirm no changes.
CM-MW-10s	59.0	1.2	-8.8	-3.8	shallow	east end of NW 31st	Outlier well	Low Flow					X				X			X	X		X		Fairly stable. Below 5 ppb.	Outside of plume? Confirm no changes.
CM-MW-10d	230.0	-169.5	-179.5	-174.5	TGA	east end of NW 31st	Outlier well	Low Flow		X			X				X			X	X				Historically NDs.	Historically ND. Annual confirmation schedule.
CM-MW-15s	55.0	-27.2	-32.2	-29.7	intermediate	southwest of Cadet facility	Plume monitoring	Low Flow		X	X		X	X	X		X		X	X	X		X		Showing increasing trend. Some variability.	Shallow well UG of source. Expected to move to ND.
CM-MW-16s****	28.5	-1.5	-6.5	-4.0	shallow	southwest of Cadet facility	NA	Low Flow	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	Iron fouling. Well eliminated from sample list. NDs.	Inactive well.
CM-MW-17i	95.0		NM		intermediate	inside Cadet	Plume monitoring	Low Flow					X		X		X		X	X	X	X	X	X	Semi to assess AS/SVE performance. Noisy data.	Intermediate well near source. Show improvement.
CM-MW-18s	29.5	11.1	-3.9	3.6	shallow	Yeoman Ave, North of Cadet	Perimeter well	Low Flow					X		X		X			X	X		X		Somewhat noisy. Below 5 ppb.	At edge of plume. Confirm change to ND.
CM-MW-18i	98.0	-62.9	-72.9	-67.9	intermediate	Yeoman Ave, North of Cadet	Perimeter well	Low Flow					X				X			X	X	X	X		Fairly stable. Below 5 ppb.	Confirm improvement change.
CM-MW-18d	198.5	-163.4	-172.9	-168.1	deep	Yeoman Ave, North of Cadet	Plume monitoring	Low Flow		X	X		X		X		X		X	X	X		X		Stable with slight variability.	Deep well. Possible slow improvement change.
CM-MW-19s	34.5	12.6	-2.5	5.1	shallow	Van Allman (north portion)	Downgradient, low conc.	Low Flow					X		X		X			X	X		X		Some variability. More recent below 5 ppb. CM-SG-11 evaluation well.	Near northern edge of plume. Confirm change to ND.
CM-MW-19i	94.0	-52.4	-62.4	-57.4	intermediate	Van Allman (north portion)	Plume monitoring	Low Flow			X		X		X		X		X	X	X	X	X		Some variability. Appears to be declining.	Confirm improvement change.
CM-MW-19d	178.5	-134.2	-144.2	-139.2	deep	Van Allman (north portion)	Plume monitoring	Low Flow		X	X		X		X		X		X	X	X		X		Stable with slight variability.	Deep well. Possible slow improvement change.
CM-MW-20s	35.0	8.7	-1.3	3.7	shallow	median, 4th Plain/Mill Plain	Plume monitoring	Low Flow		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	Variable. Appears to be increasing.	Near SMC site. Expected to change rapidly.
CM-MW-20i	99.5	-55.4	-65.4	-60.4	intermediate	median, 4th Plain/Mill Plain	Downgradient, low conc.	Low Flow					X				X			X	X	X	X	X	Stable. Recently NDs.	Near SMC site. Expected to change rapidly.
CM-MW-21s	64.0	6.7	-8.3	-0.8	shallow	east of RR tracks	Outlier well	Low Flow					X				X			X	X		X		Usually NDs.	Near edge of plume. Confirm no changes.
CM-MW-21I	120.5	-54.5	-64.5	-59.5	intermediate	east of RR tracks	Outlier well	Low Flow					X				X			X	X		X		Generally NDs.	Near edge of plume. Confirm no changes.
CM-MW-22s	40.5	-11.2	-16.2	-13.7	intermediate	Cadet east parking lot	Plume monitoring	Low Flow		X	X		X		X	X	X	X	X	X	X	X	X	X	Variable concentrations over time. RGRW influence.	Near source. Possible rapid change.
CM-MW-23s	37.0	8.2	-2.8	2.7	shallow	Unander Ave	Plume monitoring	Low Flow		X	X		X	X	X	X	X	X	X	X	X	X	X	X	Had been increasing. More recently showing a decreasing trend.	Shallow. Variable. RGRW influence. CM-SG-10 evaluation well. Quarterly.
CM-MW-23i	102.0	-58.2	-68.2	-63.2	intermediate	Unander Ave	Plume monitoring	Low Flow		X	X		X		X		X		X	X	X	X	X		Fairly stable. May be increasing.	Confirm improvement change.
CM-MW-24s	35.0	4.9	-10.1	-2.6	shallow	NW 31st and Xavier	Plume monitoring	Low Flow		X	X		X		X		X		X	X	X	X	X		Some variability. CM-SG-12 evaluation well.	Near northern edge of plume. Confirm change to ND.
CM-MW-24i	98.5	-62.6	-72.6	-67.6	intermediate	NW 31st and Xavier	Plume monitoring	Low Flow		X	X		X		X		X		X	X	X		X		Slight variability. Below 5 ppb.	Confirm improvement change.
CM-MW-25s	30.0	13.8	-1.2	6.3	shallow	NW 28th, btw Weigel and Unander	Plume monitoring	Low Flow		X	X		X	X	X	X	X	X	X	X	X	X	X	X	Recently stable after notable decline. RGRW influence.	Changing concentrations expected due to change in flow direction.
CM-MW-26s	30.0	11.6	-3.4	4.1	shallow	NW 28th and Weigel	Plume monitoring	Low Flow		X	X		X	X	X	X	X	X	X	X	X	X	X	X	Quite a bit of variability. RGRW influence. Near CM-SG-01 & -04.	Changing concentrations expected due to change in flow direction.
CM-MW-27TGA	170.0	-115.1	-125.1	-120.1	TGA	Fruit Valley/Frambois, in park	TGA monitoring	Low Flow		X	X		X				X			X	X		X		Usually NDs.	TGA well. Usually ND. Confirm no change.
CM-MW-27USA-049.5	49.5		NM		shallow	Fruit Valley/Frambois, in park	Plume monitoring	Built-in Dedicated DVP		X	X		X		X		X		X	X	X	X	X	X	Only one port works. Some variability at the 50' port.	Confirm improvement and change to ND.
CM-MW-28TGA	210.5	-166.6	-176.6	-171.6	TGA	Unander and Xavier	TGA monitoring	Built-in Dedicated DVP		X	X		X				X			X	X		X		Historically NDs.	TGA well. Usually ND. Confirm no change.
CM-MW-28USA-050	50.0		NM		intermediate	Unander and Xavier	Plume monitoring	Built-in Dedicated DVP		X	X		X		X		X		X	X	X	X	X		Slight variability. Generally below 5 ppb.	Northern plume monitoring point. Confirm change to ND.
CM-MW-28USA-120.5	120.5		NM		intermediate	Unander and Xavier	Plume monitoring	Built-in Dedicated DVP		X	X		X		X		X		X	X	X	X	X	X	Some variability. May be increasing.	Confirm improvement and change to ND.
CM-MW-28USA-180	180.0		NM		deep	Unander and Xavier	Plume monitoring	Built-in Dedicated DVP		X	X		X		X		X		X	X	X		X		Fairly stable. May be declining. Below 5 ppb.	Deep well. Possible slow improvement change.
CM-MW-29TGA	160.0	-103.6	-113.6	-108.6	TGA	NW 31st, east of Fruit Valley	Plume monitoring	Low Flow		X	X		X		X		X		X	X	X		X		Regular detections. Fairly stable.	TGA well. Usually ND. Confirm no change.
CM-MW-29USA-060.5	60.5		NM		intermediate	NW 31st, east of Fruit Valley	Plume monitoring	Built-in Dedicated DVP		X	X		X		X		X		X	X	X	X	X	X	May be declining.	Northern plume monitoring point. Confirm change to ND.
CM-MW-29USA-100	100.0		NM		intermediate	NW 31st, east of Fruit Valley	Plume monitoring	Built-in Dedicated DVP		X	X		X		X		X		X	X	X	X	X	X	May be declining.	Northern plume monitoring point. Confirm change to ND.
CM-MW-29USA-140.5	140.5		NM		intermediate	NW 31st, east of Fruit Valley	Plume monitoring	Built-in Dedicated DVP		X	X		X		X		X		X	X	X	X	X	X	Some variability. May be declining.	Northern plume monitoring point. Confirm change to ND.
CM-VE-09	30.0		NM		shallow	Inside Cadet	AS/SVE system monitoring	Low Flow			X		X		X		X		X	X	X		X		AS/SVE system gw monitoring point. System needs to be off to sample.	AS/SVE system evaluation point. Additional sampling may be completed.
CM-VE-10	30.0		NM		shallow	Inside Cadet	AS/SVE system monitoring	Low Flow			X		X		X		X		X	X	X		X		AS/SVE system gw monitoring point. System needs to be off to sample.	AS/SVE system evaluation point. Additional sampling may be completed.
CM-VE-11	30.0		NM		shallow	Inside Cadet	AS/SVE system monitoring	Low Flow			X		X		X		X		X	X	X		X		AS/SVE system gw monitoring point. System needs to be off to sample.	AS/SVE system evaluation point. Additional sampling may be completed.
CM-VE-12	30.0		NM		shallow	Inside Cadet	AS/SVE system monitoring	Low Flow			X		X		X		X		X	X	X		X		AS/SVE system gw monitoring point. System needs to be off to sample.	AS/SVE system evaluation point. Additional sampling may be completed.
CM-DPW-01	28.4		NM		shallow	Cadet east parking lot	AS/SVE system monitoring	Peristaltic Pump			X		X		X		X		X	X	X		X		AS/SVE system gw monitoring point. System needs to be off to sample.	AS/SVE system evaluation point. Additional sampling may be completed.
CM-DPW-06	28.4		NM		shallow	Cadet east parking lot	AS/SVE system monitoring	Peristaltic Pump			X		X		X		X		X	X	X		X		AS/SVE system gw monitoring point. System needs to be off to sample.	AS/SVE system evaluation point. Additional sampling may be completed.
CM-DPW-10	28.4		NM		shallow	Cadet east parking lot	AS/SVE system monitoring	Peristaltic Pump			X		X		X		X		X	X	X		X		AS/SVE system gw monitoring point. System needs to be off to sample.	AS/SVE system evaluation point.
CM-DPW-16	28.0		-1.3		shallow	Cadet east parking lot	AS/SVE system monitoring	Peristaltic Pump			X		X		X		X		X	X	X		X		AS/SVE system gw monitoring point. System needs to be off to sample.	AS/SVE system evaluation point.

Notes:
Highlighted cells - Represent future sampling events.
🟨 : Pre-GWTIA commencement sampling schedule.
🟧 : GWTIA baseline event.
🟩 : First year GWTIA operation monitoring schedule.
Swan site Groundwater Interim Treatment Action (Pump & Treat System) currently scheduled for startup mid December 2008.
A comprehensive event is scheduled for Q4 2008 prior to start up of the Groundwater Interim Treatment Action system.

X = groundwater quality sample collected or will be collected
D = sampling location was dropped from the sampling plan in 2005.
Samping Periods for Each Quarter: Q1 - 1st quarter (Jan. - Mar.); Q2 - 2nd quarter (Apr. - Jun.); Q3 - 3rd quarter (Jul. - Sept.); Q4 - 4th quarter (Oct. - Dec.)
Sampling Method: Low flow method used at all locations. Multi-port wells equipped with built-in dedicated dual valve pumps.
NM indicates that elevation at the well has not been established

* - MW-13 is not currently sampled because it is screened in a perched water zone
** - MW-22 was abandoned in June 2002
*** - CM-MW-06 was originally completed on 6/12/00 to a depth of 26.5 ft bgs. It was subsequently deepened on 2/21/01 to a total depth of 34.5 ft bgs.
**** - CM-MW-16s dropped from sampling due to NDs and close proximity to MW-15s.
***** - MW-05d was decommissioned in November 2006 and replaced with MW-05dR.

Table 7-2: Soil Gas Sampling Schedule - 2007 through 2009
Groundwater Interim Treatment Action Work Plan
Swan and Cadet Facility Sites

Well Name	Total Depth of Well (feet bgs)	Bottom of Well Screen (feet MSL)	Water Quality Zone	Well Location	Sampling Point Function	Sampling Method	2005				2006				2007				2008				2009				Notes (all concentrations listed below are µg/cm^3 TCE)	Interim Action Sample Schedule Rationale (for 2009)
							Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4		
Swan Site Soil Gas Wells																												
POV-SG-1-10	10	NM	N/A	SW of source area, N of Bldg 2224	Plume monitoring	Summa Canister			X	X	X	X	X		X		X		X		X	X	X		X		<50	associated MW-11 sample; increasing concentrations
POV-SG-1-15	15	NM	N/A	SW of source area, N of Bldg 2224	Plume monitoring	Summa Canister			X	X	X		X		X		X				X	X					~40 originally, up to 200 now	associated MW-11 sample; increasing concentrations
POV-SG-1-20	20	NM	N/A	SW of source area, N of Bldg 2224	Plume monitoring	Summa Canister			X	X			X				X		X		X	X	X		X		~50 originally, latest data ~200 (Q3/06)	associated MW-11 sample; increasing concentrations
POV-SG-2-10	10	NM	N/A	S of source area, E of Bldg 2224	Perimeter plume monitoring	Summa Canister			X	X	X	X	X		X							X	X		X		5 to 95, stable at ~ 35	stable, low concentrations; associated MW-4 sample.
POV-SG-2-15	15	NM	N/A	S of source area, E of Bldg 2224	Perimeter plume monitoring	Summa Canister			X	X	X		X		X												40 to 60, stable	stable, low concentrations; associated MW-4 sample.
POV-SG-2-20	20	NM	N/A	S of source area, E of Bldg 2224	Perimeter plume monitoring	Summa Canister			X	X	X		X				X		X		X	X	X		X		50 to 60, latest data NDs (Q3/06)	stable, low concentrations; not sampled Q1/07
POV-SG-3-10	10	NM	N/A	ENE of source area, N of bldg 2240	Plume monitoring	Summa Canister			X	X	X	X	X		X		X		X		X	X	X		X		<1,000, spike up to 6,700 in Q3/06	associated MW-8 sample; shallow sample associated with indoor air
POV-SG-3-15	15	NM	N/A	ENE of source area, N of bldg 2240	Plume monitoring	Summa Canister			X	X	X	X	X		X												<2,000, stable	mid-depth concentration shown to be between shallow and deep
POV-SG-3-20	20	NM	N/A	ENE of source area, N of bldg 2240	Plume monitoring	Summa Canister			X	X	X		X		X		X		X		X	X	X		X		30,000 originally, now ~5000	associated MW-8 sample; deep sample shows highest concentrations
POV-SG-4-10	10	NM	N/A	ESE of source area, SE of bldg 2240	Plume monitoring	Summa Canister			X	X	X	X	X		X		X		X		X	X	X		X		~23,000 originally, now ~13,000, moderate trend down	associated MW-7 sample; shallow sample associated with indoor air
POV-SG-4-15	15	NM	N/A	ESE of source area, SE of bldg 2240	Plume monitoring	Summa Canister			X	X	X	X	X		X												~33,000 originally, now ~22,000, moderate trend down	mid-depth concentration shown to be between shallow and deep
POV-SG-4-20	20	NM	N/A	ESE of source area, SE of bldg 2240	Plume monitoring	Summa Canister			X	X	X		X		X		X		X		X	X	X		X		~46,000 originally, now ~28,000, moderate trend down	associated MW-7 sample; deep sample shows highest concentrations
POV-SG-5-10	10	NM	N/A	SE of source area, adjacent to MW-06	Plume monitoring	Summa Canister			X	X	X	X	X		X		X		X		X	X	X		X		4,000 to 6,000, stable	associated MW-6 sample; shallow sample associated with indoor air
POV-SG-5-15	15	NM	N/A	SE of source area, adjacent to MW-06	Plume monitoring	Summa Canister			X	X	X	X	X		X												4,000 to to 6,000, 13,000 spike in Q3/05, now ~4,500	mid-depth concentration shown to be between shallow and deep
POV-SG-5-20	20	NM	N/A	SE of source area, adjacent to MW-06	Plume monitoring	Summa Canister			X	X	X		X		X		X		X		X	X	X		X		6,000 to 8,000, now ~4,700	associated MW-6 sample; deep sample shows highest concentrations
POV-SG-6-10	10	NM	N/A	SSE of source area, Kotobuki	Plume monitoring	Summa Canister			X	X	X	X	X		X		X		X			X	X		X		<5, spike to ~40 Q1/06	stable, low concentrations; no associated MW location.
POV-SG-6-15	15	NM	N/A	SSE of source area, Kotobuki	Plume monitoring	Summa Canister			X	X	X	X	X		X												<10	stable, low concentrations; no associated MW location.
POV-SG-6-20	20	NM	N/A	SSE of source area, Kotobuki	Plume monitoring	Summa Canister			X	X	X		X		X		X		X			X	X		X		<20, now <5	stable, low concentrations; no associated MW location.
POV-SG-7-10	10	NM	N/A	ENE of source area, N of bldg 2245	Plume monitoring	Summa Canister			X	X	X	X	X		X		X		X		X	X	X		X		200 to 600, stable	associated MW-9 sample; shallow sample associated with indoor air
POV-SG-7-15	15	NM	N/A	ENE of source area, N of bldg 2245	Plume monitoring	Summa Canister			X	X	X	X	X		X												400 to 600, now <200	mid-depth concentration shown to be between shallow and deep
POV-SG-7-20	20	NM	N/A	ENE of source area, N of bldg 2245	Plume monitoring	Summa Canister			X	X	X	X	X		X		X		X		X	X	X		X		600 to 1,100, now ~550	associated MW-9 sample; deep sample shows highest concentrations
POV-SG-8-10	10	NM	N/A	ESE of source area, SE of bldg 2245	Plume monitoring	Summa Canister			X	X	X	X	X		X		X		X		X	X	X		X		stable ~2,000	associated MW-10 sample; shallow sample associated with indoor air
POV-SG-8-15	15	NM	N/A	ESE of source area, SE of bldg 2245	Plume monitoring	Summa Canister			X	X	X	X	X		X												stable ~5,500	mid-depth concentration shown to be between shallow and deep
POV-SG-8-20	20	NM	N/A	ESE of source area, SE of bldg 2245	Plume monitoring	Summa Canister			X	X	X		X		X		X		X		X	X	X		X		variable, 30,000 originally, between 3,300 and 51,000, now 29,000	associated MW-10 sample; deep sample shows highest concentrations
POV-SG-9-10	10	NM	N/A	SSE of source area, S of bldg 2225	Perimeter plume monitoring	Summa Canister			X	X	X	X	X		X				X			X	X		X		<15	stable, low concentrations; no associated MW. Nearby MW-17 ND.
POV-SG-9-15	15	NM	N/A	SSE of source area, S of bldg 2225	Perimeter plume monitoring	Summa Canister			X	X	X	X	X		X												<15	stable, low concentrations; no associated MW. Nearby MW-17 ND.
POV-SG-9-20	20	NM	N/A	SSE of source area, S of bldg 2225	Perimeter plume monitoring	Summa Canister			X	X	X		X		X				X			X	X		X		<20, now ~5	stable, low concentrations; no associated MW. Nearby MW-17 ND.
POV-SG-10-10	10	NM	N/A	SE of source area, in bldg 2225	Plume monitoring	Summa Canister			X	X	X	X	X		X		X		X		X	X	X		X		~120, stable	no associated MW sample; shallow sample associated with indoor air
POV-SG-10-15	15	NM	N/A	SE of source area, in bldg 2225	Plume monitoring	Summa Canister			X	X	X	X	X		X												~1,000 originally, up to 3,000, now ~2,100	mid-depth concentration shown to be between shallow and deep
POV-SG-10-20	20	NM	N/A	SE of source area, in bldg 2225	Plume monitoring	Summa Canister			X	X	X	X	X		X												1,700 originally, up to ~4,500, now at 2,400	mid-depth concentration shown to be between shallow and deep
POV-SG-10-30	30	NM	N/A	SE of source area, in bldg 2225	Plume monitoring	Summa Canister											X		X		X	X	X		X		first sampled Q3 qtr 2007. Usually in water.	no associated MW sample; deep sample shows highest concentrations
Cadet Site Soil Gas Wells																												
CM-SG-1-10	10	NM	N/A	NFVN, Weigel and NW 27th	Plume monitoring	Summa Canister	X	X	X	X		X			X		X	X	X	X	X	X	X	X	X	X	historically ~2,000, now <500, RGRW-1 influence	adjacent to RGRW-1; shallow sample associated with indoor air
CM-SG-1-15	15	NM	N/A	NFVN, Weigel and NW 27th	Plume monitoring	Summa Canister	X	X	X						X												historically ~2,000, now <500, RGRW-1 influence	mid-depth concentration shown to be between shallow and deep
CM-SG-1-20	20	NM	N/A	NFVN, Weigel and NW 27th	Plume monitoring	Summa Canister	X	X	X						X		X		X		X	X	X		X		historically ~3,000, now <500, RGRW-1 influence	adjacent to RGRW-1; deep sample shows highest concentrations
CM-SG-2-10	10	NM	N/A	NFVN, Weigel and Van Allman	Plume monitoring	Summa Canister	X	X							X		X		X		X	X	X		X		historically very low or NDs	near MW-8s sample; low to ND. shallow sample assoc. w/ indoor air
CM-SG-2-15	15	NM	N/A	NFVN, Weigel and Van Allman	Plume monitoring	Summa Canister	X	X							X												historically ~1,000, now <100	mid-depth conc. shown to be between shallow and deep
CM-SG-2-20	20	NM	N/A	NFVN, Weigel and Van Allman	Plume monitoring	Summa Canister	X	X							X		X		X		X	X	X		X		historically ~1,400, now <100	near MW-8s sample; deep sample shows highest concentrations
CM-SG-3-10	10	NM	N/A	NFVN, western NW 27th	Plume monitoring	Summa Canister	X	X		X		X			X		X	X	X	X	X	X	X	X	X	X	historically 500 to 1,000, not much change	near RGRW-5; shallow sample associated with indoor air
CM-SG-3-15	15	NM	N/A	NFVN, western NW 27th	Plume monitoring	Summa Canister	X	X							X												historically 1,000 to 1,500, not much change	mid-depth concentration shown to be between shallow and deep
CM-SG-3-20	20	NM	N/A	NFVN, western NW 27th	Plume monitoring	Summa Canister	X	X							X		X		X		X	X	X		X		historically 1,400 to 2,000, now ~1,500	near RGRW-5; deep sample shows highest concentrations
CM-SG-4-10	10	NM	N/A	NFVN, middle NW 28th	Plume monitoring	Summa Canister	X	X	X	X		X			X		X	X	X	X	X	X	X	X	X	X	historically 2,000 to 4,000, now ~600	near RGRW-2; shallow sample associated with indoor air
CM-SG-4-15	15	NM	N/A	NFVN, middle NW 28th	Plume monitoring	Summa Canister	X	X	X	X		X			X												historically 4,000 to 12,000, now ~1,500	mid-depth concentration shown to be between shallow and deep
CM-SG-4-20	20	NM	N/A	NFVN, middle NW 28th	Plume monitoring	Summa Canister	X	X	X	X					X		X		X		X	X	X		X		historically 4,000 to 30,000, now ~1,800	near RGRW-2; deep sample shows highest concentrations
CM-SG-5-10	10	NM	N/A	NFVN, eastern NW 27th	Plume monitoring	Summa Canister	X	X	X	X		X			X		X	X	X	X	X	X	X	X	X	X	100 to 200, now ~25	near MW-4s sample; probable gw changes due to GWTIA..
CM-SG-5-15	15	NM	N/A	NFVN, eastern NW 27th	Plume monitoring	Summa Canister	X	X	X	X		X			X												1,000 to 2,000, now ~300	mid-depth concentration shown to be between shallow and deep
CM-SG-5-20	20	NM	N/A	NFVN, eastern NW 27th	Plume monitoring	Summa Canister	X	X	X	X					X		X		X		X	X	X		X		10,000 to 50,000, now ~750	near MW-4s sample; deep sample shows highest concentrations
CM-SG-6-10	10	NM	N/A	NFVN, western NW 28th	Plume monitoring	Summa Canister	X	X	X	X		X			X		X	X	X	X	X	X	X	X	X	X	4,000 to 6,000 in '04, now down to ~150	near RGRW- 3; possible gw changes due to GWTIA.
CM-SG-6-15	15	NM	N/A	NFVN, western NW 28th	Plume monitoring	Summa Canister	X	X	X	X		X			X												13,000 originally, now down to ~500	mid-depth concentration shown to be between shallow and deep
CM-SG-6-20	20	NM	N/A	NFVN, western NW 28th	Plume monitoring	Summa Canister	X	X	X	X					X		X		X		X	X	X		X		10,000 originally, now down to ~500	near RGRW-3; deep sample shows highest concentrations
CM-SG-7-10	10	NM	N/A	NFVN, Unander, just N of NW 28th	Plume monitoring	Summa Canister	X	X	X	X		X			X		X	X	X	X	X	X	X	X	X	X	historically ~5,000, now ~350	near RGRW- 3; possible gw changes due to GWTIA.
CM-SG-7-15	15	NM	N/A	NFVN, Unander, just N of NW 28th	Plume monitoring	Summa Canister	X	X	X	X		X			X												historically ~6,000, now ~200	mid-depth concentration shown to be between shallow and deep
CM-SG-7-20	20	NM	N/A	NFVN, Unander, just N of NW 28th	Plume monitoring	Summa Canister	X	X	X	X					X		X		X		X	X	X		X		historically ~7,000, now ~250	near RGRW-3; deep sample slightly higher than mid depth screen.
CM-SG-8-10	10	NM	N/A	NFVN, Unander, near NW 27th	Plume monitoring	Summa Canister	X	X		X		X			X		X	X	X	X	X	X	X	X	X	X	50-200, now ~5	near RGRW-7; possible changes due to GWTIA.
CM-SG-8-15	15	NM	N/A	NFVN, Unander, near NW 27th	Plume monitoring	Summa Canister	X	X							X												20,000 originally, now ~600	mid-depth concentration shown to be between shallow and deep
CM-SG-8-20	20	NM	N/A	NFVN, Unander, near NW 27th	Plume monitoring	Summa Canister	X	X							X		X		X		X	X	X		X		38,000 originally, now ~830	near RGRW-7; deep sample shows highest concentrations
CM-SG-9-10	10	NM	N/A	NFVN,Thompson, btw NW 27th n 28th	Plume monitoring	Summa Canister	X	X							X		X	X	X	X	X	X	X		X		2 to 15, now NDs	near MW-7s sample; outer edge of plume. Now ND.
CM-SG-9-15	15	NM	N/A	NFVN,Thompson, btw NW 27th n 28th	Plume monitoring	Summa Canister	X	X							X												5 to 20, now 4	mid-depth concentration shown to be between shallow and deep
CM-SG-9-20	20	NM	N/A	NFVN,Thompson, btw NW 27th n 28th	Plume monitoring	Summa Canister	X	X							X												80 to 140, now ~150	mid-depth concentration shown to be between shallow and deep
CM-SG-9-30	30	NM	N/A	NFVN,Thompson, btw NW 27th n 28th	Plume monitoring	Summa Canister	X	X							X		X		X		X	X	X		X		historically 500 to 3,000, now ~35	near MW-7 sample; deep sample shows highest concentrations

Table 7-2: Soil Gas Sampling Schedule - 2007 through 2009
Groundwater Interim Treatment Action Work Plan
Swan and Cadet Facility Sites

Well Name	Total Depth of Well (feet bgs)	Bottom of Well Screen (feet MSL)	Water Quality Zone	Well Location	Sampling Point Function	Sampling Method	2005				2006				2007				2008				2009				Notes (all concentrations listed below are $\mu g/cm^3$ TCE)	Interim Action Sample Schedule Rationale (for 2009)
							Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4		
CM-SG-10-10	10	NM	N/A	NFVN, Unander, S of NW 31st	Plume monitoring	Summa Canister		X							X		X		X		X	X	X	X	X	X	historically <50	associated MW-23 sample; shallow sample associated with indoor air
CM-SG-10-15	15	NM	N/A	NFVN, Unander, S of NW 31st	Plume monitoring	Summa Canister		X							X												historically <300, now ~320	mid-depth concentration shown to be between shallow and deep
CM-SG-10-20	20	NM	N/A	NFVN, Unander, S of NW 31st	Plume monitoring	Summa Canister		X							X												historically <400, now ~580	mid-depth concentration shown to be between shallow and deep
CM-SG-10-30	30	NM	N/A	NFVN, Unander, S of NW 31st	Plume monitoring	Summa Canister											X		X		X	X	X		X		historically <600, not sampled recently (high gw)	assoc.MW-23 sample; deep sample shows highest concentrations
CM-SG-11-10	10	NM	N/A	NFVN, Van Allman, N of NW 31st	Perimeter plume monitoring	Summa Canister		X							X		X		X		X	X	X		X		historically <2, now ND	associated MW-19 sample; out edge of plume. Now ND.
CM-SG-11-15	15	NM	N/A	NFVN, Van Allman, N of NW 31st	Perimeter plume monitoring	Summa Canister		X							X												historically <40, now 13	mid-depth concentration shown to be between shallow and deep
CM-SG-11-20	20	NM	N/A	NFVN, Van Allman, N of NW 31st	Perimeter plume monitoring	Summa Canister		X							X		X		X		X	X	X		X		historically <150, now 48	assoc. MW-19 sample; deep sample shows highest concentrations
CM-SG-12-10	10	NM	N/A	NFVN, NW 31st and Xavier	Plume monitoring	Summa Canister		X							X		X		X		X	X	X		X		historically <3, now ND	associated MW-24 sample; out edge of plume. Now ND
CM-SG-12-15	15	NM	N/A	NFVN, NW 31st and Xavier	Plume monitoring	Summa Canister		X							X												historically <50, now ~10	mid-depth concentration shown to be between shallow and deep
CM-SG-12-20	20	NM	N/A	NFVN, NW 31st and Xavier	Plume monitoring	Summa Canister		X							X		X		X		X	X	X		X		historically <700, now 230	assoc. MW-24 sample; deep sample shows highest concentrations
CM-SG-13-10	10	NM	N/A	SFVN, unnamed St just S of 4th Plain	Plume monitoring	Summa Canister		X	X	X	X	X	X		X		X		X		X	X	X	X	X	X	50-500, now 15	no associated MW sample; shallow sample associated with indoor air
CM-SG-13-15	15	NM	N/A	SFVN, unnamed St just S of 4th Plain	Plume monitoring	Summa Canister		X	X	X	X	X	X		X												1,000 to 3,000, now ~200	mid-depth concentration shown to be between shallow and deep
CM-SG-13-20	20	NM	N/A	SFVN, unnamed St just S of 4th Plain	Plume monitoring	Summa Canister		X	X	X	X	X	X		X												1,500 to 4,700, now ~500	mid-depth concentration shown to be between shallow and deep
CM-SG-13-30	30	NM	N/A	SFVN, unnamed St just S of 4th Plain	Plume monitoring	Summa Canister		X	X	X	X		X		X		X		X		X	X	X		X		originally 10,000, now ~1000	no assoc. MW sample; deep sample shows highest concentrations
CM-SG-14-10	10	NM	N/A	SFVN, Roosevelt, just S of 4th Plain	Plume monitoring	Summa Canister		X	X	X	X	X	X		X		X		X		X	X	X		X		5-25, now ~10	associated MW-20; near edge of plume. Low concentrations
CM-SG-14-15	15	NM	N/A	SFVN, Roosevelt, just S of 4th Plain	Plume monitoring	Summa Canister		X	X	X	X	X	X		X												20-50, now ~20	mid-depth concentration shown to be between shallow and deep
CM-SG-14-20	20	NM	N/A	SFVN, Roosevelt, just S of 4th Plain	Plume monitoring	Summa Canister		X	X	X	X	X	X		X												<200, now 130	mid-depth concentration shown to be between shallow and deep
CM-SG-14-30	30	NM	N/A	SFVN, Roosevelt, just S of 4th Plain	Plume monitoring	Summa Canister		X	X	X	X	X	X		X												1,000 to 1,500, now ~1,000	mid-depth concentration shown to be between shallow and deep
CM-SG-14-40	40	NM	N/A	SFVN, Roosevelt, just S of 4th Plain	Plume monitoring	Summa Canister		X	X	X	X	X	X		X												2,000 to 6,000, now ~2,400	mid-depth concentration shown to be between shallow and deep
CM-SG-14-50	50	NM	N/A	SFVN, Roosevelt, just S of 4th Plain	Plume monitoring	Summa Canister			X	X	X		X				X		X		X	X	X		X		2,000 to 6,000, latest ~500 (Q3/06)	assoc. MW-20 sample; deep sample shows highest concentrations
CM-SG-15-10	10	NM	N/A	SFVN, Simpson and 24th	Plume monitoring	Summa Canister		X	X	X	X	X	X		X		X		X		X	X	X	X	X	X	~2,500, now ~1,000	no associated MW sample; shallow sample associated with indoor air
CM-SG-15-15	15	NM	N/A	SFVN, Simpson and 24th	Plume monitoring	Summa Canister		X	X	X	X	X	X		X												~2,500 to ~4,000, now ~1,000	mid-depth concentration shown to be between shallow and deep
CM-SG-15-20	20	NM	N/A	SFVN, Simpson and 24th	Plume monitoring	Summa Canister		X	X	X	X	X	X		X												~4,000 to ~6,000, now ~1,000	mid-depth concentration shown to be between shallow and deep
CM-SG-15-30	30	NM	N/A	SFVN, Simpson and 24th	Plume monitoring	Summa Canister		X	X	X	X		X		X		X		X		X	X	X		X		originally ~23,000, now ~2,500	no assoc. MW sample; deep sample shows highest concentrations
CM-SG-16-10	10	NM	N/A	SFVN N end Thompson, adj to MW-16	Plume monitoring	Summa Canister			X	X	X	X	X		X		X		X		X	X	X		X		<1,000, now ~300	associated MW-16 sample; shallow sample associated with indoor air
CM-SG-16-15	15	NM	N/A	SFVN N end Thompson, adj to MW-16	Plume monitoring	Summa Canister			X	X	X	X	X		X												3,000 to 6,000, now ~2,500	mid-depth concentration shown to be between shallow and deep
CM-SG-16-20	20	NM	N/A	SFVN N end Thompson, adj to MW-16	Plume monitoring	Summa Canister			X	X	X	X	X		X		X		X		X	X	X		X		4,000 to 7,500, now ~3,000	assoc. MW-16 sample; deep sample shows highest concentrations
CM-SG-17-10	10	NM	N/A	SFVN, Roosevelt, adj to MW-21	Plume monitoring	Summa Canister		X	X	X	X	X	X		X		X		X		X	X	X		X		historically <250, now 17	associated MW-21 sample; near outer edge of plume
CM-SG-17-15	15	NM	N/A	SFVN, Roosevelt, adj to MW-21	Plume monitoring	Summa Canister		X	X	X	X	X	X		X												variable, up to 4,500, then ~300, now ~1,500	mid-depth concentration shown to be between shallow and deep
CM-SG-17-20	20	NM	N/A	SFVN, Roosevelt, adj to MW-21	Plume monitoring	Summa Canister		X	X	X	X	X	X		X												2,500 to 4,500, not much change	mid-depth concentration shown to be between shallow and deep
CM-SG-17-30	30	NM	N/A	SFVN, Roosevelt, adj to MW-21	Plume monitoring	Summa Canister		X	X	X	X		X		X		X		X		X	X	X		X		2,500 to 4,000, not much change	associated MW-21 sample; deep sample shows highest concentrations

Notes:

Highlighted cells - Represent future sampling events.

🟨 : Pre-GWTIA commencement sampling schedule.
🟧 : GWTIA baseline event.
🟩 : First year GWTIA operation monitoring schedule.

Swan site Groundwater Interim Treatment Action (Pump & Treat System) currently scheduled for startup mid December 2008.

A comprehensive event is scheduled for Q4 2008 prior to start up of the Groundwater Interim Treatment Action system.

X = soil gas sample collected or will be collected

Samping Periods for Each Quarter: Q1 - 1st quarter (Jan. - Mar.); Q2 - 2nd quarter (Apr. - Jun.); Q3 - 3rd quarter (Jul. - Sept.); Q4 - 4th quarter (Oct. - Dec.)

Sampling Method: summa canister.

Sampling objective is to collect soil gas samples same time period as groundwater sampling is being completed.

NM indicates that elevation at the well has not been established

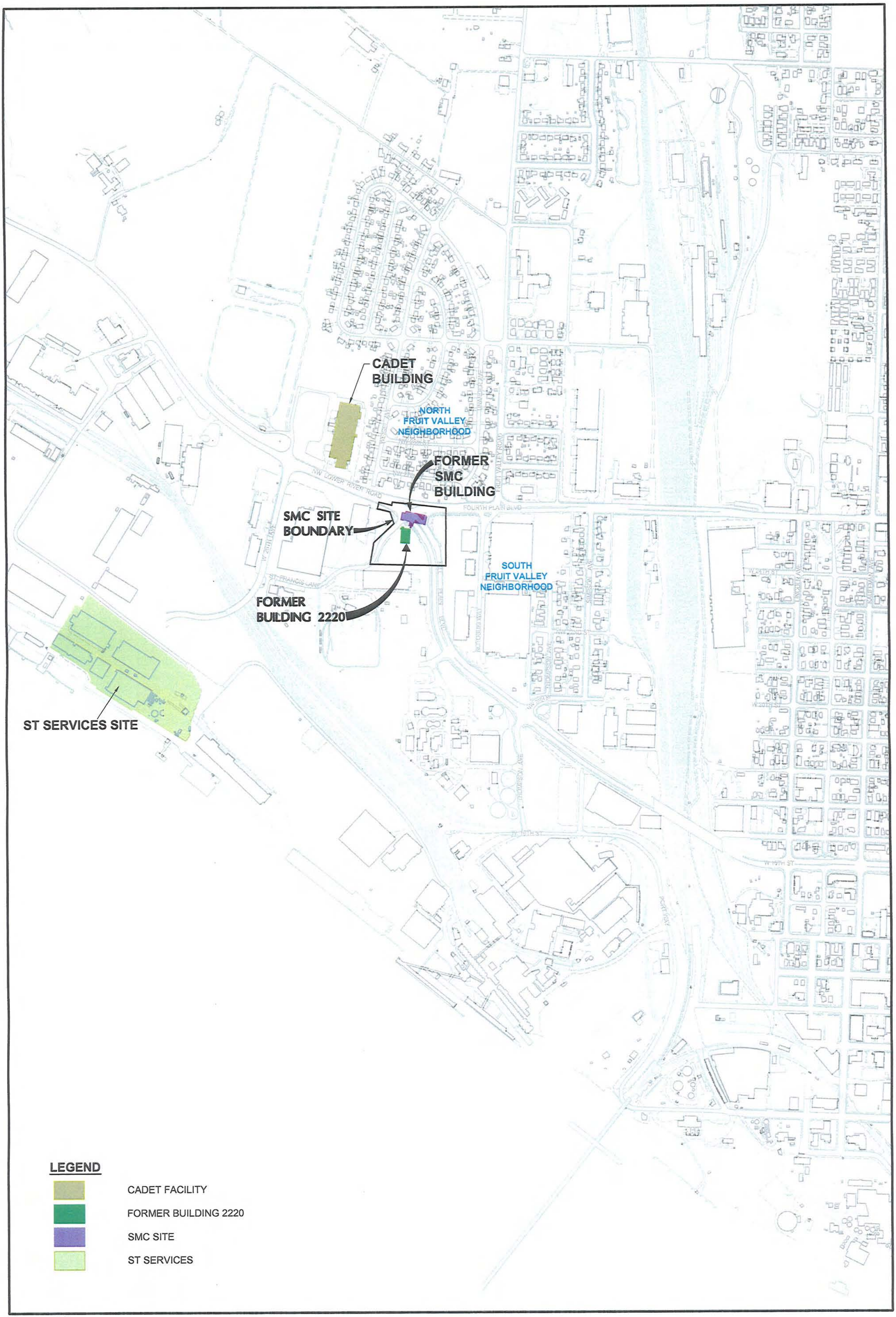
FIGURES

Analysis by C. Hainey; Analysis Date: October-2007; Plot Date: October-2007; File Name: P:\GIS\POV\MXD\POV_InterimActionPlan.mxd

Parametrix

Figure 1-1
Site Location Map

Interim Action Work Plan
Port of Vancouver, Washington



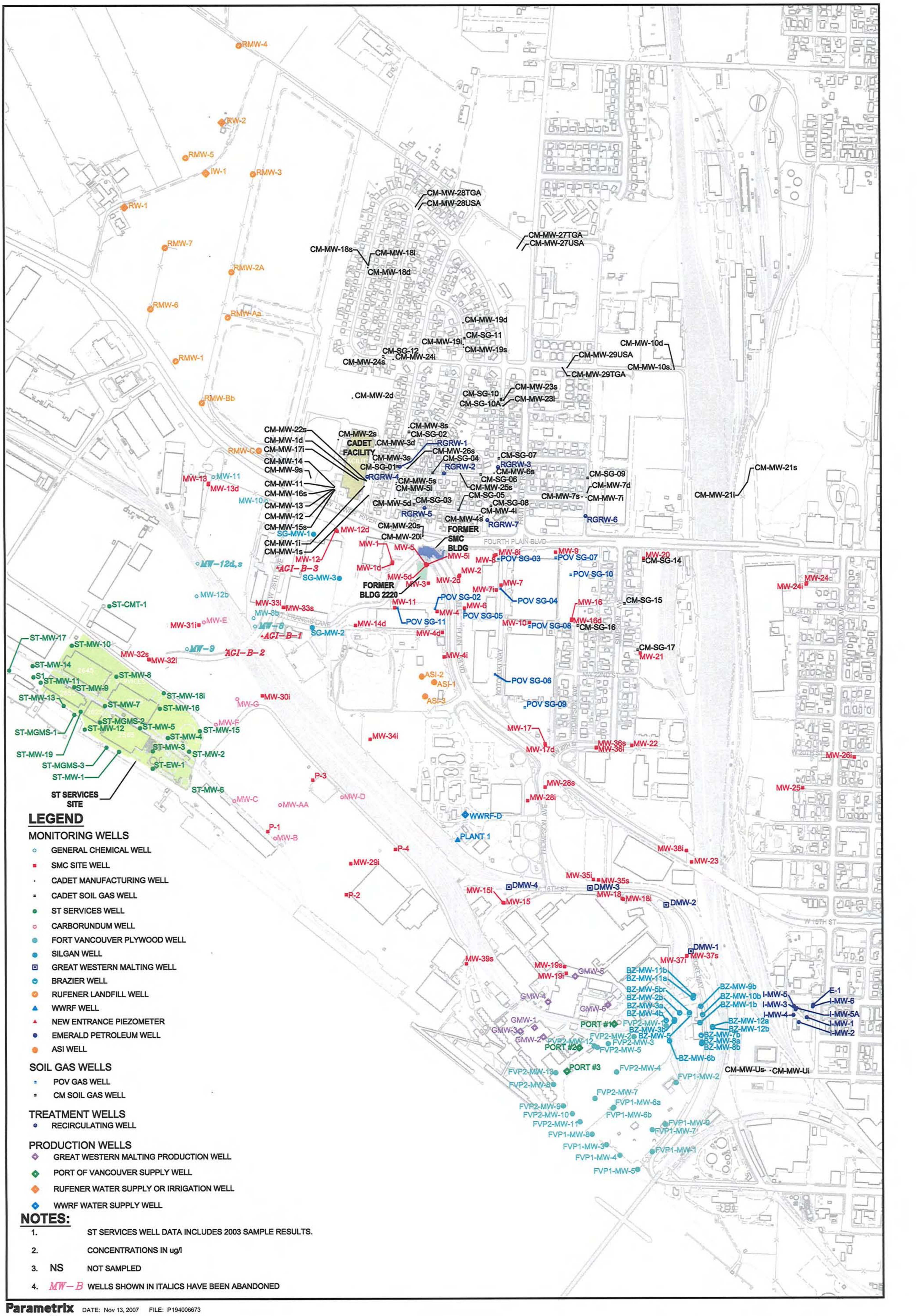
Parametrix DATE: 10/24/07 08:33am FILE: P194006672

N

0 600'

SCALE IN FEET

Figure 1-2
Project Area
INTERIM ACTION WORK PLAN
PORT OF VANCOUVER, WASHINGTON



LEGEND

MONITORING WELLS

- ○ GENERAL CHEMICAL WELL
- ■ SMC SITE WELL
- · CADET MANUFACTURING WELL
- ▪ CADET SOIL GAS WELL
- ● ST SERVICES WELL
- ○ CARBORUNDUM WELL
- ● FORT VANCOUVER PLYWOOD WELL
- ● SILGAN WELL
- ⊡ GREAT WESTERN MALTING WELL
- ⊖ BRAZIER WELL
- ● RUFENER LANDFILL WELL
- ▲ WWRF WELL
- ▲ NEW ENTRANCE PIEZOMETER
- ● EMERALD PETROLEUM WELL
- ● ASI WELL

SOIL GAS WELLS

- ▪ POV GAS WELL
- ▪ CM SOIL GAS WELL

TREATMENT WELLS

- ⊙ RECIRCULATING WELL

PRODUCTION WELLS

- ◆ GREAT WESTERN MALTING PRODUCTION WELL
- ◆ PORT OF VANCOUVER SUPPLY WELL
- ◆ RUFENER WATER SUPPLY OR IRRIGATION WELL
- ◆ WWRF WATER SUPPLY WELL

NOTES:

1. ST SERVICES WELL DATA INCLUDES 2003 SAMPLE RESULTS.
2. CONCENTRATIONS IN ug/l
3. NS NOT SAMPLED
4. *MW–B* WELLS SHOWN IN ITALICS HAVE BEEN ABANDONED

Parametrix DATE: Nov 13, 2007 FILE: P194006673

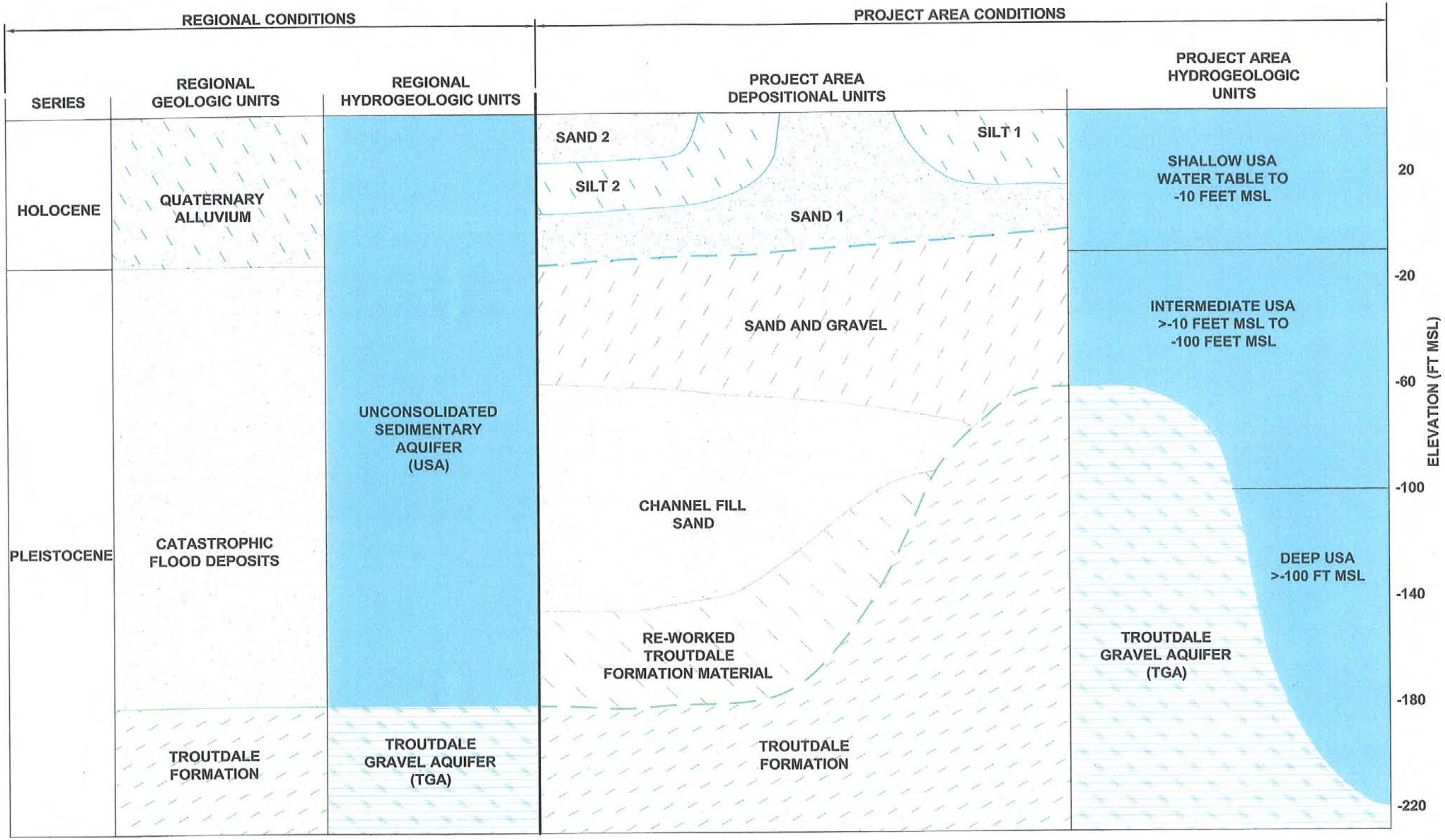
N

0 650'

SCALE IN FEET

Figure 2-1
Project Area Well Network

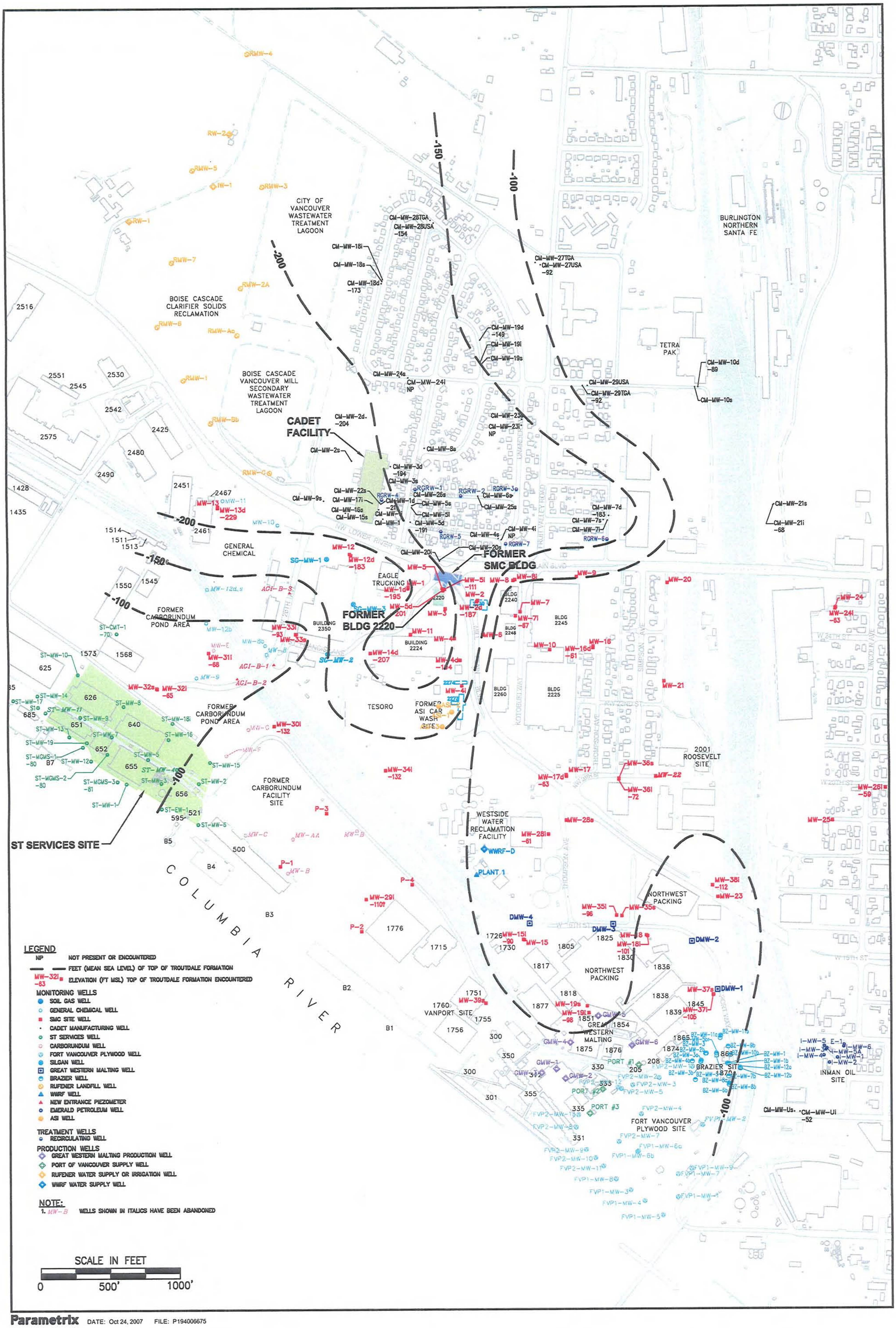
INTERIM ACTION WORK PLAN
PORT OF VANCOUVER, WASHINGTON



Parametrix DATE: Oct 23, 2007 FILE: P194006674

SCALE: HORIZONTAL NOT TO SCALE
VERTICAL 1"=40'

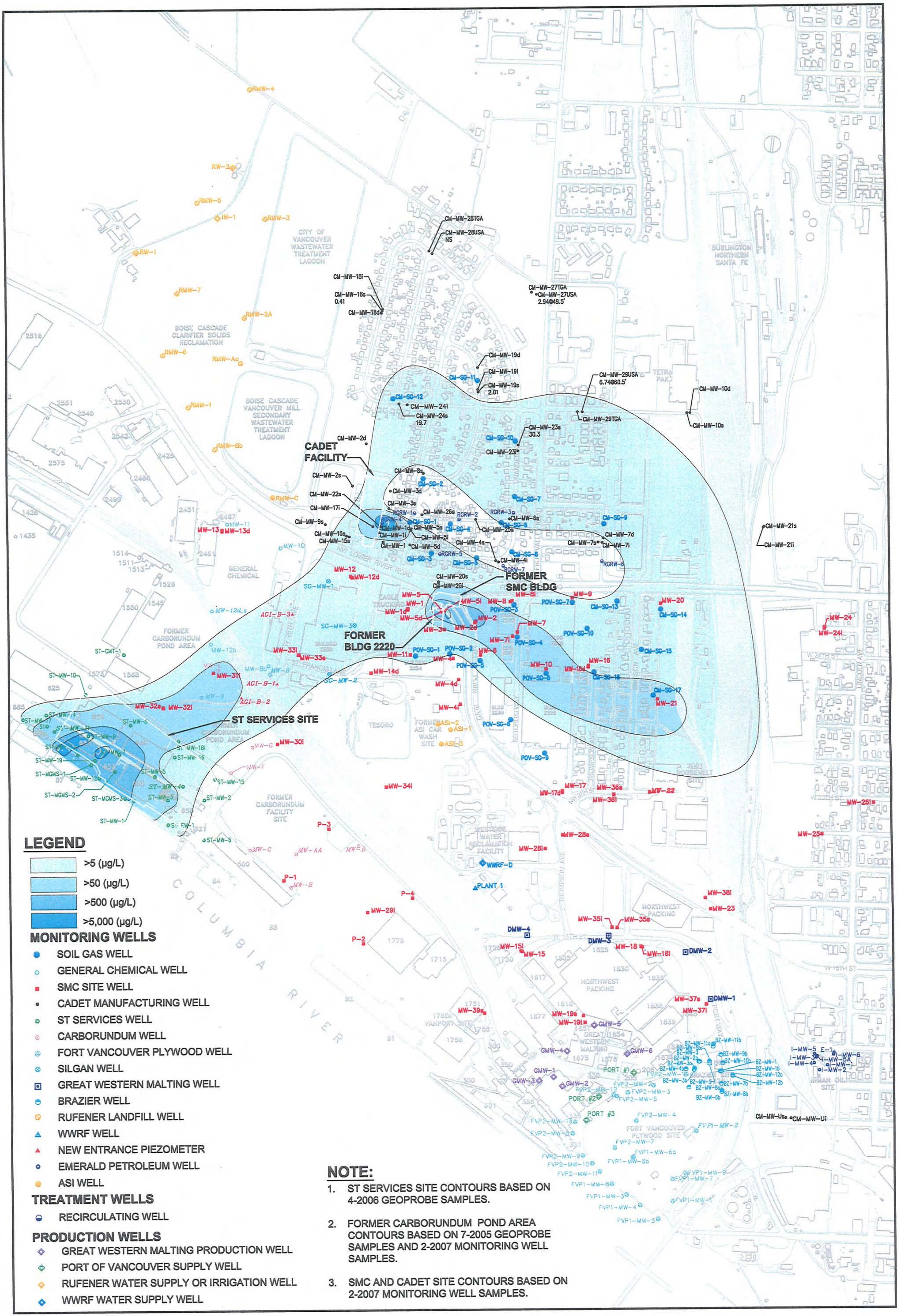
Figure 3-1
Regional And Project Area Geologic And Hydrologic Units
INTERIM ACTION WORK PLAN
PORT OF VANCOUVER, WASHINGTON



Parametrix DATE: Oct 24, 2007 FILE: P194006675

N

Figure 3-2
Top of Troutdale Formation
INTERIM ACTION WORK PLAN
PORT OF VANCOUVER, WASHINGTON



LEGEND

- ▨ >5 (µg/L)
- ▨ >50 (µg/L)
- ▨ >500 (µg/L)
- ▨ >5,000 (µg/L)

MONITORING WELLS

- ● SOIL GAS WELL
- ○ GENERAL CHEMICAL WELL
- ■ SMC SITE WELL
- • CADET MANUFACTURING WELL
- ● ST SERVICES WELL
- ○ CARBORUNDUM WELL
- ● FORT VANCOUVER PLYWOOD WELL
- ⊗ SILGAN WELL
- ▣ GREAT WESTERN MALTING WELL
- ● BRAZIER WELL
- ● RUFENER LANDFILL WELL
- ▲ WWRF WELL
- ▲ NEW ENTRANCE PIEZOMETER
- ○ EMERALD PETROLEUM WELL
- ● ASI WELL

TREATMENT WELLS

- ◒ RECIRCULATING WELL

PRODUCTION WELLS

- ◇ GREAT WESTERN MALTING PRODUCTION WELL
- ◇ PORT OF VANCOUVER SUPPLY WELL
- ◇ RUFENER WATER SUPPLY OR IRRIGATION WELL
- ◆ WWRF WATER SUPPLY WELL

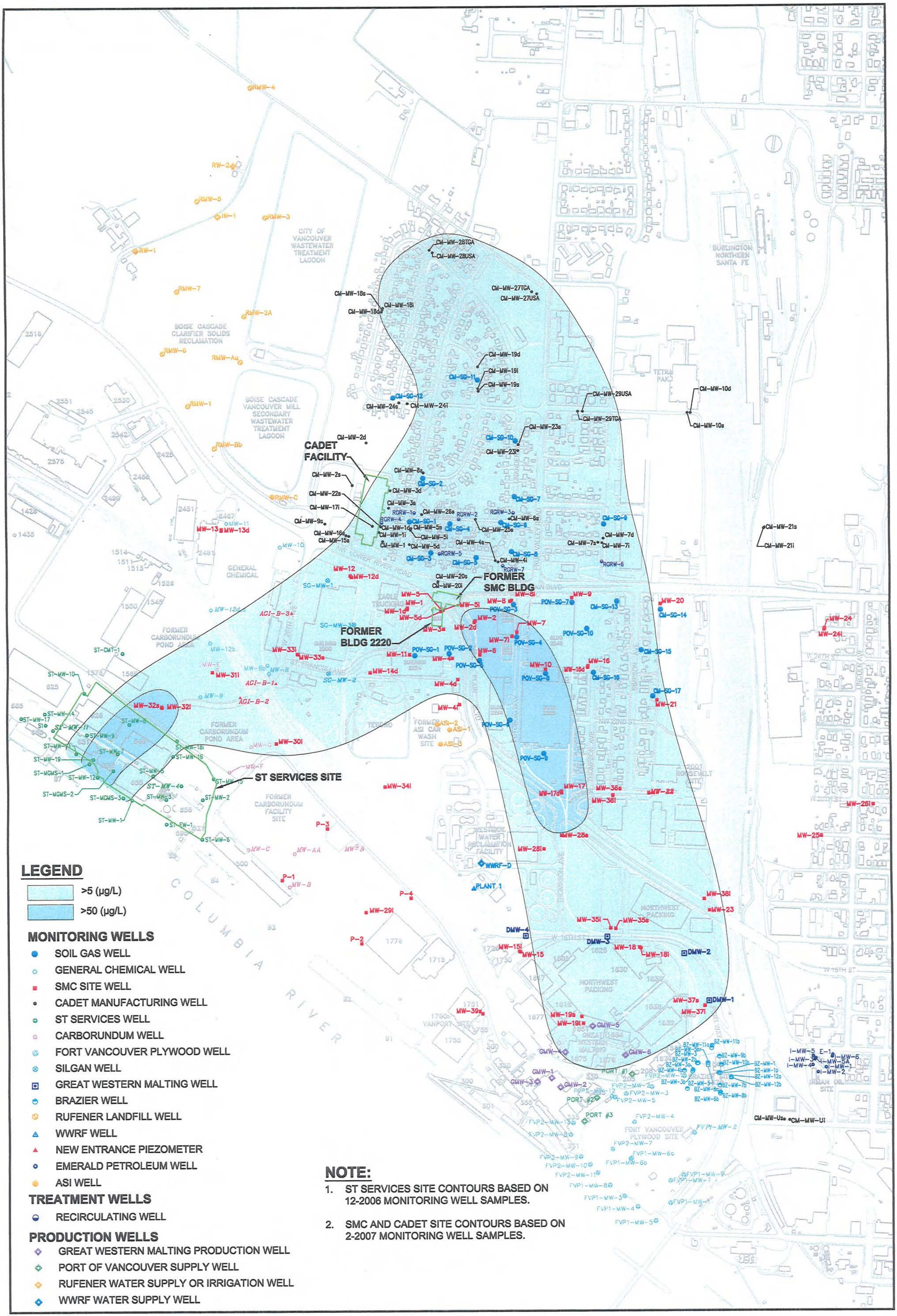
NOTE:

1. ST SERVICES SITE CONTOURS BASED ON 4-2006 GEOPROBE SAMPLES.
2. FORMER CARBORUNDUM POND AREA CONTOURS BASED ON 7-2005 GEOPROBE SAMPLES AND 2-2007 MONITORING WELL SAMPLES.
3. SMC AND CADET SITE CONTOURS BASED ON 2-2007 MONITORING WELL SAMPLES.

Parametrix DATE: Oct 31, 2007 FILE: P194006676

N

Figure 4-1
TCE Concentrations
Shallow USA Zone
INTERIM ACTION WORK PLAN
PORT OF VANCOUVER, WASHINGTON



LEGEND

▨	>5 (µg/L)
■	>50 (µg/L)

MONITORING WELLS

- ● SOIL GAS WELL
- ○ GENERAL CHEMICAL WELL
- ■ SMC SITE WELL
- • CADET MANUFACTURING WELL
- ○ ST SERVICES WELL
- ○ CARBORUNDUM WELL
- ○ FORT VANCOUVER PLYWOOD WELL
- ⊗ SILGAN WELL
- ▣ GREAT WESTERN MALTING WELL
- ◒ BRAZIER WELL
- ⊗ RUFENER LANDFILL WELL
- △ WWRF WELL
- ▲ NEW ENTRANCE PIEZOMETER
- ○ EMERALD PETROLEUM WELL
- ● ASI WELL

TREATMENT WELLS

- ◒ RECIRCULATING WELL

PRODUCTION WELLS

- ◇ GREAT WESTERN MALTING PRODUCTION WELL
- ◇ PORT OF VANCOUVER SUPPLY WELL
- ◇ RUFENER WATER SUPPLY OR IRRIGATION WELL
- ◆ WWRF WATER SUPPLY WELL

NOTE:

1. ST SERVICES SITE CONTOURS BASED ON 12-2006 MONITORING WELL SAMPLES.
2. SMC AND CADET SITE CONTOURS BASED ON 2-2007 MONITORING WELL SAMPLES.

Parametrix DATE: Oct 23, 2007 FILE: P194006677

N

Figure 4-2
TCE Concentrations Intermediate USA Zone

INTERIM ACTION WORK PLAN
PORT OF VANCOUVER, WASHINGTON

Parametrix DATE: Oct 23, 2007 FILE: P194006679

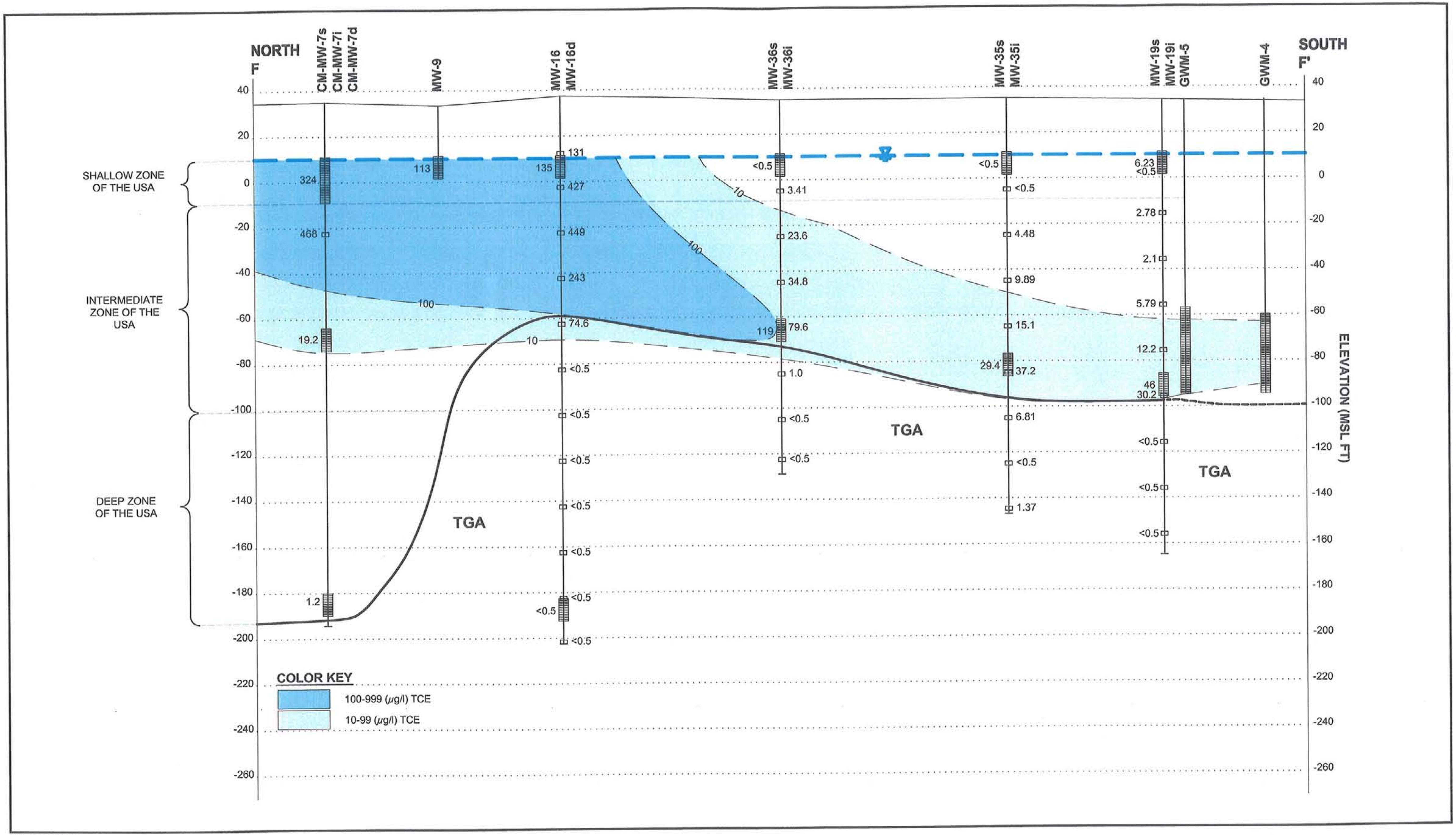
N

0 600'

SCALE IN FEET

Figure 4-3
Cross Section Orientation

INTERIM ACTION WORK PLAN
PORT OF VANCOUVER, WASHINGTON



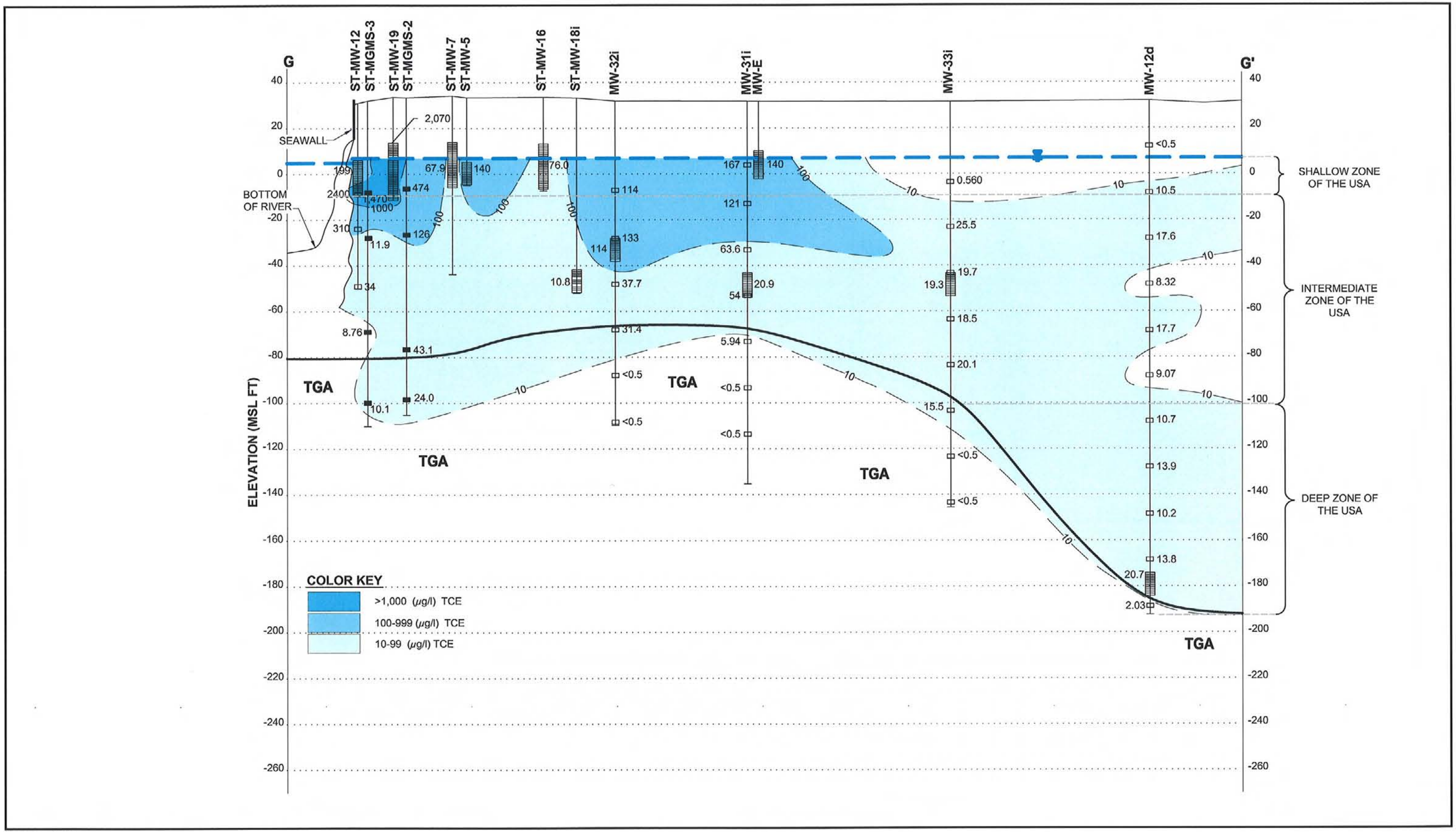
Parametrix DATE: Oct 23, 2007 FILE: P194006680

NOTE:
CONCENTRATIONS SHOWN ARE FROM VARIOUS SAMPLE COLLECTION AND WELL DRILLING EVENTS.

HORIZONTAL SCALE (1"=300')
VERTICAL SCALE (1"=40')

LEGEND
- BOREHOLE
- TEMPORARY WELL POINT LOCATION WITH TCE CONCENTRATION(µg/l)
- MONITORING WELL SCREEN INTERVAL WITH TCE CONCENTRATION(µg/l)
- —10— —10— PLUME CONCENTRATION CONTOUR INTERVAL (µg/l)

Figure 4-4
Vertical Distribution of TCE Along Cross Section F-F'
INTERIM ACTION WORK PLAN
PORT OF VANCOUVER, WASHINGTON



Parametrix DATE: Nov 13, 2007 FILE: P194006681

NOTE:

CONCENTRATIONS SHOWN ARE FROM VARIOUS SAMPLE COLLECTION AND WELL DRILLING EVENTS.

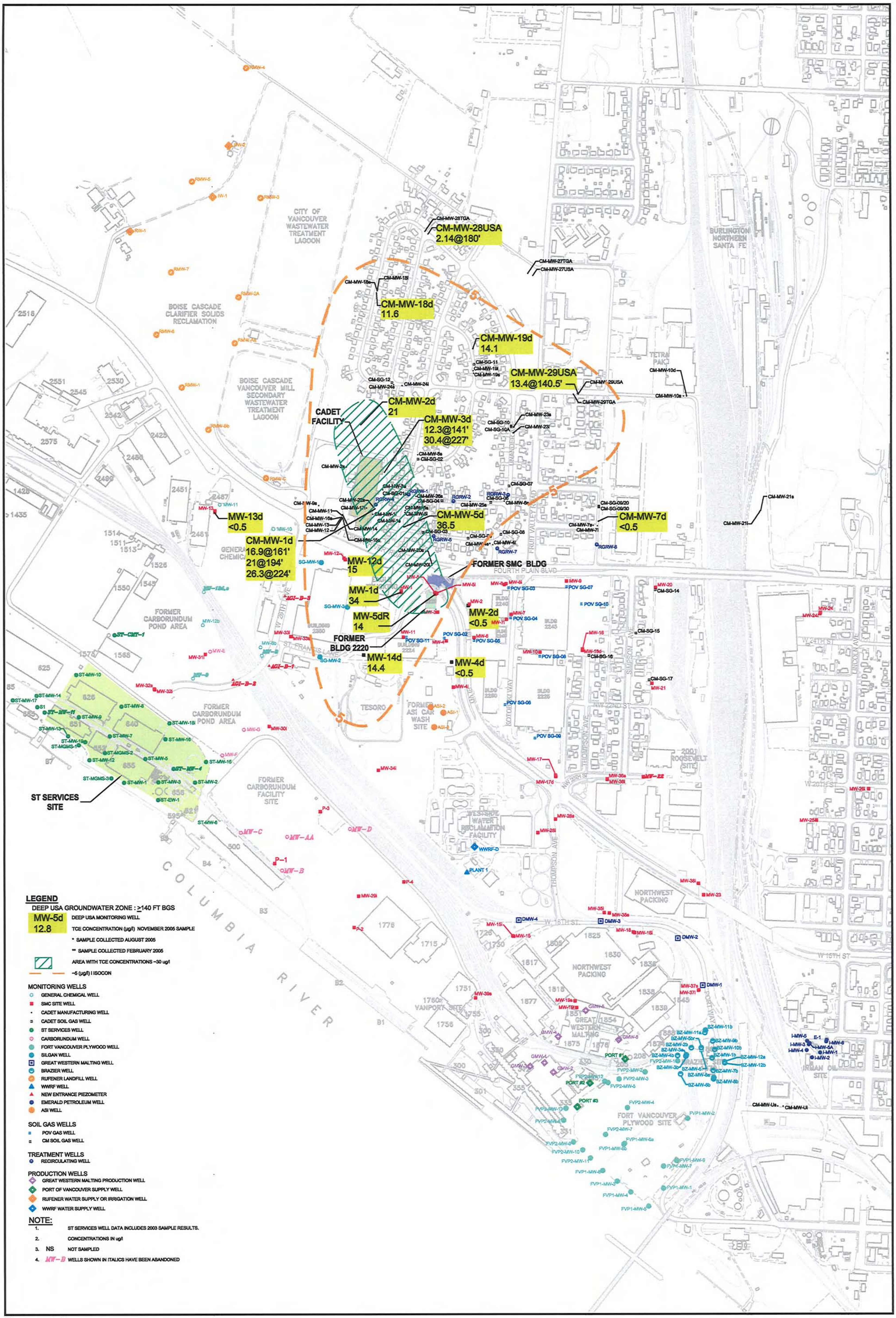
HORIZONTAL SCALE (1"=300')
DISTANCE BETWEEN WELLS IS APPROXIMATE.
VERTICAL SCALE (1"=40')

LEGEND

MULTI-PORT SAMPLE LOCATION WITH TCE CONCENTRATION (μg/l)
BOREHOLE
TEMPORARY WELL POINT LOCATION WITH TCE CONCENTRATION (μg/l)
MONITORING WELL SCREEN INTERVAL WITH TCE CONCENTRATION (μg/l)
—?— —?— PLUME CONCENTRATION CONTOUR INTERVAL (μg/l)

Figure 4-5
Vertical Distribution of TCE Along Cross Section G-G'

INTERIM ACTION WORK PLAN
PORT OF VANCOUVER, WASHINGTON



Parametrix DATE: Nov 13, 2007 FILE: P194006682

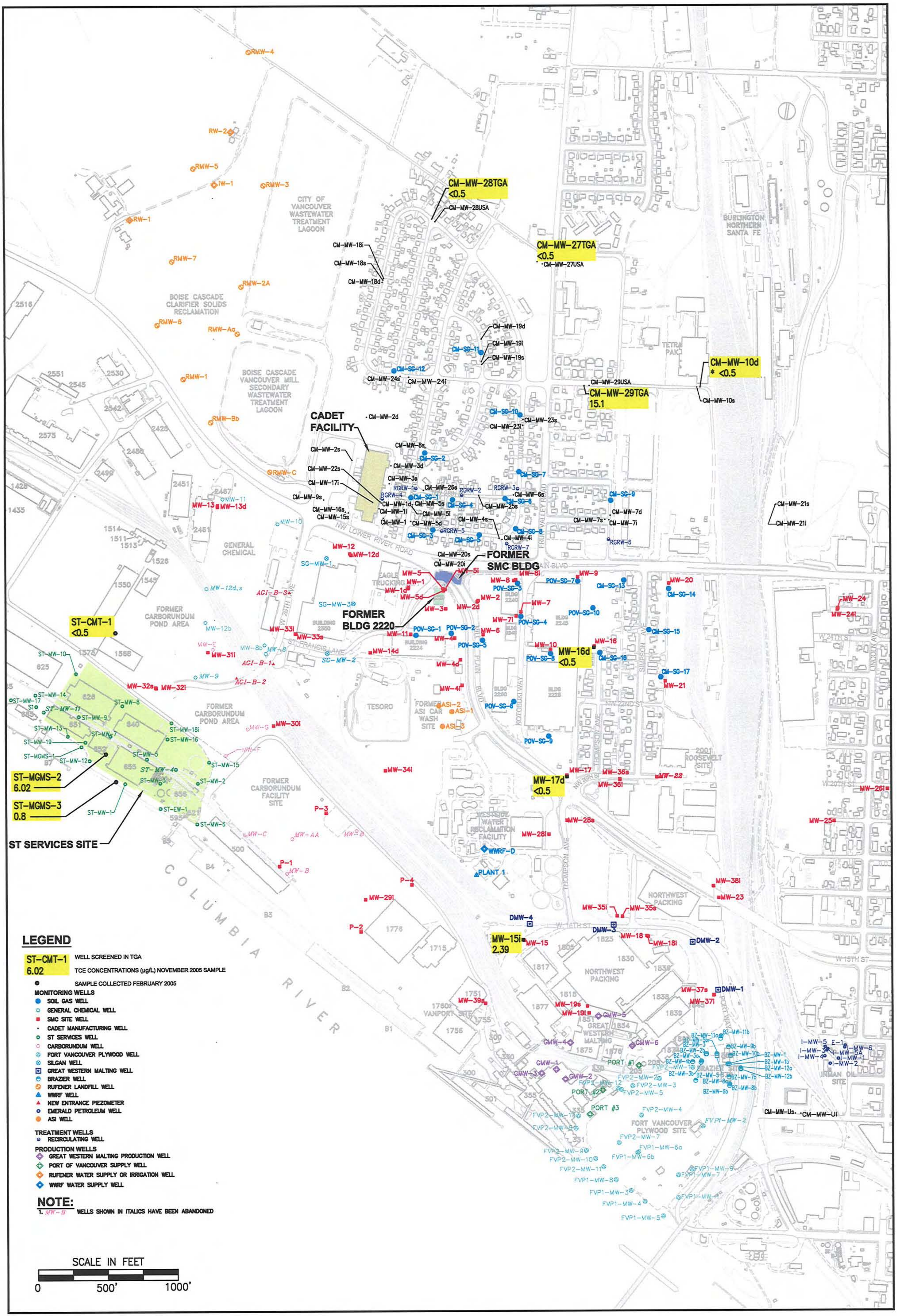
N

0 650'

SCALE IN FEET

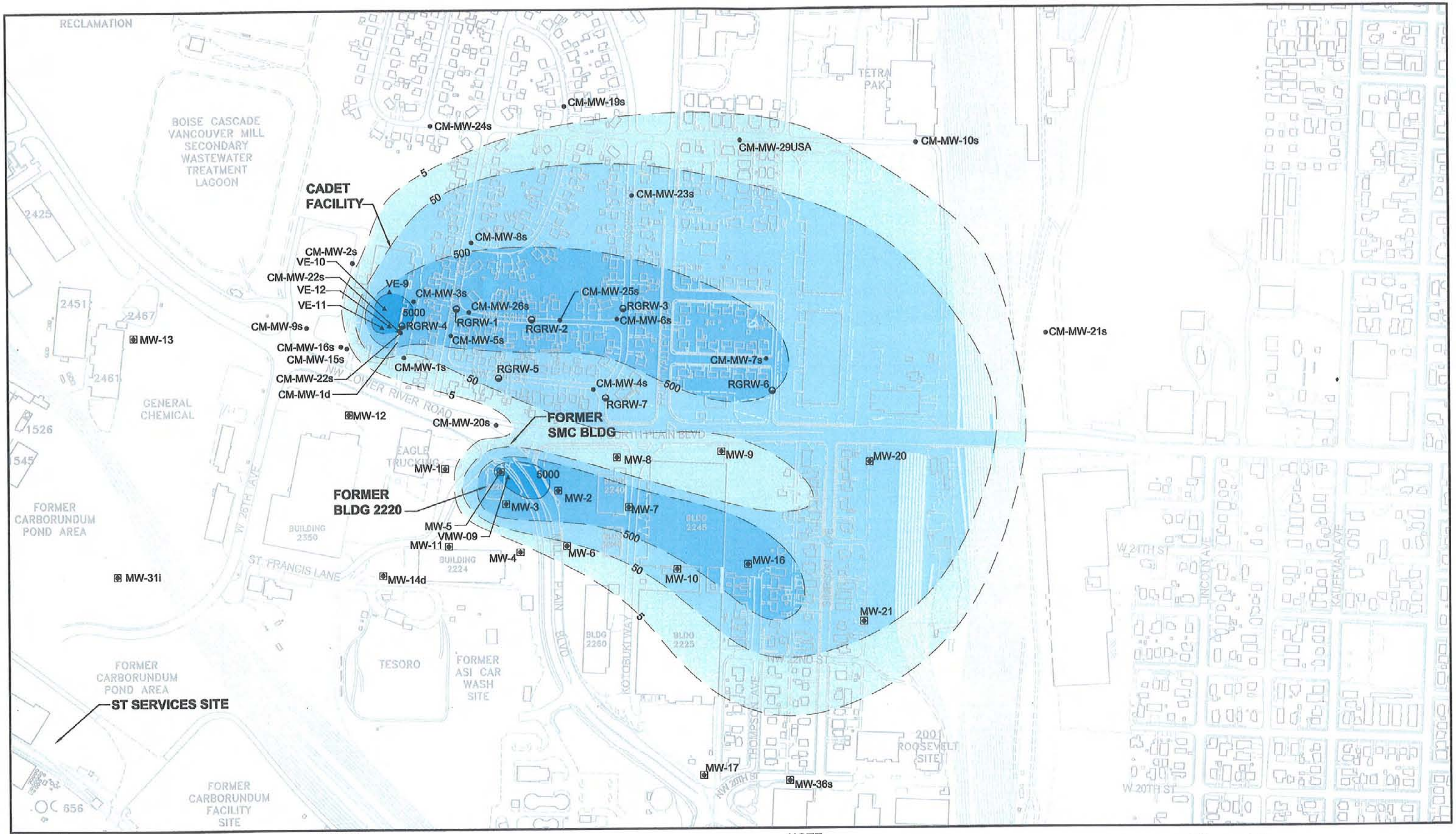
Figure 4-6
Distribution of TCE in the Deep USA Groundwater Zone

INTERIM ACTION WORK PLAN
PORT OF VANCOUVER, WASHINGTON



Parametrix DATE: Nov 13, 2007 FILE: P194006683

Figure 4-7
TGA Monitoring Wells
INTERIM ACTION WORK PLAN
PORT OF VANCOUVER, WASHINGTON



Parametrix DATE: Oct 31, 2007 FILE: P194006685

N

0 400'

SCALE IN FEET

LEGEND

▨	>5 µg/l
▨	>50 µg/l
▨	>500 µg/l
▨	>5000 µg/l

● CM-MW-4s	CADET MONITORING WELL
■ MW-11	SMC MONITORING WELL

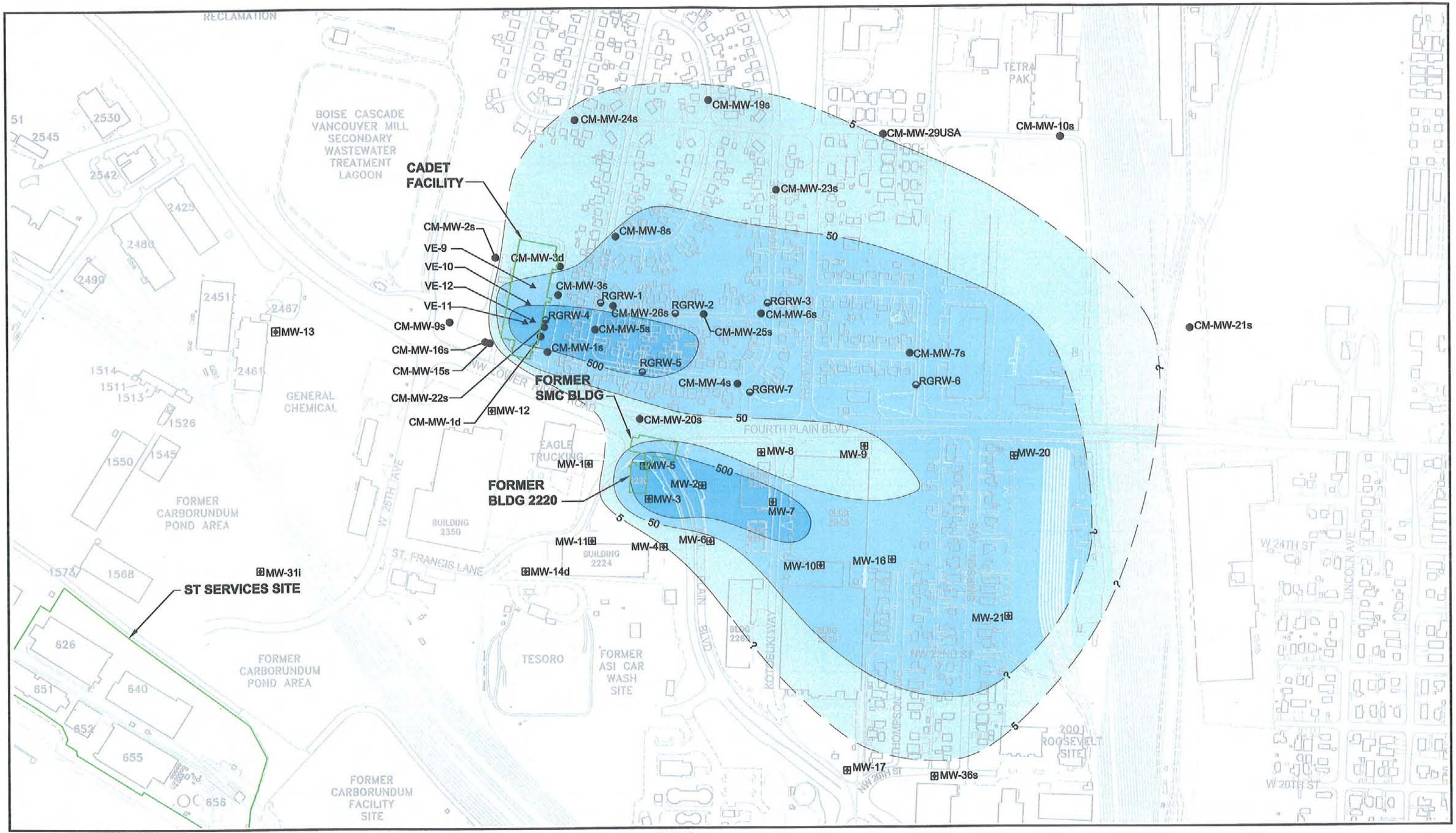
NOTE:

FIGURE ADAPTED FROM AMEC PREPARED DRAWING (AMEC 2005)

THE ISOCONCENTRATION PLUMES ARE ESTIMATED BASED ON AVAILABLE DATA POINTS. THERE IS SOME UNCERTAINTY BETWEEN DATA POINTS.

Figure 4-8
TCE Isoconcentrations in Shallow Groundwater January - March 2002

INTERIM ACTION WORK PLAN
PORT OF VANCOUVER, WASHINGTON



Parametrix DATE: Oct 31, 2007 FILE: P194006686

N

0 400'
SCALE IN FEET

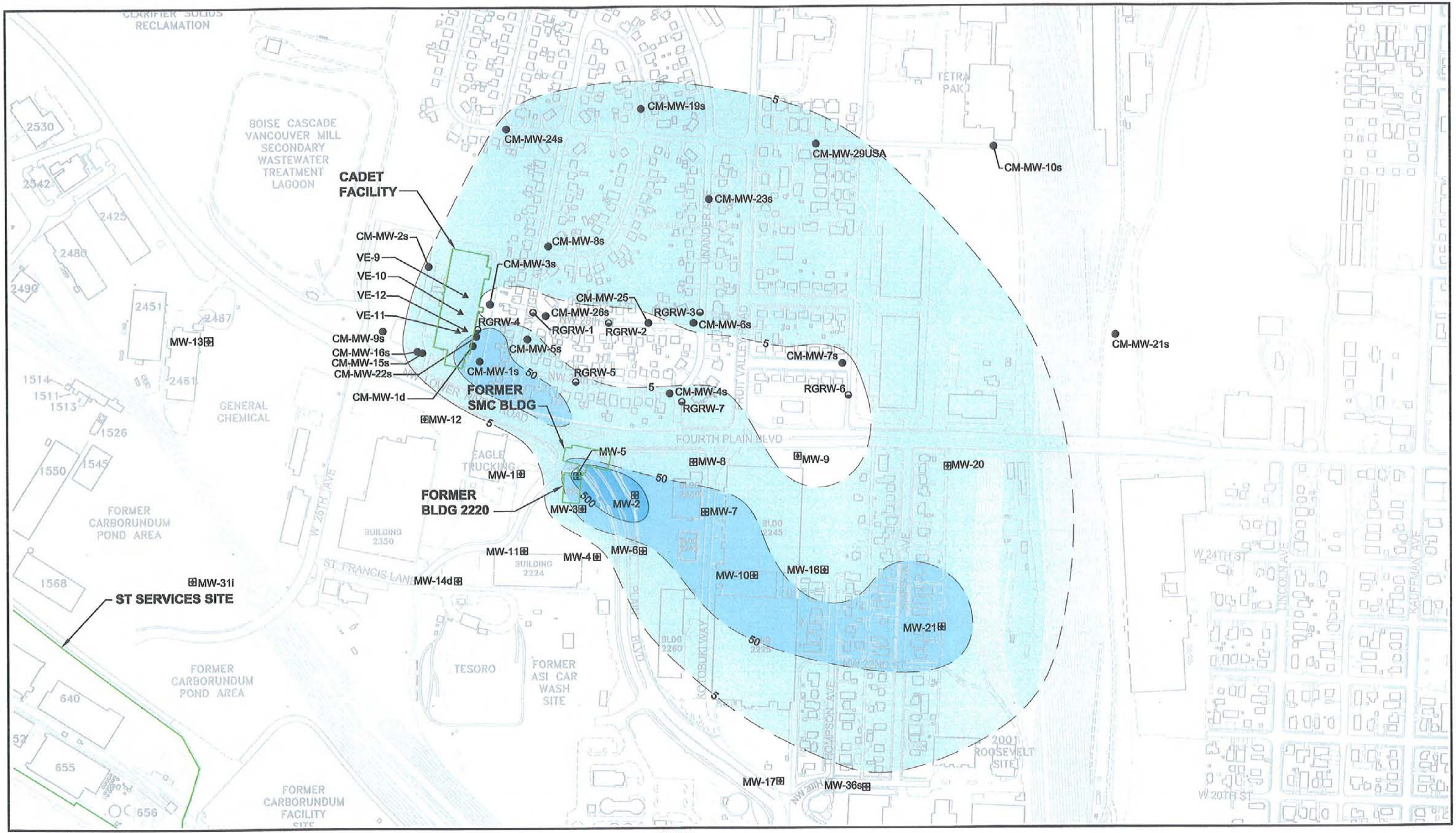
LEGEND

▨	>5 µg/l	● CM-MW-4s	CADET MONITORING WELL
▨	>50 µg/l	MW-14d ⊞	SMC MONITORING WELL
▨	>500 µg/l		

NOTE:
THE ISOCONCENTRATION PLUMES ARE ESTIMATED BASED ON AVAILABLE DATA POINTS. THERE IS SOME UNCERTAINTY BETWEEN DATA POINTS.

Figure 4-9
TCE Isoconcentrations in Shallow Groundwater January - Feburary 2004

INTERIM ACTION WORK PLAN
PORT OF VANCOUVER, WASHINGTON



Parametrix DATE: Oct 31, 2007 FILE: P194006687

N

0 400'

SCALE IN FEET

LEGEND

▨	>5 µg/l	● CM-MW-4s	CADET MONITORING WELL
▨	>50 µg/l	MW-14d ⊞	SMC MONITORING WELL
▨	>500 µg/l		

NOTE:

THE ISOCONCENTRATION PLUMES ARE ESTIMATED BASED ON AVAILABLE DATA POINTS. THERE IS SOME UNCERTAINTY BETWEEN DATA POINTS.

Figure 4-10
TCE Isoconcentrations in Shallow Groundwater - September 2006
INTERIM ACTION WORK PLAN
PORT OF VANCOUVER, WASHINGTON

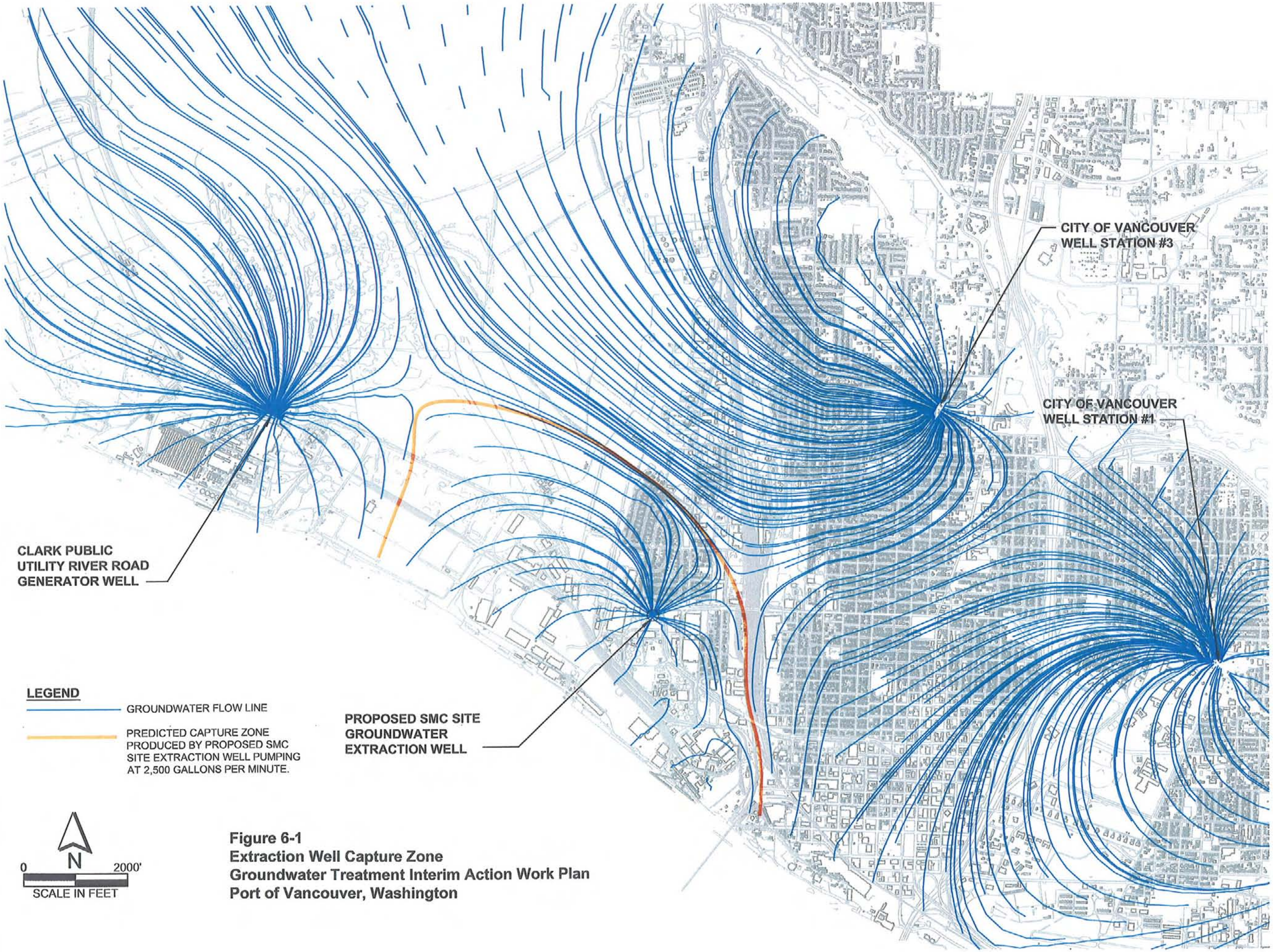
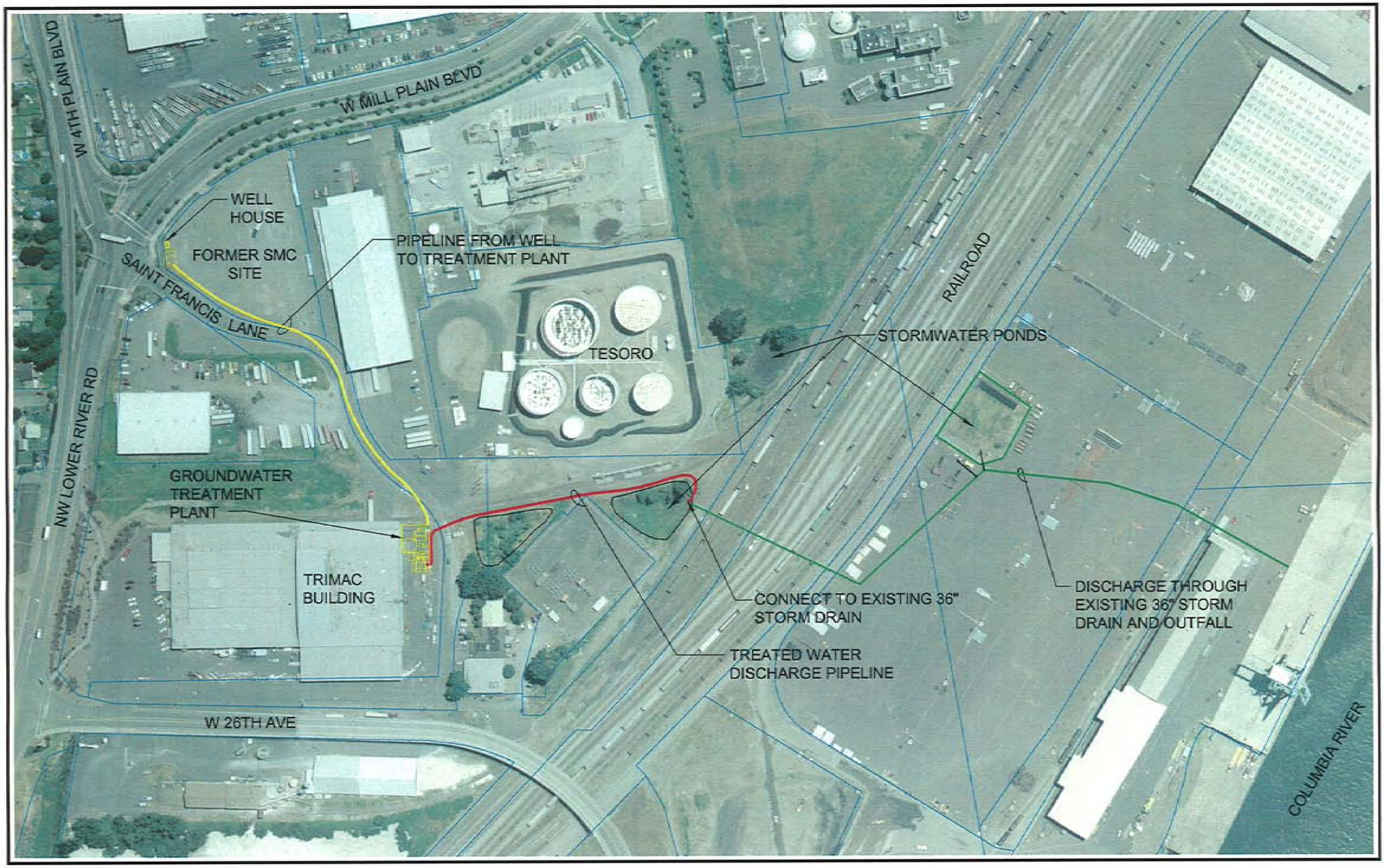
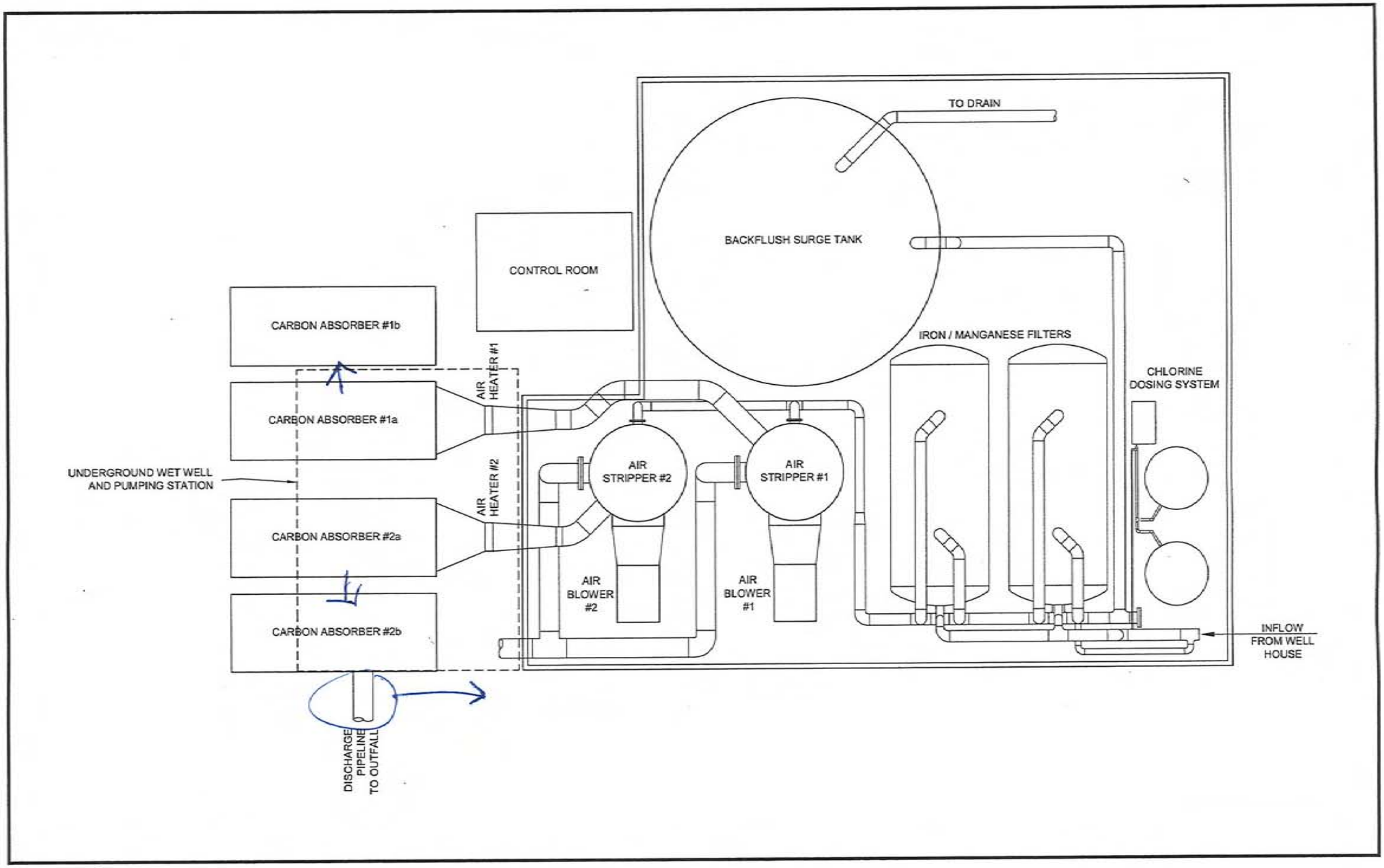


Figure 6-1
Extraction Well Capture Zone
Groundwater Treatment Interim Action Work Plan
Port of Vancouver, Washington



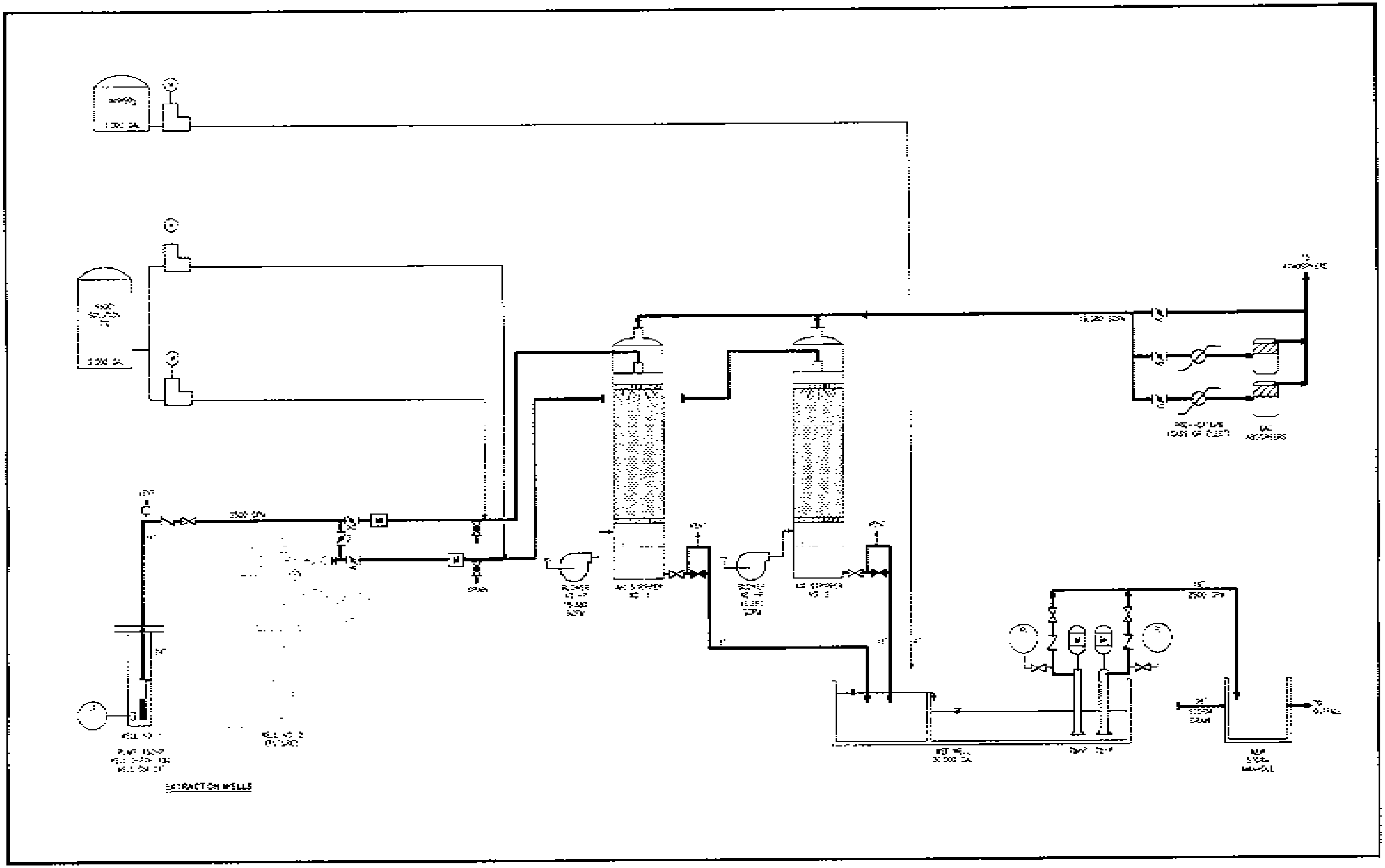
Parametrix DATE: Nov 13, 2007 FILE: P194006696

Figure 7-1
Conceptual Layout of
Interim Action System
INTERIM ACTION WORK PLAN
PORT OF VANCOUVER, WASHINGTON



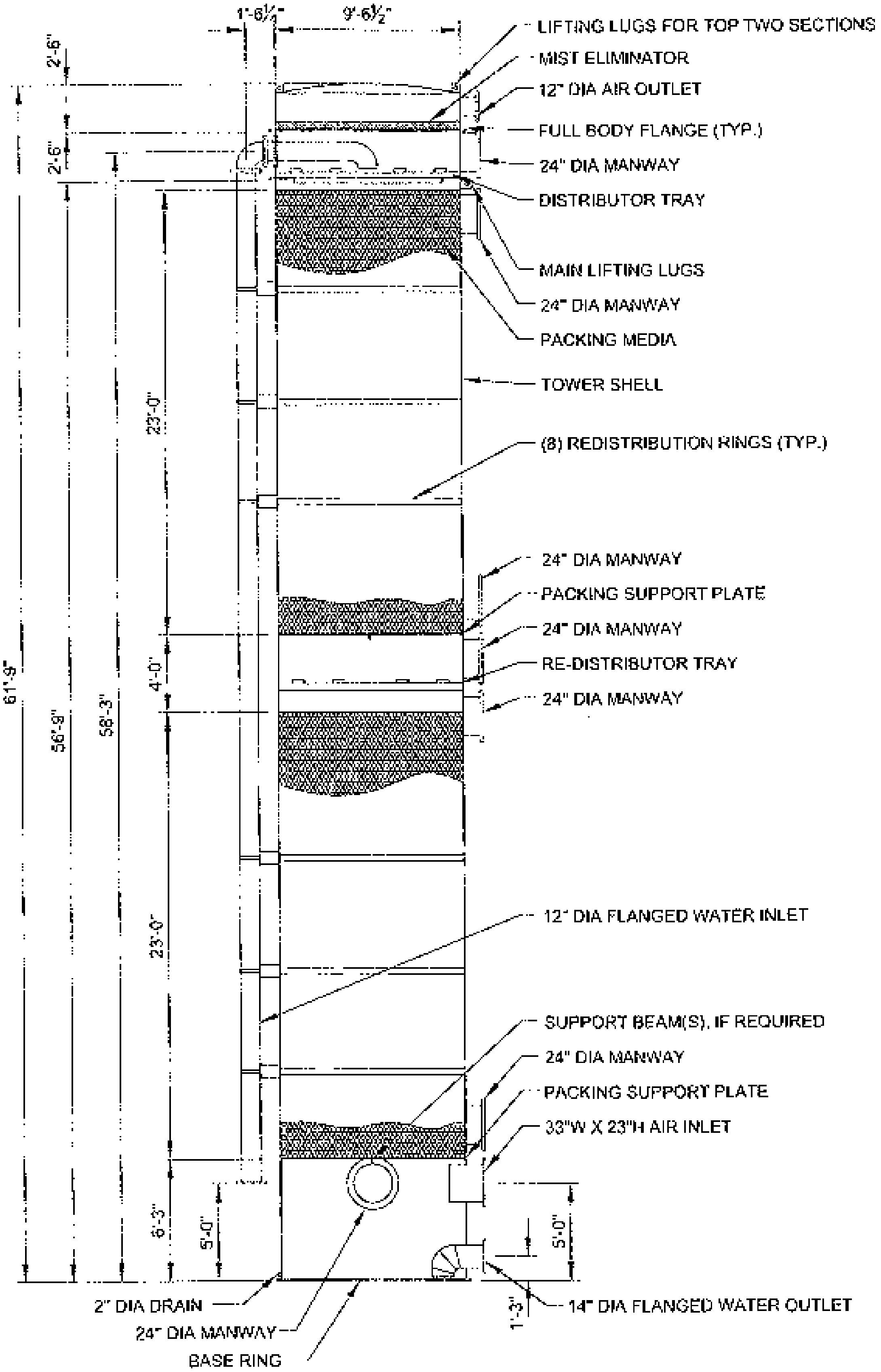
Parametrix DATE: Oct 31, 2007 FILE: PO1940006P0407-F07

Figure 7-2
Conceptual Layout of Treatment Facility
INTERIM ACTION WORK PLAN
PORT OF VANCOUVER, WASHINGTON



Parametrix DATE Oct 31, 2007 FILE [illegible]

Figure 7-3
Process Schematic
INTERIM ACTION WORK PLAN
PORT OF VANCOUVER, WASHINGTON

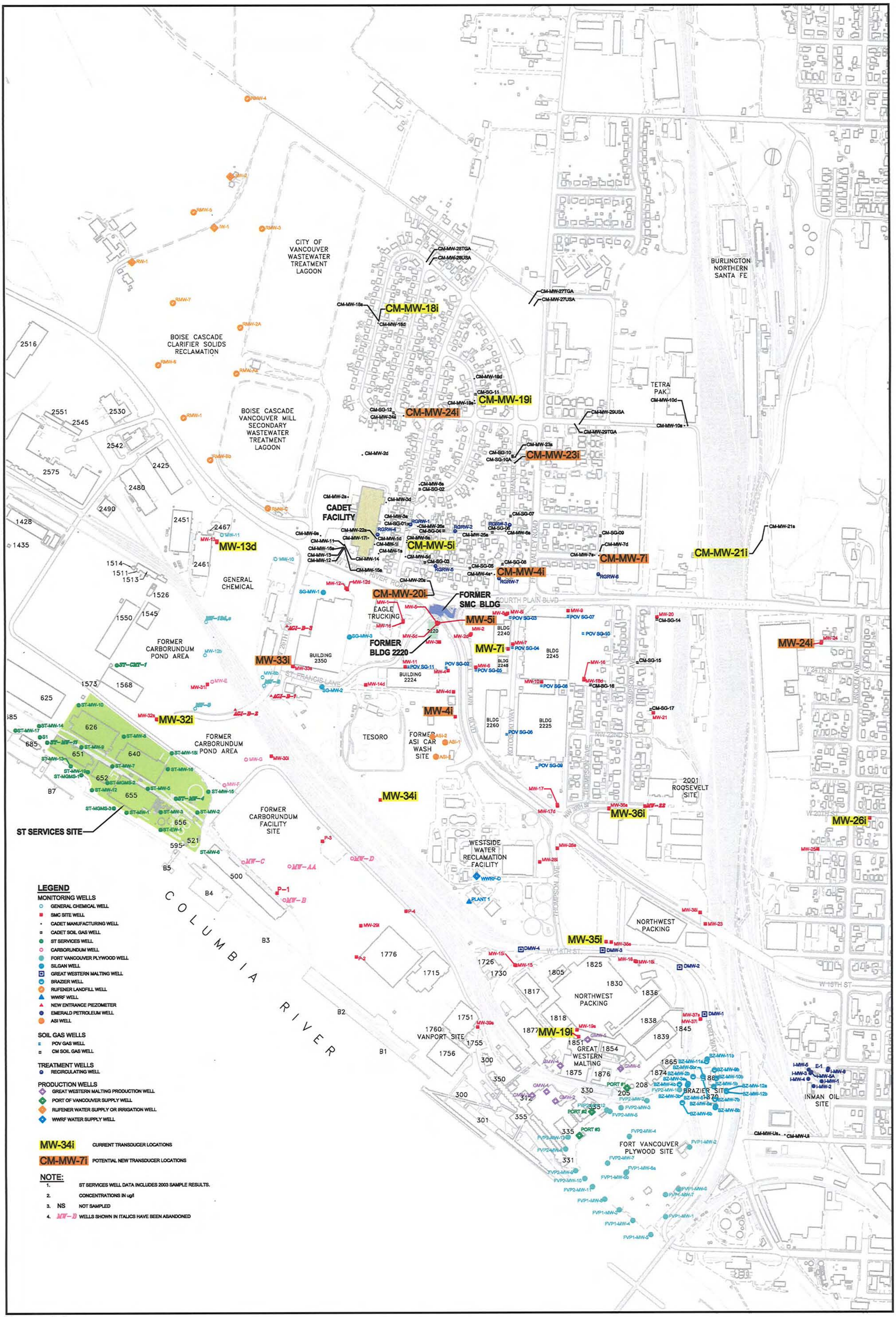


Parametrix DATE: Oct 31, 2007 FILE: PD1942006P0457-F09

SOURCE: LAYNE CHRISTENSEN CO.

0 1/8
SCALE IN FEET

Figure 7-4
Conceptual Design of Air Stripper
INTERIM ACTION WORK PLAN
PORT OF VANCOUVER, WASHINGTON



Parametrix DATE: Nov 13, 2007 FILE: P194006692

N

0 650'

SCALE IN FEET

Figure 7-5

Transducer Monitoring Locations

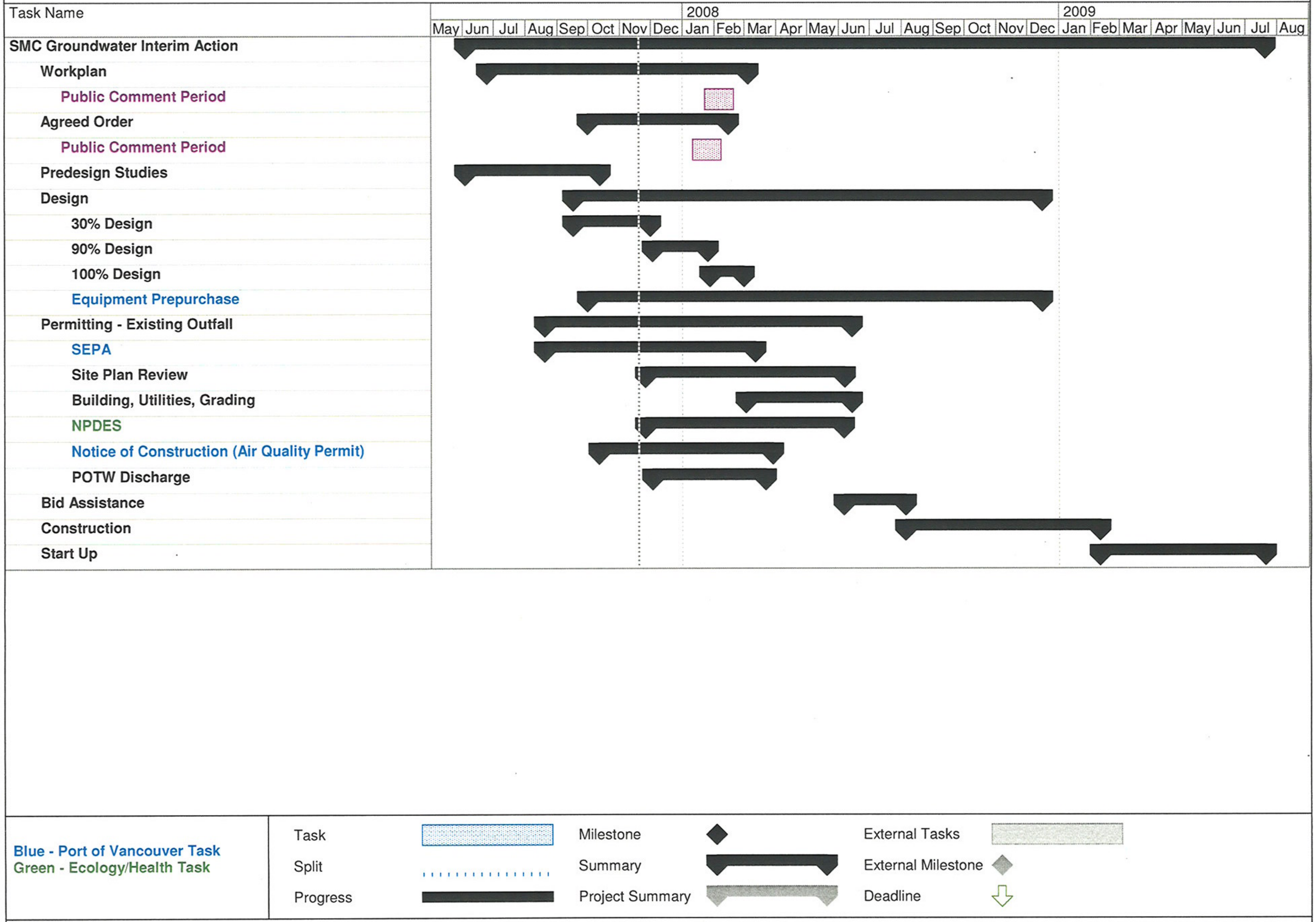
INTERIM ACTION WORK PLAN

PORT OF VANCOUVER, WASHINGTON

APPENDIX A

Interim Action Project Schedule

PROJECT SCHEDULE FOR GROUNDWATER PUMP & TREAT INTERIM ACTION - SMC/CADET COMMINGLED PLUME



Date: Mon 11/19/07

APPENDIX A

Material Safety Data Sheets

MATERIAL SAFETY DATA SHEET

Effective Date: 08/01/00

Product: 12x40BC

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1. Product Identification

Synonyms: Charcoal, Activated
CAS No.: 7440-44-0
Molecular Weight: 12.01
Chemical Formula: C

---

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Activated Carbon	7440-44-0	90 - 100%	Yes

---

3. Hazards Identification

Emergency Overview

WARNING! FLAMMABLE SOLID. ACTIVATED CARBON AFFECTS THE RESPIRATORY AND CARDIOVASCULAR SYSTEMS.

CAUTION!!! Wet activated carbon removes oxygen from air causing a severe hazard to workers inside carbon vessels and enclosed or confined spaces. Before entering such an area, sampling and work procedures for low oxygen levels should be taken to ensure ample oxygen availability, observing all local, state, and federal regulations.

J.T. Baker SAF-T-DATA(tm) Ratings (Provided here for your convenience)

Health Rating: 1 - Slight
Flammability Rating: 3 - Severe (Flammable)
Reactivity Rating: 1 - Slight
Contact Rating: 1 - Slight

Lab Protective Equip: GOGGLES; LAB COAT; CLASS B EXTINGUISHER
Storage Color Code: Orange (General Storage)

Potential Health Effects

Inhalation:
May cause mild irritation to the respiratory tract. The acute inhalation LC_{50} (Rat) is >64.4 mg/l (nominal concentration) for activated carbon.

Ingestion:
No adverse effects expected. May cause mild irritation to the gastrointestinal tract. The acute oral LD_{50} (Rat) is >10g/kg.

Skin Contact:
Not expected to be a health hazard from skin exposure. May cause mild irritation and redness. The primary skin irritation index (Rabbit) is 0.

Eye Contact:
No adverse effects expected. May cause mild irritation, possible reddening.

Chronic Exposure:
Prolonged inhalation of excessive dust may produce pulmonary disorders. The effects of long-term, low-level exposures to this product have not been determined. Safe handling of this material on a long-term basis should emphasize the avoidance of all effects from repetitive acute exposures.

Aggravation of Pre-existing Conditions:
No information found.

---

4. First Aid Measures

Inhalation:
Remove to fresh air. Get medical attention for any breathing difficulty.

Ingestion:
Give several glasses of water to drink to dilute. If large amounts were swallowed, seek medical attention.

Skin Contact:
Not expected to require first aid measures. Wash exposed area with soap and water. Seek medical attention if irritation develops.

Eye Contact:
Wash thoroughly with running water for at least 15 minutes. Seek medical attention if irritation develops.

---

5. Fire Fighting Measures

Fire:

As with most organic solids, fire is possible at elevated temperatures or by contact with an ignition source.

Explosion:
Fine dust dispersed in air in sufficient concentrations, and in the presence of an ignition source is a potential dust explosion hazard. Minimum explosible concentration 0.140 g/l.

Fire Extinguishing Media:
Water or water spray.

Unusual Fire and Explosion Hazards:
Contact with strong oxidize such as ozone, liquid oxygen, chlorine, permanganate, etc., may result in fire.

Special Information:
In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode.

6. Accidental Release Measures

Remove all sources of ignition. Ventilate area of leak or spill. Wear appropriate personal protective equipment as specified in Section 8. Spills: Clean up spills in a manner that does not disperse dust into the air. Use non-sparking tools and equipment. Reduce airborne dust and prevent scattering by moistening with water. Pick up spill for recovery or disposal and place in a closed container. Warning! Spent product may have absorbed hazardous materials.

7. Handling and Storage

Protect against physical damage. Store in a cool, dry well-ventilated location, away from any area where the fire hazard may be acute. Outside or detached storage is preferred. Separate from incompatibles. Containers should be bonded and grounded for transfers to avoid static sparks. Storage and use areas should be No Smoking areas. Use non-sparking type tools and equipment, including explosion proof ventilation. Containers of this material may be hazardous when empty since they retain product residues (dust, solids); observe all warnings and precautions listed for the product.

CAUTION!! Wet activated carbon removes oxygen from air causing a severe hazard to workers inside carbon vessels and enclosed or confined spaces. Before entering such an area, sampling and work procedures for low oxygen levels should be taken to ensure ample oxygen availability, observing all local, state, and federal or national regulations.

8. Exposure Controls/Personal Protection

Exposure Guidelines:
OSHA PEL*:
5mg/M3 (Respirable)
ACGIH TLV*:
10 mg/M3 (Total)

*PELs and TLVs are 8-hour TWAs unless otherwise noted.

Ventilation System:
A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details.

Personal Respirators (NIOSH Approved):
For conditions of use where exposure to the dust or mist is apparent, a half-face dust/mist respirator may be worn. For emergencies or instances where the exposure levels are not known, use a full-face positive-pressure, air-supplied respirator. WARNING: Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.

Skin Protection:
Wear protective gloves and clean body-covering clothing.

Eye Protection:
Use chemical safety goggles. Maintain eye wash fountain and quick-drench facilities in work area.

---

9. Physical and Chemical Properties

Appearance:
Black particulate solid, pellet, or powder.

Odor:
Odorless.

Solubility:
Insoluble in water.

Specific Gravity:
1.5-1.8

pH:
No information found.

% Volatiles by volume @ 21C (70F):
0

Boiling Point:
Sublimes.

Melting Point:
3550C (6422F)

Vapor Density (Air=1):
0.4

Vapor Pressure (mm Hg):
1 @ 3586C (6487F)

Evaporation Rate (BuAc=1):
No information found.

10. Stability and Reactivity

Stability:
Stable under ordinary conditions of use and storage.

Hazardous Decomposition Products:
Involvement in a fire causes formation of carbon dioxide and carbon monoxide.

Hazardous Polymerization:
Will not occur.

Incompatibilities:
Liquid air and oxidizing materials. Strong oxidizers such as ozone, liquid oxygen, chlorine, permanganate, etc.

Conditions to Avoid:
Incompatibles.

11. Toxicological Information

Investigated as a reproductive effector.

```
--------\Cancer Lists\------------------------------------------------------------
                                          ---NTP Carcinogen---
Ingredient                                Known    Anticipated    IARC Category
----------------------------------------  -----    -----------    -------------
Activated Carbon (7440-44-0)               No          No             None
```

12. Ecological Information

Environmental Fate:
No information found.

Environmental Toxicity:
No information found.

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be managed in an appropriate and approved waste disposal facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

---

14. Transport Information

Proper Shipping Name:
NOT REGULATED
Hazard Class:
N/A
Identification Number:
N/A
Packing Group:
N/A
This product has been tested according to the United Nations *Transport of Dangerous Goods* test protocol for spontaneously combustible materials. It has been specifically determined that this product does not meet the definition of a self heating substance or any hazard class, and therefore is not a hazardous material and not regulated.

---

15. Regulatory Information

SARA TITLE III:
N/A
TSCA:
The ingredients of this product are on the TSCA Inventory List.
OSHA:
Nonhazardous according to definitions of health hazard and physical hazard provided in the Hazard Communication Standard (29 CFR 1910.1200)
CANADA

WHMIS CLASSIFICATION:
Not Classified
DSL#:
6798
EEC
Council Directives relating to the classification, packaging, and labeling of dangerous substances and preparations.
Risk (R) and Safety (S) phrases:
May be irritating to eyes (R36).

---

16. Other Information

NFPA Ratings: Health: 0 **Flammability:** 1 **Reactivity:** 0

Label Hazard Warning:
WARNING! FLAMMABLE SOLID. ACTIVATED CARBON AFFECTS THE RESPIRATORY AND CARDIOVASCULAR SYSTEMS.

Label Precautions:
Keep away from heat, sparks and flame. Avoid contact with eyes, skin and clothing. Avoid breathing dust. Keep container closed. Use with adequate ventilation. Wash thoroughly after handling.

Label First Aid:
If inhaled, remove to fresh air. Get medical attention for any breathing difficulty.

Product Use:
Laboratory Reagent.

Revision Information:
Pure. New 16 section MSDS format, all sections have been revised.

Disclaimer:

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ASI provides the information contained herein in good faith but makes no representation as to its comprehensiveness or accuracy. This document is intended only as a guide to the appropriate precautionary handling of the material by a properly trained person using this product. Individuals receiving the information must exercise their independent judgment in determining its appropriateness for a particular purpose. ASI MAKES NO REPRESENTATIONS OR WARRANTIES, EITHER EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION ANY WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE WITH RESPECT TO THE INFORMATION SET FORTH HEREIN OR THE PRODUCT TO WHICH THE INFORMATION REFERS. ACCORDINGLY, ASI WILL NOT BE RESPONSIBLE FOR DAMAGES RESULTING FROM USE OF OR RELIANCE UPON THIS INFORMATION.

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MSDS Number: **A2052** * * * * * *Effective Date: 08/03/07* * * * * * *Supercedes: 02/16/06*

MSDS *Material Safety Data Sheet*

24 Hour Emergency Telephone: 908-859-2151
CHEMTREC: 1-800-424-9300

National Response in Canada
CANUTEC: 613-996-6666

Outside U.S. And Canada
Chemtrec: 703-527-3887

NOTE: CHEMTREC, CANUTEC and National Response Center emergency numbers to be used only in the event of chemical emergencies involving a spill, leak, fire, exposure or accident involving chemicals.

From: Mallinckrodt Baker, Inc.
222 Red School Lane
Phillipsburg, NJ 08865

J.T.Baker

All non-emergency questions should be directed to Customer Service (1-800-582-2537) for assistance

ALCONOX®

1. Product Identification

Synonyms: Proprietary blend of sodium linear alkylaryl sulfonate, alcohol sulfate, phosphates, and carbonates.
CAS No.: Not applicable.
Molecular Weight: Not applicable to mixtures.
Chemical Formula: Not applicable to mixtures.
Product Codes: A461

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Alconox® proprietary detergent mixture	N/A	90 - 100%	Yes

3. Hazards Identification

Emergency Overview

CAUTION! MAY BE HARMFUL IF SWALLOWED OR INHALED. MAY CAUSE IRRITATION TO EYES AND RESPIRATORY TRACT.

SAF-T-DATA$^{(tm)}$ Ratings (Provided here for your convenience)

Health Rating: 1 - Slight
Flammability Rating: 0 - None
Reactivity Rating: 0 - None
Contact Rating: 2 - Moderate
Lab Protective Equip: GOGGLES; LAB COAT; PROPER GLOVES
Storage Color Code: Green (General Storage)

Potential Health Effects

Inhalation:
May cause irritation to the respiratory tract. Symptoms may include coughing and shortness of breath.
Ingestion:
May cause irritation to the gastrointestinal tract. Symptoms may include nausea, vomiting and diarrhea.
Skin Contact:
No adverse effects expected.
Eye Contact:
May cause irritation, redness and pain.
Chronic Exposure:
No information found.
Aggravation of Pre-existing Conditions:
No information found.

4. First Aid Measures

Inhalation:
Remove to fresh air. Get medical attention for any breathing difficulty.
Ingestion:
If swallowed, DO NOT INDUCE VOMITING. Give large quantities of water. Never give anything by mouth to an unconscious person. Get medical attention.
Skin Contact:
Wash exposed area with soap and water. Get medical advice if irritation develops.
Eye Contact:
Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

5. Fire Fighting Measures

Fire:
Not expected to be a fire hazard.
Explosion:
No information found.
Fire Extinguishing Media:
Dry chemical, foam, water or carbon dioxide.
Special Information:
In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode.

6. Accidental Release Measures

Ventilate area of leak or spill. Wear appropriate personal protective equipment as specified in Section 8. Spills: Pick up and place in a suitable container for reclamation or disposal, using a method that does not generate dust. When mixed with water, material foams profusely. Small amounts of residue may be flushed to sewer with plenty of water.

7. Handling and Storage

Keep in a tightly closed container, stored in a cool, dry, ventilated area. Protect against physical damage. Moisture may cause material to cake. Containers of this material may be hazardous when empty since they retain product residues (dust, solids); observe all warnings and precautions listed for the product.

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:
None established.
Ventilation System:
A system of local and/or general exhaust is recommended to keep employee exposures as low as possible. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details.
Personal Respirators (NIOSH Approved):
For conditions of use where exposure to dust or mist is apparent and engineering controls are not feasible, a particulate respirator (NIOSH type N95 or better filters) may be worn. If oil particles (e.g. lubricants, cutting fluids, glycerine, etc.) are present, use a NIOSH type R or P filter. For emergencies or instances where the exposure levels are not known, use a full-face positive-pressure, air-supplied respirator. WARNING: Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.

Skin Protection:
Wear protective gloves and clean body-covering clothing.
Eye Protection:
Use chemical safety goggles. Maintain eye wash fountain and quick-drench facilities in work area.

9. Physical and Chemical Properties

Appearance:
White powder interspersed with cream colored flakes.
Odor:
No information found.
Solubility:
Moderate (1-10%)
Specific Gravity:
No information found.
pH:
No information found.
% Volatiles by volume @ 21C (70F):
0
Boiling Point:
No information found.
Melting Point:
No information found.
Vapor Density (Air=1):
No information found.
Vapor Pressure (mm Hg):
No information found.
Evaporation Rate (BuAc=1):
No information found.

10. Stability and Reactivity

Stability:
Stable under ordinary conditions of use and storage.
Hazardous Decomposition Products:
Carbon dioxide and carbon monoxide may form when heated to decomposition.
Hazardous Polymerization:
Will not occur.
Incompatibilities:
No information found.
Conditions to Avoid:
No information found.

11. Toxicological Information

No LD50/LC50 information found relating to normal routes of occupational exposure.

--------\Cancer Lists\--

Ingredient	---NTP Carcinogen--- Known	---NTP Carcinogen--- Anticipated	IARC Category
Alconox® proprietary detergent mixture	No	No	None

12. Ecological Information

Environmental Fate:
This product is biodegradable.
Environmental Toxicity:
No information found.

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be managed in an appropriate and approved waste disposal facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

14. Transport Information

Not regulated.

15. Regulatory Information

--------\Chemical Inventory Status - Part 1\---------------------------------

Ingredient	TSCA	EC	Japan	Australia
Alconox® proprietary detergent mixture	Yes	No	No	No

--------\Chemical Inventory Status - Part 2\---------------------------------

Ingredient	Korea	--Canada-- DSL	--Canada-- NDSL	Phil.

Alconox® proprietary detergent mixture	No	No	Yes	No

--------\Federal, State & International Regulations - Part 1\----------------

Ingredient	-SARA 302- RQ	TPQ	------SARA 313------ List	Chemical Catg.
Alconox® proprietary detergent mixture	No	No	No	No

--------\Federal, State & International Regulations - Part 2\----------------

Ingredient	CERCLA	-RCRA- 261.33	-TSCA- 8(d)
Alconox® proprietary detergent mixture	No	No	No

Chemical Weapons Convention: No TSCA 12(b): No CDTA: No
SARA 311/312: Acute: Yes Chronic: No Fire: No Pressure: No
Reactivity: No (Pure / Solid)

Australian Hazchem Code: None allocated.
Poison Schedule: None allocated.
WHMIS:
This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

16. Other Information

NFPA Ratings: Health: **0** Flammability: **0** Reactivity: **0**
Label Hazard Warning:
CAUTION! MAY BE HARMFUL IF SWALLOWED OR INHALED. MAY CAUSE IRRITATION TO EYES AND RESPIRATORY TRACT.
Label Precautions:
Avoid contact with eyes.
Keep container closed.
Use with adequate ventilation.
Avoid breathing dust.
Wash thoroughly after handling.
Label First Aid:
If swallowed, DO NOT INDUCE VOMITING. Give large quantities of water. Never give anything by mouth to an unconscious person. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. In case of eye contact, immediately flush eyes with plenty of water for at least 15 minutes. In all cases, get medical attention.
Product Use:
Laboratory Reagent.
Revision Information:

MSDS Section(s) changed since last revision of document include: 3.

Disclaimer:

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Prepared by: Environmental Health & Safety
Phone Number: (314) 654-1600 (U.S.A.)

SINCLAIR
MATERIAL SAFETY DATA SHEET
SINCLAIR DIESEL MSDS No. 58

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Trade Name (Used on Label):	Diesel
Description:	Diesel
Synonyms:	Diesel, Distillate, Cycle Oil, Fuel Oil, Diesels Cycle Oil, Furnace Oil
Chemical Family:	Liquid Hydrocarbons

EMERGENCY TELEPHONE: CHEMTREC - (800) 424-9300 or (703) 527-3887 (collect)

SUPPLIER:
Sinclair Oil Corporation
P. O. Box 30825
Salt Lake City, Utah 84130

TELEPHONE: (888) 340-3466

FAX: (801) 524-2740

2. COMPOSITION, INFORMATION ON INGREDIENTS

CAS Registry Number:
#1 Diesel 8008-20-6
#2 Diesel 68476-34-6

COMPOSITION COMMENTS:

	Typical wt.%	CAS Registry #
#1 Diesel		
Toluene	0-0.5	108-88-3
Naphthalene	0-0.5	91-20-3
#2 Diesel		
Toluene	0-0.5	108-88-3
Naphthalene	0-0.5	91-20-3

EXPOSURE GUIDELINES:

	OSHA		ACGIH			
COMPONENTS	TWA	STEL	CEILING	TWA	STEL	UNIT
Toluene	200		300			ppm
Naphthalene	10			10	15	ppm
Petroleum Distillates (Naphtha)	500					ppm

3. HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW:

Colorless, red, blue, or amber liquid with kerosene odor. May cause eye, skin and respiratory tract irritation.

POTENTIAL HEALTH EFFECTS:

Trauma and burns secondary to explosions and fires can result. In enclosed spaces, oxygen may be displaced by vapors or consumed by combustion. Incomplete combustion will produce carbon monoxide and other toxic gases.

INHALATION:

Overexposure may cause weakness, headache, nausea, confusion, blurred vision, drowsiness and other central nervous system effects.

EYE CONTACT:

Contact may cause eye irritation. Naphthalene vapor causes eye irritation.

SKIN CONTACT:

Contact may irritate or burn skin. Absorption through the skin may cause symptoms of intoxication, followed by kidney damage.

INGESTION:

If aspirated (liquid enters lung) following ingestion, severe lung irritation and pulmonary edema (swelling of lung tissue) may occur. Aspiration may also result in central nervous system depression or excitement. Serious permanent lung damage may result. Nausea, vomiting, diarrhea, and abdominal pain may occur following ingestion.

4. FIRST AID MEASURES

Remove all clothing impregnated with material immediately. Consult a physician for major exposures of inhalation or skin contact.

INHALATION:

Remove from further exposure. If unconsciousness occurs, seek immediate medical assistance. If breathing stops, use mouth-to-mouth resuscitation.

EYE CONTACT:

Flush immediately with water for at least 15 minutes minimum. Seek medical attention promptly.

SKIN CONTACT:
Discard contaminated leather articles. Wash contact areas with soap and water. Launder contaminated clothing before reuse.

INGESTION:
DO NOT INDUCE VOMITING. Get medical assistance promptly. (Note to physician: Material if aspirated into the lungs may cause chemical pneumonitis. Treat appropriately.)

5. FIRE FIGHTING MEASURES

Flashpoint and Method:	100° F Minimum	
Flammable Limits:	LEL - 1.3	UEL - 6
Autoignition Temperature:	490° - 545° F	

GENERAL HAZARD:
Incomplete burning can produce carbon monoxide. Vapors will be released above flash point and when mixed with air, can burn or explode in confined space if exposed to sources of ignition.

FIRE FIGHTING INSTRUCTIONS:
Use foam, dry chemical, CO_2, water fog or vaporizing liquid (Halon). Keep personnel removed from and up-wind of fire. Cool adjacent structures and storage drums with water spray. Evacuate area. Prevent runoff from fire control dilution from entering streams or drinking water supply.

FIRE FIGHTING EQUIPMENT:
Use of SCBA in enclosed or confined spaces, or as otherwise needed. Bunker gear.

HAZARDOUS COMBUSTION PRODUCTS:
May produce carbon monoxide.

6. ACCIDENTAL RELEASE MEASURES

LAND SPILL:

Shut off and eliminate all ignition sources. Keep people away. Remove leaking containers to a safe area. Contain and remove by mechanical means. Add sand, earth or other suitable absorbent to spill area than scrape off the ground. Guard against contamination of water supplies. Report spills to appropriate authorities. Dispose of in accordance with Federal, State and Local regulations.

WATER SPILL:

Spill may be removed from water with mechanical dredges or lifts. Report spills to appropriate authorities. Dispose of in accordance with Federal, State and Local regulations.

7. HANDLING AND STORAGE

GENERAL:

Ground and bond all transfer and storage equipment. Drums must be grounded/ bonded/ equipped with self- closing valves, pressure vacuum bungs and flame arrestors. Store away from ignition sources in a cool area. Outside or detached storage is preferred.

When handling use non-sparking tools and equipment. Do not use as a cleaner or solvent, use only as fuel. Do not siphon by mouth.

8. ENGINEERING CONTROLS, RESPIRATORY & PERSONAL PROTECTION

ENGINEERING CONTROLS:

Provide ventilation sufficient to prevent exceeding recommended exposure limit or build-up of explosive concentrations of vapor in air. Use explosion-proof equipment.

PERSONAL PROTECTION:

RESPIRATOR:

Approved respiratory protection must be used when vapors or mist concentrations are unknown or exceed the TLV. Avoid prolonged or repeated breathing of vapor or mists.

PROTECTIVE CLOTHING:

Use full-face shield, chemical goggles, impervious gloves, boots and whole body protection.

9. PHYSICAL AND CHEMICAL PROPERTIES

Vapor Pressure: < 1 PSIA	Vapor Density: >1
Specific Gravity: 0.75 - 0.90	(Air = 1)
Solubility in Water: No	Freezing Point: 0° F
pH: N/A	Appearance: colorless, red, blue or amber
Boiling Point: 550° F	Physical State: Liquid

10. STABILITY AND REACTIVITY

GENERAL:
This product is stable.

INCOMPATIBLE MATERIALS AND CONDITIONS TO AVOID:
Strong acids, alkalies and oxidizers. Avoid heat, sparks, flame and static electricity.

HAZARDOUS DECOMPOSITION:
Incomplete burning can produce carbon monoxideGENERAL:

11. TOXICOLOGICAL INFORMATION

SYSTEMIC:
Petroleum-derived fuels and fuel oils are complex and variable mixtures of hydrocarbons. In general, the more viscous the mixture, the less toxic it will be. At high level exposures, humans experience multiple organ failures, some of which may be due to hypoxia and secondary to the failure of other organ systems. In humans kidney failure has been noted only at high, acute levels of exposures, and appears reversible. Liver enzymes may be transiently elevated. At lower level exposures, most acute health effects are reversible. People can be exposed by inhalation, ingestion and dermal contact. Frequently, people are exposed by combined dermal and inhalation exposure.

ACUTE:
Inhalation: Headaches, confusion, disorientation, blurred vision occur with inhalation. Higher exposures may cause hallucinations, CNS excitation, drowsiness, CNS depression. Seizure and coma occur from very high exposures and death may result from respiratory depression. ECG changes, cardiac arrhythmias, tachycardia, shock and cardiovascular collapse can occur. Pneumonia, pulmonary edema and hemorrhages can occur.

Inhalation of 8000-16000 mg/m3 for 2 to 4 hours was lethal to rats.

Ingestion: Central nervous system, cardiovascular, and respiratory effects have been reported with acute exposures to various hydrocarbon fuels and oils similar to those reported with inhalation. Nausea, vomiting, cramping and diarrhea may occur.

Eye: Conjunctivitis and burning, watery eyes have been reported in acute exposures to various hydrocarbon fuels and oils.

Skin: Mild erythema to full thickness chemical burns have occurred after prolonged exposure to various hydrocarbon fuels and oils.

Chronic:
Chronic dermatitis with acanthosis, inflammation, parakeratosis and hyperkeratosis have occurred with chronic exposures to various hydrocarbon fuels and oils.
Occupational exposures in petroleum refining are considered Group 2A (probably carcinogenic) by IARC.

12. DISPOSAL CONSIDERATIONS

RCRA: Disposal of this product or material contaminated with this product may be regulated by RCRA due to the characteristic of ignitability.

EPA Hazard Class: Acute Hazard/Chronic Hazard/Fire Hazard

Dispose of in accordance with Federal, State, and Local regulations.

13.TRANSPORT INFORMATION

DOT (Department of Transportation):

PROPER SHIPPING NAME:	Combustible Liquid nos (Diesel #1, Diesel #2)
HAZARD CLASS:	Combustible Liquid
IDENTIFICATION NUMBER:	UN 1993 PG III
NAERG96 NUMBER:	128

14. REGULATORYINFORMATION

CERCLA (Comprehensive Environmental Response Compensation, and Liability Act):
Naphthalene and Toluene are hazardous substances under CERCLA and therefore are subject to emergency notification requirements.

SARA TITLE III (Superfund Amendments and Reauthorization Act): Naphthalene and Toluene are subject to SARA Title III, Sections 311 and 312, which require MSDS reporting and hazardous chemical inventory reporting.

Naphthalene and Toluene are also subject to SARA Title III, Section 313, which requires chemical release reporting.

15.OTHER INFORMATION

NFPA 704/HMIS

Health - 0 Flammability - 2 Reactivity - 0

(0=insignificant, 1=slight, 2=moderate, 3=high, 4=extreme)

REVISION SUMMARY:
Complete review of MSDS, December 2002.

THIS PRODUCT MATERIAL SAFETY DATA SHEET PROVIDES HEALTH AND SAFETY INFORMATION. THE PRODUCT SHOULD BE USED IN APPLICATIONS CONSISTENT WITH THIS PRODUCT LITERATURE. FOR ANY OTHER USES, EXPOSURES SHOULD BE EVALUATED SO THAT APPROPRIATE HANDLING PRACTICES AND TRAINING PROGRAMS CAN BE ESTABLISHED TO ENSURE SAFE WORKPLACE OPERATIONS

THIS MATERIAL SAFETY DATA SHEET IS PROVIDED IN GOOD FAITH AND MEETS THE REQUIREMENTS OF THE HAZARDOUS COMMUNICATION PROVISIONS OF SARA TITLE III AND 29CFR1910.1200(g) OF THE OSHA REGULATIONS. THE ABOVE INFORMATION IS BASED ON REVIEW OF AVAILABLE INFORMATION SINCLAIR BELIEVES IS RELIABLE AND IS SUPPLIED FOR INFORMATIONAL PURPOSES ONLY. SINCLAIR DOES NOT GUARANTEE ITS COMPLETENESS OR ACCURACY. SINCE CONDITIONS OF USE ARE OUTSIDE THE CONTROL OF SINCLAIR, SINCLAIR DISCLAIMS ALL WARRANTIES, EXPRESS OR IMPLIED, AND ANY LIABILITY FOR DAMAGE OR INJURY WHICH RESULTS FROM THE USE OF THE ABOVE DATA. NOTHING HEREIN IS INTENDED TO PERMIT INFRINGEMENT OF VALID PATENTS AND LICENSES.

DATE:	**July 2004**
SUPERSEDES:	**July 2003**

MATERIAL SAFETY DATA SHEET
Revision Date: 09/29/2004

SECTION 1 PRODUCT AND COMPANY IDENTIFICATION

PRODUCT: Shell™ Hydraulic Oil 46
MSDS NUMBER: 60170E - 3
PRODUCT CODE(S): 65237, 6523700055

MANUFACTURER ADDRESS:SOPUS Products, P.O. Box 4427, Houston, TX. 77210-4427

TELEPHONE NUMBERS
Spill Information: (877) 242-7400
Health Information: (877) 504-9351
MSDS Assistance Number: (877) 276-7285

SECTION 2 PRODUCT/INGREDIENTS

CAS#	CONCENTRATION	INGREDIENTS
		Hydraulic Oil
Blend	90 - 98.99 %weight	Highly refined petroleum oils
Mixture	1 - 2.99 %weight	Additives

SECTION 3 HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW
Appearance & Odor: Amber, clear liquid. Mild odor.
Health Hazards: No known immediate health hazards. High-pressure injection under the skin may cause serious damage.
Physical Hazards: No known physical hazards.
NFPA Rating (Health, Fire, Reactivity): 0, 1, 0
Hazard Rating:Least - 0 Slight - 1 Moderate - 2 High - 3 Extreme - 4

Inhalation:
Inhalation of vapors (generated at high temperatures only) or oil mist may cause mild irritation of the nose, throat, and respiratory tract.

Eye Irritation:
Lubricating oils are generally considered no more than minimally irritating to the eyes.

Skin Contact:
May cause slight irritation of the skin. If irritation occurs, a temporary burning sensation and minor redness and/or swelling may result. Release of the material during high-pressure applications may result in injection under the skin causing possible extensive tissue damage which is difficult to heal. Other adverse effects not expected from brief skin contact.

Ingestion:
Lubricating oils are generally no more than slightly toxic if swallowed.

Signs and Symptoms:
Irritation as noted above. Local necrosis is evidenced by delayed onset of pain and tissue damage a few hours following injection.

Aggravated Medical Conditions:
Pre-existing eye, skin and respiratory disorders may be aggravated by exposure to this product.

For additional health information, refer to section 11.

SECTION 4 FIRST AID MEASURES

Inhalation:
If the victim has difficulty breathing or tightness of the chest, is dizzy, vomiting or unresponsive, give 100% oxygen with rescue breathing or CPR as required and transport to the nearest medical facility.

Skin:
Remove contaminated clothing and shoes and wipe excess from skin. Flush skin with water, then wash with soap and water. If irritation occurs, get medical attention. Do not reuse clothing until cleaned. If material is injected under the skin, transport to the nearest medical facility for additional treatment. If redness, swelling, pain and/or blisters occur, transport to the nearest medical facility for additional treatment.

Eye:
Flush with water. If irritation occurs, get medical attention.

Ingestion:
Do not induce vomiting. In general, no treatment is necessary unless large quantities of product are ingested. However, get medical attention. Have victim rinse mouth out with water, then drink sips of water to remove taste from mouth. If vomiting occurs spontaneously, keep head below hips to prevent aspiration.

Note to Physician:
In general, emesis induction is unnecessary in high viscosity, low volatility products such as oils and greases.

SECTION 5 FIRE FIGHTING MEASURES

Flash Point [Method]: 400 °F -440 °F/204.44 °C -226.67 °C [Cleveland Open Cup]

Extinguishing Media:
Material will float and can be re-ignited on surface of water.

SECTION 6 ACCIDENTAL RELEASE MEASURES

Protective Measures:
May burn although not readily ignitable.

Wear appropriate personal protective equipment when cleaning up spills. Refer to Section 8.

Spill Management:
FOR LARGE SPILLS: Remove with vacuum truck or pump to storage/salvage vessels.

FOR SMALL SPILLS: Soak up residue with an absorbent such as clay, sand or other suitable material. Place in non-leaking container and seal tightly for proper disposal.

Reporting:
CERCLA: Product is covered by EPA's Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) petroleum exclusion. Releases to air, land, or water are not reportable under CERCLA (Superfund).

CWA: This product is an oil as defined under Section 311 of EPA's Clean Water Act (CWA). Spills into or leading to surface waters that cause a sheen must be reported to the National Response Center, 1-800-424-8802.

SECTION 7 HANDLING AND STORAGE

Precautionary Measures:
Wash with soap and water before eating, drinking, smoking, applying cosmetics, or using toilet. Launder contaminated clothing before reuse. Properly dispose of contaminated leather articles such as shoes or belts that cannot be decontaminated. Avoid heat, open flames, including pilot lights, and strong oxidizing agents. Use explosion-proof ventilation to prevent vapor accumulation. Ground all handling equipment to prevent sparking.

Storage:
Do not store in open or unlabeled containers. Store in a cool, dry place with adequate ventilation. Keep away from open flames and high temperatures.

Container Warnings:
Keep containers closed when not in use. Containers, even those that have been emptied, can contain explosive vapors. Do not cut, drill, grind, weld or perform similar operations on or near containers.

SECTION 8 EXPOSURE CONTROLS/PERSONAL PROTECTION

Oil mist, mineral	ACGIH TLV	TWA: 5 mg/m3	STEL: 10 mg/m3
Oil mist, mineral	OSHA PEL	TWA: 5 mg/m3	

EXPOSURE CONTROLS

Provide adequate ventilation to control airborne concentrations below the exposure guidelines/limits.

PERSONAL PROTECTION
Personal protective equipment (PPE) selections vary based on potential exposure conditions such as handling practices, concentration and ventilation. Information on the selection of eye, skin and respiratory protection for use with this material is provided below.

Eye Protection:
Chemical Goggles, or Safety Glasses

Skin Protection:
Use protective clothing which is chemically resistant to this material. Selection of protective clothing depends on potential exposure conditions and may include gloves, boots, suits and other items. The selection(s) should take into account such factors as job task, type of exposure and durability requirements.

Published literature, test data and/or glove and clothing manufacturers indicate the best protection is provided by:
Neoprene, or Nitrile Rubber

Respiratory Protection:
If engineering controls do not maintain airborne concentrations to a level which is adequate to protect worker health, an approved respirator must be worn. Respirator selection, use and maintenance should be in accordance with the requirements of the OSHA Respiratory Protection Standard, 29 CFR 1910.134.

Types of respirator(s) to be considered in the selection process include:
For Mist: Air Purifying, R or P style NIOSH approved respirator.
For Vapors: Air Purifying, R or P style prefilter & organic cartridge, NIOSH approved respirator. Self-contained breathing apparatus for use in environments with unknown concentrations or emergency situations.

SECTION 9 PHYSICAL AND CHEMICAL PROPERTIES

Appearance & Odor: Amber, clear liquid. Mild odor.
Substance Chemical Family: Lubricants
API Gravity: 30 - 32.3

Appearance: Amber, clear liquid.

Flash Point: 400 °F - 440 °F [Cleveland Open Cup]

Pour Point: -10 °F - 0 °F

Specific Gravity: 0.8856

Viscosity: 30 cSt - 100 cSt @ 40 °C

SECTION 10 REACTIVITY AND STABILITY

Stability:
Material is stable under normal conditions.

Conditions to Avoid:
Avoid heat and open flames.

Materials to Avoid:
Avoid contact with strong oxidizing agents.

Hazardous Decomposition Products:
Thermal decomposition products are highly dependent on combustion conditions. A complex mixture of airborne solids, liquids and gases will evolve when this material undergoes pyrolysis or combustion. Aldehydes, Carbon Monoxide, Carbon Dioxide, Ketones, Methacrylate monomers and other unidentified organic compounds may be formed upon combustion.

SECTION 11 TOXICOLOGICAL INFORMATION

Acute Toxicity
  Dermal LD50 >5.0 g/kg(Rabbit) OSHA: Non-Toxic Based on components(s)
  Oral LD50 >5.0 g/kg(Rat) OSHA: Non-Toxic Based on components(s)
Carcinogenicity Classification
Hydraulic Oil
  NTP: No IARC: Not Reviewed ACGIH: No OSHA: No

SECTION 12 ECOLOGICAL INFORMATION

Environmental Impact Summary:
There is no ecological data available for this product. However, this product is an oil. It is persistent and does not readily biodegrade. However, it does not bioaccumulate.

SECTION 13 DISPOSAL CONSIDERATIONS

RCRA Information:

Under RCRA, it is the responsibility of the user of the material to determine, at the time of the disposal, whether the material meets RCRA criteria for hazardous waste. This is because material uses, transformations, mixtures, processes, etc. may affect the classification. Refer to the latest EPA, state and local regulations regarding proper disposal.

SECTION 14 TRANSPORT INFORMATION

US Department of Transportation Classification
This material is not subject to DOT regulations under 49 CFR Parts 171-180.

Oil: This product is an oil under 49CFR (DOT) Part 130. If shipped by rail or highway in a tank with a capacity of 3500 gallons or more, it is subject to these requirements. Mixtures or solutions containing 10% or more of this product may also be subject to this rule.

International Air Transport Association
Not regulated under IATA rules.

International Maritime Organization Classification
Not regulated under International Maritime Organization rules.

SECTION 15 REGULATORY INFORMATION

FEDERAL REGULATORY STATUS

OSHA Classification:
Product is hazardous according to the OSHA Hazard Communication Standard, 29 CFR 1910.1200, because it carries the occupational exposure limit for mineral oil mist.

Ozone Depleting Substances (40 CFR 82 Clean Air Act):
This material does not contain nor was it directly manufactured with any Class I or Class II ozone depleting substances.

Superfund Amendment & Reauthorization Act (SARA) Title III:

There are no components in this product on the SARA 302 list.

SARA Hazard Categories (311/312):
Immediate Health:NO Delayed Health:NO Fire:NO Pressure:NO
Reactivity:NO

SARA Toxic Release Inventory (TRI) (313):
There are no components in this product on the SARA 313 list.

Toxic Substances Control Act (TSCA) Status:
All component(s) of this material is(are) listed on the EPA/TSCA Inventory of Chemical Substances.

Other Chemical Inventories:
Component(s) of this material is (are) listed on the Australian AICS, Canadian DSL, Chinese Inventory, European EINECS, Korean Inventory, Philippines PICCS,

State Regulation
The following chemicals are specifically listed by individual states; other product specific health and safety data in other sections of the MSDS may also be applicable for state requirements. For details on your regulatory requirements you should contact the appropriate agency in your state.

SECTION 16 OTHER INFORMATION

Revision#: 3
Revision Date: 09/29/2004
Revisions since last change (discussion): This Material Safety Data Sheet (MSDS) has been reviewed to fully comply with the guidance contained in the ANSI MSDS standard (ANSI Z400.1-1998). We encourage you to take the opportunity to read the MSDS and review the information contained therein.

SECTION 17 LABEL INFORMATION

READ AND UNDERSTAND MATERIAL SAFETY DATA SHEET BEFORE HANDLING OR DISPOSING OF PRODUCT. THIS LABEL COMPLIES WITH THE REQUIREMENTS OF THE OSHA HAZARD COMMUNICATION STANDARD (29 CFR 1910.1200) FOR USE IN THE WORKPLACE. THIS LABEL IS NOT INTENDED TO BE USED WITH PACKAGING INTENDED FOR SALE TO CONSUMERS AND MAY NOT CONFORM WITH THE REQUIREMENTS OF THE CONSUMER PRODUCT SAFETY ACT OR OTHER RELATED REGULATORY REQUIREMENTS.

PRODUCT CODE(S): 65237, 6523700055

Shell™ Hydraulic Oil 46

ATTENTION!

PROLONGED OR REPEATED SKIN CONTACT MAY CAUSE OIL ACNE OR DERMATITIS.
HIGH-PRESSURE INJECTION UNDER SKIN MAY CAUSE SERIOUS DAMAGE.

Precautionary Measures:
Avoid prolonged or repeated contact with eyes, skin and clothing. Avoid breathing of vapors, fumes, or mist. Use only with adequate ventilation. Wash thoroughly after handling.

FIRST AID

Inhalation: If the victim has difficulty breathing or tightness of the chest, is dizzy, vomiting or unresponsive, give 100% oxygen with rescue breathing or CPR as required and transport to the nearest medical facility.
Skin Contact: Remove contaminated clothing and shoes and wipe excess from skin. Flush skin with water, then wash with soap and water. If irritation occurs, get medical attention. Do not reuse clothing until cleaned. If material is injected under the skin, transport to the nearest medical facility for additional treatment. If redness, swelling, pain and/or blisters occur, transport to the nearest medical facility for additional treatment.
Eye Contact: Flush with water. If irritation occurs, get medical attention.
Ingestion: Do not induce vomiting. In general, no treatment is necessary unless large quantities of product are ingested. However, get medical attention. If vomiting occurs spontaneously, keep head below hips to prevent aspiration. Have victim rinse mouth out with water, then drink sips of water to remove taste from mouth.

FIRE

In case of fire, Material will float and can be re-ignited on surface of water.

SPILL OR LEAK
Dike and contain spill.

FOR LARGE SPILLS: Remove with vacuum truck or pump to storage/salvage vessels.

FOR SMALL SPILLS: Soak up residue with an absorbent such as clay, sand or other suitable material. Place in non-leaking container and seal tightly for proper disposal.

CONTAINS: Highly refined petroleum oils, Blend; Additives, Mixture

NFPA Rating (Health, Fire, Reactivity): 0, 1, 0

TRANSPORTATION
US Department of Transportation Classification
This material is not subject to DOT regulations under 49 CFR Parts 171-180.

Oil: This product is an oil under 49CFR (DOT) Part 130. If shipped by rail or highway in a tank with a capacity of 3500 gallons or more, it is subject to these requirements. Mixtures or solutions containing 10% or more of this product may also be subject to this rule.

CAUTION: Misuse of empty containers can be hazardous. Empty containers can be hazardous if used to store toxic, flammable, or reactive materials. Cutting or welding of empty containers might cause fire, explosion or toxic fumes from residues. Do not pressurize or expose to open flames or heat. Keep container closed and drum bungs in place.

Name and Address
SOPUS Products
P.O. Box 4427
Houston, TX 77210-4427

ADMINISTRATIVE INFORMATION
MANUFACTURER ADDRESS: SOPUS Products, P.O. Box 4427, Houston, TX. 77210-4427
Company Product Stewardship & Regulatory Compliance Contact: Timothy W Childs
Phone Number: (713) 241-1524

THE INFORMATION CONTAINED IN THIS DATA SHEET IS BASED ON THE DATA AVAILABLE TO US AT THIS TIME, AND IS BELIEVED TO BE ACCURATE BASED UPON THAT : IT IS PROVIDED INDEPENDENTLY OF ANY SALE OF THE PRODUCT, FOR PURPOSE OF HAZARD COMMUNICATION. IT IS NOT INTENDED TO CONSTITUTE PRODUCT PERFORMANCE INFORMATION, AND NO EXPRESS OR IMPLIED WARRANTY OF ANY KIND IS MADE WITH RESPECT TO THE PRODUCT, UNDERLYING DATA OR THE INFORMATION CONTAINED HEREIN. YOU ARE URGED TO OBTAIN DATA SHEETS FOR ALL PRODUCTS YOU BUY, PROCESS, USE OR DISTRIBUTE, AND ARE ENCOURAGED TO ADVISE THOSE WHO MAY COME IN CONTACT WITH SUCH PRODUCTS OF THE INFORMATION CONTAINED HEREIN.

TO DETERMINE THE APPLICABILITY OR EFFECT OF ANY LAW OR REGULATION WITH RESPECT TO THE PRODUCT, YOU SHOULD CONSULT WITH YOUR LEGAL ADVISOR OR THE APPROPRIATE GOVERNMENT AGENCY. WE WILL NOT PROVIDE ADVICE ON SUCH MATTERS, OR BE RESPONSIBLE FOR ANY INJURY FROM THE USE OF THE PRODUCT DESCRIBED HEREIN. THE UNDERLYING DATA, AND THE INFORMATION PROVIDED HEREIN AS A RESULT OF THAT DATA, IS THE PROPERTY OF SOPUS PRODUCTS AND IS NOT TO BE THE SUBJECT OF SALE OR EXCHANGE WITHOUT THE EXPRESS WRITTEN CONSENT OF SOPUS PRODUCTS.

43309-11719-100R-09/29/2004

BOC GASES

MATERIAL SAFETY DATA SHEET

PRODUCT NAME: ISOBUTYLENE

1. Chemical Product and Company Identification

BOC Gases,
Division of
The BOC Group, Inc.
575 Mountain Avenue
Murray Hill, NJ 07974

TELEPHONE NUMBER: (908) 464-8100
24-HOUR EMERGENCY TELEPHONE NUMBER:
CHEMTREC (800) 424-9300

BOC Gases
Division of
BOC Canada Limited
5975 Falbourne Street, Unit 2
Mississauga, Ontario L5R 3W6

TELEPHONE NUMBER: (905) 501-1700
24-HOUR EMERGENCY TELEPHONE NUMBER:
(905) 501-0802
EMERGENCY RESPONSE PLAN NO: 20101

PRODUCT NAME: ISOBUTYLENE
CHEMICAL NAME: Isobutylene
COMMON NAMES/SYNONYMS: 2-Methylpropene, Isobutene
TDG (Canada) CLASSIFICATION: 2.1
WHMIS CLASSIFICATION: A, B1, D2B

PREPARED BY: Loss Control (908)464-8100/(905)501-1700
PREPARATION DATE: 6/1/95
REVIEW DATES: 6/7/96

2. Composition, Information on Ingredients

INGREDIENT	% VOLUME	PEL-OSHA[1]	TLV-ACGIH[2]	LD$_{50}$ or LC$_{50}$ Route/Species
Isobutylene FORMULA: C4H8 CAS: 115-11-7 RTECS #: UD0890000	99.0 to 99.8	Simple Asphyxiant	Simple Asphyxiant	LC$_{50}$ 620 mg/m^3/3H (rat)

[1] As stated in 29 CFR 1910, Subpart Z (revised July 1, 1993)

[2] As stated in the ACGIH 1994-95 Threshold Limit Values for Chemical Substances and Physical Agents

3. Hazards Identification

EMERGENCY OVERVIEW

This product does not contain oxygen and may cause asphyxia if released in a confined area. Simple hydrocarbons can cause irritation and central nervous system depression at high concentrations. flammable.

ROUTE OF ENTRY:

Skin Contact	Skin Absorption	Eye Contact	Inhalation	Ingestion
Yes	No	Yes	Yes	No

HEALTH EFFECTS:

Exposure Limits No	Irritant Yes	Sensitization No
Teratogen No	Reproductive Hazard No	Mutagen No
Synergistic Effects None Reported		

Carcinogenicity: -- NTP: No IARC: No OSHA: No

EYE EFFECTS:
Irritation may occur.

SKIN EFFECTS:
None anticipated as product is a gas at room temperature.

INGESTION EFFECTS:
Ingestion is unlikely.

INHALATION EFFECTS:
Product is relatively nontoxic. Simple hydrocarbons can irritate the eyes, mucous membranes and respiratory system at high concentrations.

Inhalation of high concentrations may cause dizziness, disorientation, incoordination, narcosis, nausea or narcotic effects.

This product may displace oxygen if released in a confined space. Maintain oxygen levels above 19.5% at sea level to prevent asphyxiation.

Effects of oxygen deficiency resulting from simple asphyxiants may include: rapid breathing, diminished mental alertness, impaired muscular coordination, faulty judgement, depression of all sensations, emotional instability, and fatigue. As asphyxiation progresses, nausea, vomiting, prostration, and loss of consciousness may result, eventually leading to convulsions, coma, and death.

Oxygen deficiency during pregnancy has produced developmental abnormalities in humans and experimental animals.

NFPA HAZARD CODES	**HMIS HAZARD CODES**	**RATINGS SYSTEM**
Health: 1	Health: 1	0 = No Hazard
Flammability: 4	Flammability: 4	1 = Slight Hazard
Reactivity: 0	Reactivity: 0	2 = Moderate Hazard
		3 = Serious Hazard
		4 = Severe Hazard

4. First Aid Measures

EYES:
Never introduce oil or ointment into the eyes without medical advice! If pain is present, refer the victim to an ophthalmologist for further treatment and follow up.

SKIN:

Remove contaminated clothing and wash affected area with soap and water. If irritation persists, seek medical attention.

INGESTION:
Not normally required. Seek immediate medical attention.

INHALATION:
PROMPT MEDICAL ATTENTION IS MANDATORY IN ALL CASES OF OVEREXPOSURE TO PRODUCT. RESCUE PERSONNEL SHOULD BE EQUIPPED WITH SELF-CONTAINED BREATHING APPARATUS. Conscious persons should be assisted to an uncontaminated area and inhale fresh air. Quick removal from the contaminated area is most important. Unconscious persons should be moved to an uncontaminated area, given assisted (artificial) respiration and supplemental oxygen. Further treatment should be symptomatic and supportive.

5. Fire Fighting Measures

Conditions of Flammability: Flammable liquid and vapor		
Flash point: -105 °F (-76 °C)	Method: Closed Cup	Autoignition Temperature: 869 °F (465 °C)
LEL(%): 1.8	UEL(%): 9.6	
Hazardous combustion products: Carbon monoxide, Carbon dioxide		
Sensitivity to mechanical shock: None		
Sensitivity to static discharge: Not Available		

FIRE AND EXPLOSION HAZARDS:
Isobutylene is heavier than air and may travel a considerable distance to an ignition source. Isobutylene is a flammable gas! Keep away from open flame and other sources of ignition. Do not allow smoking in storage areas or when handling.

EXTINGUISHING MEDIA:
Water, carbon dioxide, dry chemical.

FIRE FIGHTING INSTRUCTIONS:
If possible, stop the flow of gas with a remote valve. Use water spray to cool fire exposed containers. If fire is extinguished and flow of gas is continued, increase ventilation to prevent a build up of a flammable/ explosive atmosphere. Extinguish sources of ignition.

Be cautious of a Boiling Liquid Evaporating Vapor Explosion, BLEVE, if flame is impinging on surrounding containers. Direct 500 GPM water stream onto containers above the liquid level with remote monitors. Limit the number of personnel in proximity to the fire. Evacuate surrounding areas to at least 3000 feet in all directions.

6. Accidental Release Measures

Evacuate all personnel from affected area. Use appropriate protective equipment. Increase ventilation to prevent build up of a flammable/explosive atmosphere. Extinguish all sources of ignition! If leak is in user's equipment, be certain to purge piping with inert gas prior to attempting repairs. If leak is in container or container valve, contact the appropriate emergency telephone number listed in Section 1 or call your closest BOC location

7. Handling and Storage

Earth bond and ground all lines and equipment associated with the product system. Electrical equipment should be non-sparking and explosion proof.

Use only in well-ventilated areas. Valve protection caps must remain in place unless container is secured with valve outlet piped to use point. Do not drag, slide or roll cylinders. Use a suitable hand truck for cylinder movement. Use a pressure regulator when connecting cylinder to lower pressure (<250 psig) piping or systems. Do not heat cylinder by any means to increase the discharge rate of product from the cylinder. Use a check valve or trap in the discharge line to prevent hazardous back flow into the cylinder.

Protect cylinders from physical damage. Store in cool, dry, well-ventilated area away from heavily trafficked areas and emergency exits. Do not allow the temperature where cylinders are stored to exceed 130°F (54°C). Cylinders should be stored upright and firmly secured to prevent falling or being knocked over. Full and empty cylinders should be segregated. Use a "first in-first out" inventory system to prevent full cylinders from being stored for excessive periods of time.

Post "No Smoking" signs in storage or use areas.

For additional recommendations consult Compressed Gas Association Pamphlet P-1.

Never carry a compressed gas cylinder or a container of a gas in cryogenic liquid form in an enclosed space such as a car trunk, van or station wagon. A leak can result in a fire, explosion, asphyxiation or a toxic exposure.

8. Exposure Controls, Personal Protection

EXPOSURE LIMITS[1]:

INGREDIENT	% VOLUME	PEL-OSHA[2]	TLV-ACGIH[3]	LD_{50} or LC_{50} Route/Species
Isobuylene FORMULA: C4H8 CAS: 115-11-7 RTECS #: UD0890000	99.0 to 99.8	Simple Asphyxiant	Simple Asphyxiant	LC_{50} 620 mg/m^3/3H (rat)

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[1] Refer to individual state of provincial regulations, as applicable, for limits which may be more stringent than those listed here.

[2] As stated in 29 CFR 1910, Subpart Z (revised July 1, 1993)

[3] As stated in the ACGIH 1994-1995 Threshold Limit Values for Chemical Substances and Physical Agents.

ENGINEERING CONTROLS:
Use local exhaust to prevent accumulation. Use general ventilation to prevent build up of flammable concentrations. May use hood with forced ventilation when handling small quantities. If product is handled routinely where the potential for leaks exists, all electrical equipment must be rated for use in potentially flammable atmospheres. Consult the National Electrical Code for details.

EYE/FACE PROTECTION:
Safety goggles or glasses.

SKIN PROTECTION:
Protective gloves made of plastic or rubber.

RESPIRATORY PROTECTION:
Positive pressure air line with full-face mask and escape bottle or self-contained breathing apparatus should be available for emergency use.

OTHER/GENERAL PROTECTION:
Safety shoes, safety shower, eyewash.

9. Physical and Chemical Properties

PARAMETER	VALUE	UNITS
Physical state (gas, liquid, solid)	: Gas	
Vapor pressure at 70°F	: 39	psia
Vapor density at STP (Air = 1)	: 1.98	
Evaporation point	: Not Available	
Boiling point	: 19.5	°F
	: -6.9	°C
Freezing point	: -220.6	°F
	: -140.3	°C
pH	: Not Available	
Specific gravity	: Not Available	
Oil/water partition coefficient	: Not Available	
Solubility (H20)	: Insoluble	
Odor threshold	: Not Available	
Odor and appearance	: A colorless gas with an unpleasant odor similar to that of burning coal.	

10. Stability and Reactivity

STABILITY:
Stable

CONDITIONS TO AVOID (STABILITY):
None

INCOMPATIBLE MATERIALS:
Oxidizers

DISCLAIMER OF EXPRESSED AND IMPLIED WARRANTIES:

AIR PRODUCTS

MATERIAL SAFETY DATA SHEET

SECTION 1. PRODUCT IDENTIFICATION

PRODUCT NAME:	**Nitrogen, compressed**
CHEMICAL NAME:	Nitrogen
FORMULA:	N_2
SYNONYMS:	Nitrogen gas, Gaseous Nitrogen, GAN
MANUFACTURER:	**Air Products and Chemicals, Inc.** 7201 Hamilton Boulevard Allentown, PA 18195 - 1501
PRODUCT INFORMATION:	1-800-752-1597

MSDS NUMBER: 1011 **REVISION:** 5

REVISION DATE: March 1994 **REVIEW DATE:** August 1997

SECTION 2. COMPOSITION/INFORMATION ON INGREDIENTS

Nitrogen is sold as pure product > 99%.

CAS NUMBER: 7727-37-9

EXPOSURE LIMITS:

OSHA: Not established **ACGIH:** Simple asphyxiant **NIOSH:** Not established

SECTION 3. HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW

Nitrogen is a nontoxic, odorless, colorless, nonflammable compressed gas stored in cylinders at high pressure. It can cause rapid suffocation when concentrations are sufficient to reduce oxygen levels below 19.5%. Self Contained Breathing Apparatus (SCBA) may be required.

EMERGENCY TELEPHONE NUMBERS

800-523-9374 Continental U.S. , Canada and Puerto Rico
610-481-7711 other locations

POTENTIAL HEALTH EFFECTS INFORMATION:

INHALATION: Simple asphyxiant. Nitrogen is nontoxic, but may cause suffocation by displacing the oxygen in air. Lack of sufficient oxygen can cause serious injury or death.

EYE CONTACT: No adverse effect.

SKIN CONTACT: No adverse effect.

EXPOSURE INFORMATION:

ROUTE OF ENTRY: Inhalation

TARGET ORGANS: None

EFFECT: Asphyxiation (suffocation)

SYMPTOMS: Exposure to an oxygen deficient atmosphere (<19.5%) may cause dizziness, drowsiness, nausea, vomiting, excess salivation, diminished mental alertness, loss of consciousness and death. Exposure to atmospheres containing 8-10% or less oxygen will bring about unconsciousness without warning and so quickly that the individuals cannot help themselves.

MEDICAL CONDITIONS AGGRAVATED BY OVEREXPOSURE: None

CARCINOGENIC POTENTIAL: Nitrogen is not listed as a carcinogen or potential carcinogen by NTP, IARC, or OSHA .

SECTION 4. FIRST AID

INHALATION: Persons suffering from lack of oxygen should be moved to fresh air. If victim is not breathing, administer artificial respiration. If breathing is difficult, administer oxygen. Obtain prompt medical attention.

EYE CONTACT: Not applicable.

SKIN CONTACT: Not applicable.

SECTION 5. FIRE AND EXPLOSION

FLASH POINT:	**AUTOIGNITION:**	**FLAMMABLE LIMITS:**
Not applicable	Nonflammable	Nonflammable

EXTINGUISHING MEDIA: Nitrogen is nonflammable and does not support combustion. Use extinguishing media appropriate for the surrounding fire.

HAZARDOUS COMBUSTION PRODUCTS: None

SPECIAL FIRE FIGHTING INSTRUCTIONS: Nitrogen is a simple asphyxiant. If possible, remove nitrogen cylinders from fire area or cool with water. SCBA may be required by rescue workers.

UNUSUAL FIRE AND EXPLOSION HAZARDS: Upon exposure to intense heat or flame cylinder may vent rapidly and/or rupture violently. Most cylinders are designed to vent contents when exposed to elevated temperatures. Pressure in a container can build up due to heat and it may rupture if pressure relief devices should fail to function.

SECTION 6. ACCIDENTAL RELEASE MEASURES

Evacuate all personnel from affected area. Increase ventilation to release area and monitor oxygen level. Use appropriate protective equipment (SCBA). If leak is from container or its valve, call the Air Products emergency telephone number. If leak is in user's system close cylinder valve and vent pressure before attempting repairs.

SECTION 7. HANDLING AND STORAGE

STORAGE: Cylinders should be stored upright in a well-ventilated, secure area, protected from the weather. Storage area temperatures should not exceed 125 °F (52 °C) and area should be free of combustible materials. Storage should be away from heavily traveled areas and emergency exits. Avoid areas where salt or other corrosive materials are present. Valve protection caps and valve outlet seals should remain on cylinders not connected for use. Separate full from empty cylinders. Avoid excessive inventory and storage time. Use a first-in first-out system. Keep good inventory records.

HANDLING: Do not drag, roll, or slide cylinder. Use a suitable handtruck designed for cylinder movement. Never attempt to lift a cylinder by its cap. Secure cylinders at all times while in use. Use a pressure reducing regulator or separate control valve to safely discharge gas from cylinder. Use a check valve to prevent reverse flow into cylinder. Do not overheat cylinder to increase pressure or discharge rate. If user experiences any difficulty operating cylinder valve, discontinue use and contact supplier. Never insert an object (e.g., wrench, screwdriver, pry bar, etc.) into valve cap openings. Doing so may damage valve causing a leak to occur. Use a special cap wrench or adjustable strap-wrench to remove over-tight or rusted caps.

Nitrogen is compatible with all common materials of construction. Pressure requirements should be considered when selecting materials and designing systems.

SPECIAL REQUIREMENTS: Always store and handle compressed gases in accordance with Compressed Gas Association, Inc. (ph. 703-412-0900) pamphlet CGA P-1, *Safe Handling of Compressed Gases in Containers*. Local regulations may require specific equipment for storage or use.

CAUTION: Users of nitrogen must be aware of the hazards caused by the accumulation of high concentrations, especially in confined spaces. Compliance with OSHA regulations, especially 29 CFR 1910.146 (confined space entry), is essential

SECTION 8. PERSONAL PROTECTION / EXPOSURE CONTROL

ENGINEERING CONTROLS: Provide good ventilation and/or local exhaust to prevent accumulation of high concentrations of gas. Oxygen levels in work area should be monitored to ensure they do not fall below 19.5%.

RESPIRATORY PROTECTION:

GENERAL USE: None required.

EMERGENCY: Use SCBA or positive pressure air line with mask and escape pack in areas where oxygen concentration is less than 19.5%. Air purifying respirators will not provide protection.

OTHER PROTECTIVE EQUIPMENT: Safety glasses. Safety shoes and leather work gloves are recommended when handling cylinders.

SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES

APPEARANCE: Colorless gas

ODOR: Odorless

MOLECULAR WEIGHT: 28.01

BOILING POINT (1 Atm): -320.4 °F (-195.8 °C)

SPECIFIC GRAVITY (Air =1): 0.967

SPECIFIC VOLUME (at 70 °F (21.1 °C) and 1 atm): 13.81 ft^3/lb (0.867m^3/kg)

FREEZING POINT/MELTING POINT: -345.8 °F (-209.9 °C)

VAPOR PRESSURE: Not applicable at 70 °F

GAS DENSITY (at 70 °F (21.1 °C) and 1 atm): 0.072 lb/ft^3 (1.153 kg/m^3)

SOLUBILITY IN WATER (Vol./Vol. at 32°F (0°C)): 0.023

SECTION 10. STABILITY AND REACTIVITY

CHEMICAL STABILITY: Stable

CONDITIONS TO AVOID: None

INCOMPATIBILITY: None

HAZARDOUS DECOMPOSITION PRODUCTS: None

HAZARDOUS POLYMERIZATION: Will not occur.

SECTION 11. TOXICOLOGICAL INFORMATION

Nitrogen is a simple asphyxiant.

SECTION 12. ECOLOGICAL INFORMATION

The atmosphere contains approximately 78% nitrogen. No adverse ecological effects are expected. Nitrogen does not contain any Class I or Class II ozone depleting chemicals. Nitrogen is not listed as a marine pollutant by DOT (49 CFR 171).

SECTION 13. DISPOSAL

UNUSED PRODUCT / EMPTY CONTAINER: Return cylinder and unused product to supplier. Do not attempt to dispose of residual or unused quantities.

DISPOSAL: For emergency disposal, secure the cylinder and slowly discharge gas to the atmosphere in a well ventilated area or outdoors.

SECTION 14. TRANSPORT INFORMATION

DOT HAZARD CLASS: 2.2

DOT SHIPPING LABEL: Nonflammable Gas

DOT SHIPPING NAME: Nitrogen, Compressed

IDENTIFICATION NUMBER: UN1066

REPORTABLE QUANTITY (RQ): None

SPECIAL SHIPPING INFORMATION: Cylinders should be transported in a secure upright position in a well ventilated truck. Never transport in passenger compartment of a vehicle.

Compressed gas cylinders shall not be refilled except by qualified producers of compressed gases. Shipment of a compressed gas cylinder which has not been filled by the owner or with the owner's written consent is a violation of federal law.

SECTION 15. REGULATORY INFORMATION

U.S. FEDERAL REGULATIONS:

ENVIRONMENTAL PROTECTION AGENCY (EPA):

CERCLA: Comprehensive Environmental Response, Compensation, and Liability Act of 1980 requires notification to the National Response Center of a release of quantities of hazardous substances equal to or greater than their reportable quantities (RQ's) in 40 CFR 302.4.

CERCLA Reportable Quantity: None.

SARA TITLE III: Superfund Amendment and Reauthorization Act of 1986

SECTION 302/304: Requires emergency planning on threshold planning quantities (TPQ) and release reporting based on reportable quantities (RQ) of EPA's extremely hazardous substances (40 CFR 355).

Nitrogen is not listed as an extremely hazardous substance.

Threshold Planning Quantity (TPQ): None

SECTIONS 311/312: Require submission of material safety data sheets (MSDSs) and chemical inventory reporting with identification of EPA defined hazard classes. The hazard classes for this product are:

IMMEDIATE HEALTH: No

DELAYED HEALTH: No

PRESSURE: Yes

REACTIVITY: No

FIRE: No

SECTION 313: Requires submission of annual reports of release of toxic chemicals that appear in 40 CFR 372.

Nitrogen does not require reporting under Section 313.

40 CFR Part 68 - Risk Management for Chemical Accident Release Prevention: Requires the development and implementation of risk management programs at facilities that manufacture, use, store, or otherwise handle regulated substances in quantities that exceed specified thresholds.

Nitrogen is not listed as a regulated substance.

TSCA - TOXIC SUBSTANCES CONTROL ACT: Nitrogen is listed on the TSCA inventory.

OSHA - OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION:

29 CFR 1910.119 - Process Safety Management of Highly Hazardous Chemicals: Requires facilities to develop a process safety management program based on Threshold Quantities (TQ) of highly hazardous chemicals.

Nitrogen is not listed in Appendix A as a highly hazardous chemical.

STATE REGULATIONS

CALIFORNIA:

Proposition 65:	This product does NOT contain any listed substances which the State of California requires warning under this statute.
SCAQMD Rule:	VOC = Not applicable

SECTION 16. OTHER INFORMATION

NFPA RATINGS:		HMIS RATINGS:	
HEALTH:	0	HEALTH:	0
FLAMMABILITY:	0	FLAMMABILITY:	0
REACTIVITY:	0	REACTIVITY:	0
SPECIAL:	SA*		

*Compressed Gas Association recommendation to designate simple asphyxiant.

*** Documents with Review Dates August 1997 and Revision Date March 1994 are identical in content and either may be used.*

MATERIAL SAFETY DATA SHEET

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

MATHESON TRI-GAS, INC.
150 Allen Road Suite 302
Basking Ridge, New Jersey 07920
Information: 1-800-416-2505

Emergency Contact:
CHEMTREC 1-800-424-9300
Calls Originating Outside the US:
703-527-3887 (Collect Calls Accepted)

SUBSTANCE: NITROGEN, COMPRESSED GAS

TRADE NAMES/SYNONYMS:
MTG MSDS 67; DIATOMIC NITROGEN; DINITROGEN; NITROGEN; NITROGEN-14; NITROGEN GAS; UN 1066; N2; MAT16625; RTECS QW9700000

CHEMICAL FAMILY: inorganic, gas

CREATION DATE: Jan 24 1989
REVISION DATE: Jan 01 2007

2. COMPOSITION, INFORMATION ON INGREDIENTS

COMPONENT: NITROGEN, COMPRESSED GAS
CAS NUMBER: 7727-37-9
PERCENTAGE: 100

3. HAZARDS IDENTIFICATION

NFPA RATINGS (SCALE 0-4): HEALTH=1 FIRE=0 REACTIVITY=0

EMERGENCY OVERVIEW:
COLOR: colorless
PHYSICAL FORM: gas
ODOR: odorless
MAJOR HEALTH HAZARDS: difficulty breathing
PHYSICAL HAZARDS: Containers may rupture or explode if exposed to heat.

POTENTIAL HEALTH EFFECTS:
INHALATION:
SHORT TERM EXPOSURE: nausea, vomiting, difficulty breathing, headache, drowsiness, dizziness, tingling sensation, loss of coordination, convulsions, coma

LONG TERM EXPOSURE: no information is available
SKIN CONTACT:
SHORT TERM EXPOSURE: no information on significant adverse effects
LONG TERM EXPOSURE: no information on significant adverse effects
EYE CONTACT:
SHORT TERM EXPOSURE: irritation
LONG TERM EXPOSURE: no information on significant adverse effects
INGESTION:
SHORT TERM EXPOSURE: ingestion of a gas is unlikely
LONG TERM EXPOSURE: ingestion of a gas is unlikely

4. FIRST AID MEASURES

INHALATION: If adverse effects occur, remove to uncontaminated area. Give artificial respiration if not breathing. If breathing is difficult, oxygen should be administered by qualified personnel. Get immediate medical attention.

SKIN CONTACT: Wash exposed skin with soap and water.

EYE CONTACT: Flush eyes with plenty of water.

INGESTION: If a large amount is swallowed, get medical attention.

NOTE TO PHYSICIAN: For inhalation, consider oxygen.

5. FIRE FIGHTING MEASURES

FIRE AND EXPLOSION HAZARDS: Negligible fire hazard. Pressurized containers may rupture or explode if exposed to sufficient heat.

EXTINGUISHING MEDIA: carbon dioxide, regular dry chemical

Large fires: Use regular foam or flood with fine water spray.

FIRE FIGHTING: Move container from fire area if it can be done without risk. Cool containers with water spray until well after the fire is out. Stay away from the ends of tanks. Withdraw immediately in case of rising sound from venting safety device or any discoloration of tanks due to fire. For tank, rail car or tank truck, evacuation radius: 800 meters (1/2 mile). Use extinguishing agents appropriate for surrounding fire. Cool containers with water spray until well after the fire is out. Apply water from a protected location or from a safe distance. Do not get water directly on material. Reduce vapors with water spray. Avoid inhalation of material or combustion by-products. Stay upwind and keep out of low areas. Consider downwind evacuation if material is leaking.

6. ACCIDENTAL RELEASE MEASURES

OCCUPATIONAL RELEASE:
Stop leak if possible without personal risk. Keep unnecessary people away, isolate hazard area and deny entry. Stay upwind and keep out of low areas.

7. HANDLING AND STORAGE

STORAGE: Store and handle in accordance with all current regulations and standards. Subject to storage regulations: U.S. OSHA 29 CFR 1910.101. Keep separated from incompatible substances.

8. EXPOSURE CONTROLS, PERSONAL PROTECTION

EXPOSURE LIMITS:
NITROGEN, COMPRESSED GAS:
NITROGEN:
ACGIH (simple asphyxiant)

VENTILATION: Provide local exhaust ventilation system. Ensure compliance with applicable exposure limits.

EYE PROTECTION: Eye protection not required, but recommended.

CLOTHING: Protective clothing is not required.

GLOVES: Protective gloves are not required.

RESPIRATOR: Under conditions of frequent use or heavy exposure, respiratory protection may be needed. Respiratory protection is ranked in order from minimum to maximum. Consider warning properties before use.
For Unknown Concentrations or Immediately Dangerous to Life or Health -
Any supplied-air respirator with full facepiece and operated in a pressure-demand or other positive-pressure mode in combination with a separate escape supply.
Any self-contained breathing apparatus with a full facepiece.

9. PHYSICAL AND CHEMICAL PROPERTIES

PHYSICAL STATE: gas
COLOR: colorless
ODOR: odorless
TASTE: tasteless

MOLECULAR WEIGHT: 28.0134
MOLECULAR FORMULA: N2
BOILING POINT: -321 F (-196 C)
FREEZING POINT: -346 F (-210 C)
VAPOR PRESSURE: 760 mmHg @ -196 C
VAPOR DENSITY (air=1): 0.967
SPECIFIC GRAVITY: Not applicable
DENSITY: 1.2506 g/L
WATER SOLUBILITY: 1.6% @ 20 C
PH: Not applicable
VOLATILITY: 100%
ODOR THRESHOLD: Not available
EVAPORATION RATE: Not applicable
VISCOSITY: 0.01787 cP @ 27 C
COEFFICIENT OF WATER/OIL DISTRIBUTION: Not applicable
SOLVENT SOLUBILITY:
Soluble: liquid ammonia
Slightly Soluble: alcohol

10. STABILITY AND REACTIVITY

REACTIVITY: Stable at normal temperatures and pressure.

CONDITIONS TO AVOID: Protect from physical damage and heat. Containers may rupture or explode if exposed to heat.

INCOMPATIBILITIES: metals, oxidizing materials

HAZARDOUS DECOMPOSITION:
Thermal decomposition products: oxides of nitrogen

POLYMERIZATION: Will not polymerize.

11. TOXICOLOGICAL INFORMATION

Not available

12. ECOLOGICAL INFORMATION

Not available

13. DISPOSAL CONSIDERATIONS

Dispose in accordance with all applicable regulations.

14. TRANSPORT INFORMATION

U.S. DOT 49 CFR 172.101:
PROPER SHIPPING NAME: Nitrogen, compressed
ID NUMBER: UN1066
HAZARD CLASS OR DIVISION: 2.2
LABELING REQUIREMENTS: 2.2

CANADIAN TRANSPORTATION OF DANGEROUS GOODS:
SHIPPING NAME: Nitrogen, compressed
UN NUMBER: UN1066
CLASS: 2.2

15. REGULATORY INFORMATION

U.S. REGULATIONS:
CERCLA SECTIONS 102a/103 HAZARDOUS SUBSTANCES (40 CFR 302.4): Not regulated.

SARA TITLE III SECTION 302 EXTREMELY HAZARDOUS SUBSTANCES (40 CFR 355.30): Not regulated.

SARA TITLE III SECTION 304 EXTREMELY HAZARDOUS SUBSTANCES (40 CFR 355.40): Not regulated.

SARA TITLE III SARA SECTIONS 311/312 HAZARDOUS CATEGORIES (40 CFR 370.21):
ACUTE: Yes
CHRONIC: No
FIRE: No
REACTIVE: No
SUDDEN RELEASE: Yes

SARA TITLE III SECTION 313 (40 CFR 372.65): Not regulated.

OSHA PROCESS SAFETY (29CFR1910.119): Not regulated.

STATE REGULATIONS:
California Proposition 65: Not regulated.

CANADIAN REGULATIONS:

WHMIS CLASSIFICATION: A.

NATIONAL INVENTORY STATUS:
U.S. INVENTORY (TSCA): Listed on inventory.

TSCA 12(b) EXPORT NOTIFICATION: Not listed.

CANADA INVENTORY (DSL/NDSL): Listed on inventory.

16. OTHER INFORMATION

MATHESON TRI-GAS, INC. MAKES NO EXPRESS OR IMPLIED WARRANTIES, GUARANTEES OR REPRESENTATIONS REGARDING THE PRODUCT OR THE INFORMATION HEREIN, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR USE. MATHESON TRI-GAS, INC. SHALL NOT BE LIABLE FOR ANY PERSONAL INJURY, PROPERTY OR OTHER DAMAGES OF ANY NATURE, WHETHER COMPENSATORY, CONSEQUENTIAL, EXEMPLARY, OR OTHERWISE, RESULTING FROM ANY PUBLICATION, USE OR RELIANCE UPON THE INFORMATION HEREIN.

MATERIAL SAFETY DATA SHEET
LIQUOX® Sodium Permanganate

Section 1 Product and Company Identification

PRODUCT NAME: LIQUOX® sodium permanganate, $NaMnO_4$
SYNONYMS: Permanganic acid sodium salt solution

MANUFACTURER'S NAME: CARUS CORPORATION

MANUFACTURER'S ADDRESS:
Carus Chemical Company
1500 Eighth Street
P. O. Box 1500
LaSalle, IL 61301

TRADE NAME: LIQUOX® sodium permanganate

TELEPHONE NUMBER FOR INFORMATION: 815/223-1500

EMERGENCY TELEPHONE NO: 800/435-6856

AFTER HOURS NO. 815/223-1565
5:00 PM-8:00 AM Central Standard Time
Monday-Friday, Weekends and Holidays

CHEMTREC TELEPHONE NO.: 800/424-9300

Section 2 Composition/Information on Ingredients

Material or component	CAS No.	%	Hazard Data	
Sodium Permanganate	10101-50-5	40% - 42%	PEL/C	5 mg Mn per cubic meter of air
			TLV-TWA	0.2 mg Mn per cubic meter of air

Section 3 Hazards Identification

1. Eye Contact
Sodium Permanganate is damaging to eye tissue on contact. It may cause severe burns that result in damage to the eye.

2. Skin Contact
Momentary contact of solution at room temperature may be irritating to the skin, leaving brown stains. Prolonged contact is damaging to the skin.

3. Inhalation
Acute inhalation toxicity data are not available. However, airborne concentrations of sodium permanganate in the form of mist may cause damage to the respiratory tract

4. Ingestion
Sodium permanganate solution, if swallowed, may cause severe burns to mucous membranes of the mouth, throat, esophagus, and stomach.

Section 4 First Aid Measures

1. Eyes
   Immediately flush eyes with large amounts of water for at least 15 minutes holding lids apart to ensure flushing of the entire surface. Do not attempt to neutralize chemically. Seek medical attention immediately. Note to physician: Decomposition products are alkaline.

2. Skin
   Immediately wash contaminated areas with water. Remove contaminated clothing and footwear (Caution: Solution may ignite certain textiles). Wash clothing and decontaminate footwear before reuse. Seek medical attention immediately, if irritation is severe and persistent.

3. Inhalation
   Remove person from contaminated area to fresh air. If breathing has stopped, resuscitate and administer oxygen if readily available. Seek medical attention immediately.

4. Ingestion
   Never give anything by mouth to an unconscious or convulsing person. If person is conscious, give large quantities of water or milk. Seek medical attention immediately.

Section 5 Fire Fighting Measures

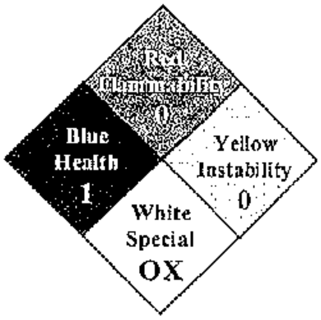
NFPA* HAZARD SIGNAL

Health Hazard (less than 1 hour exposure)	1	=	Materials which under fire conditions would give off irritating combustion products. Materials which on the skin could cause irritation.
Flammability Hazard	0	=	Materials that will not burn.
Reactivity Hazard	0	=	Materials which in themselves are normally stable, even under fire exposure conditions, and which are not reactive with water.
Special Hazard	OX	=	Oxidizer

*National Fire Protection Association 704

FIRST RESPONDERS:

Wear protective gloves, boots, goggles, and respirator.
In case of fire, wear positive pressure breathing apparatus.
Approach incident with caution. Use Emergency Response Guide NAERG 96 (RSPA P5800.7). Guide No. 140.



FLASHPOINT	None
FLAMMABLE OR EXPLOSIVE LIMITS	Lower: Nonflammable Upper: Nonflammable
EXTINGUISHING MEDIA	Use large quantities of water. Water will turn pink to purple, if in contact with sodium permanganate. Dike to contain. Do not use dry chemicals, CO_2 Halon® or foams.
SPECIAL FIREFIGHTING PROCEDURES	If material is involved in fire, flood with water. Cool all affected containers with large quantities of water. Apply water from as far a distance as possible. Wear self-contained breathing apparatus and full protective clothing.
UNUSUAL FIRE AND EXPLOSION HAZARDS	Powerful oxidizing material. May decompose spontaneously if exposed to intense heat (135°C/275°F). May be explosive in contact with certain other chemicals (Section 10). May react violently with finely divided and readily oxidizable substances. Increases burning rate of combustible material. May ignite wood and cloth.

Section 6 Accidental Release Measures

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED
Contain spill by collecting the liquid in a pit or holding behind a dam (sand or soil). Dilute to approximately 6% with water, then reduce with sodium thiosulfate, a bisulfite or ferrous salt solution. The bisulfite or ferrous salt may require some dilute sulfuric acid (10% w/w) to promote reduction. Neutralize with sodium carbonate to neutral pH, if acid was used. Decant or filter and deposit sludge in an approved landfill. Where permitted, the sludge may be drained into sewer with large quantities of water. To clean contaminated floors, flush with abundant quantities of water into sewer, if permitted by federal, state, and local regulations. If not, collect water and treat as above.

PERSONAL PRECAUTIONS
Personnel should wear protective clothing suitable for the task. Remove all ignition sources and incompatible materials before attempting clean-up.

Section 7 Handling and Storage

WORK/HYGIENIC PRACTICES
Wash hands thoroughly with soap and water after handling permanganate solution, and before eating or smoking. Wear proper protective equipment. Remove contaminated clothing.

VENTILATION REQUIREMENTS
Provide sufficient mechanical and/or local exhaust to maintain exposure below the TLV/TWA.

CONDITIONS FOR SAFE STORAGE
Store in accordance with NFPA 430 requirements for Class II oxidizers. Protect containers from physical damage. Store in a cool, dry area in closed containers. Segregate from acids, peroxides, formaldehyde, and all combustible, organic or easily oxidizable materials including antifreeze and hydraulic fluid.

Section 8 Exposure Controls/Personal Protection

RESPIRATORY PROTECTION
In the case where exposure to mist may occur, the use of an approved NIOSH-MSHA mist respirator or an air supplied respirator is advised. Engineering or administrative controls should be implemented to control mist.

EYE
Faceshield, goggles, or safety glasses with side shields should be worn. Provide eye wash in working area.

GLOVES
Rubber or plastic gloves should be worn.

OTHER PROTECTIVE EQUIPMENT
Normal work clothing covering arms and legs, and rubber, or plastic apron should be worn. Caution: If clothing becomes contaminated, wash off immediately. Spontaneous ignition may occur with cloth or paper.

Section 9 Physical and Chemical Properties

APPEARANCE AND ODOR	Dark purple solution, odorless
BOILING POINT, 760 mm Hg	105°C
VAPOR PRESSURE (mm Hg)	760 mm at 105°C
SOLUBILITY IN WATER % BY SOLUTION	Miscible in all proportions with water
PERCENT VOLATILE BY VOLUME	60% (as water)
EVAPORATION RATE	Same as water
MELTING POINT	Not applicable
SPECIFIC GRAVITY	1.36
pH	6-7
OXIDIZING PROPERTIES	Strong oxidizer. May ignite wood and cloth.
EXPLOSIVE PROPERTIES	Explosive in contact with sulfuric acid or peroxides, or readily oxidizable substances.

Section 10 Stability and Reactivity

STABILITY Under normal conditions, the material is stable.

CONDITIONS TO AVOID Contact with incompatible materials or heat (135°C/275°F).

INCOMPATIBLE MATERIALS Contact with acids, peroxides, and all combustible organic or readily oxidizable materials including inorganic oxidizable materials and metal powders. With hydrochloric acid, chlorine gas is liberated.

HAZARDOUS DECOMPOSITION PRODUCT When involved in a fire, sodium permanganate may form corrosive fumes.

CONDITIONS CONTRIBUTING TO HAZARDOUS POLYMERIZATION Material is not known to polymerize.

Section 11 Toxicological Information

SODIUM PERMANGANATE: **Acute oral LD_{50} not known.**

EFFECTS OF OVEREXPOSURE

1. Acute Overexposure
   Irritating to body tissue with which it comes into contact.

2. Chronic Overexposure
   No known cases of chronic poisoning due to permanganates have been reported. Prolonged exposure (usually over many years) to heavy concentrations of manganese oxides in the form of dust and fumes, may lead to chronic manganese poisoning, chiefly involving the central nervous system.

3. Carcinogenicity
   Sodium permanganate has not been classified as a carcinogen by OSHA, NTP, IARC.

4. Medical Conditions Generally Aggravated by Exposure
   Sodium permanganate solution will cause further irritation of tissue, open wounds, burns, or mucous membranes.

   Registry of Toxic Effects of Chemical Substances
   RTECS #SD6650000

Section 12 Ecological Information

Entry to the Environment

Permanganate has a low estimated lifetime in the environment, being readily converted by oxidizable materials to insoluble MnO_2.

Bioconcentration Potential

In non-reducing and non-acidic environments, MnO_2 is insoluble and has a very low bioaccumulative potential.

Aquatic Toxicity

No Data.

Section 13 Disposal Consideration

WASTE DISPOSAL

Sodium permanganate is considered a D001 hazardous (ignitable) waste. For disposal of sodium permanganate solutions, follow procedures in Section 6 and deactivate the permanganate to insoluble manganese dioxide. Dispose of it in a permitted landfill. Contact Carus Chemical Company for additional recommendations.

Section 14 Transport Information

U. S. DEPARTMENT OF TRANSPORTATION INFORMATION:

Proper Shipping Name:	49 CFR172.101	Permanganates, inorganic, aqueous solution, n.o.s. (contains sodium permanganate)
ID Number:	49 CFR172.101	UN 3214
Hazard Class:	49 CFR172.101	Oxidizer
Division:	49 CFR172.101	5.1
Packing Group:	49 CFR172.101	II

Section 15 Regulatory Information

TSCA	Listed in the TSCA Chemical Substance Inventory.
CERCLA	Not listed.
RCRA	Oxidizers such as sodium permanganate solution meet the criteria of ignitable waste. 40 CFR 261.21.

SARA TITLE III Information

Section 302/303	Extremely hazardous substance: Not listed
Section 311/312	Hazard categories: Fire, acute and chronic toxicity
Section 313	LIQUOX® Sodium Permanganate contains 40% manganese compounds as part of chemical infrastructure (manganese compounds CAS Reg. No. N/A) and is subject to the reporting requirements of Section 313 of Title III Superfund Amendments and Reauthorization Act of 1986 and 40 CFR 372.

STATE LISTS

Michigan Critical Materials Register:	Not listed
California Proposition 65:	Not listed
Massachusetts Substance List:	Not listed
Pennsylvania Hazard Substance List:	Not listed

FOREIGN LISTS

Canadian Ingredient Disclosure List	Not listed
Canadian Non-Domestic Substance List	Listed
EINECS	Listed

Section 16 Other Information

C	OSHA Ceiling Exposure Limit
CAS	Chemical Abstract Service
EINECS	Inventory of Existing Chemical Substances (European)
IARC	International Agency for Research on Cancer
TLV-TWA	Threshold Limit Value-Time Weighted Average
MSHA	Mine Safety and Health Administration
NIOSH	National Institute for Occupational Safety and Health
NTP	National Toxicology Program
OSHA	Occupational Safety and Health Administration
PEL	OSHA Permissible Exposure Limit

Kenneth Kroguleski

Kenneth Kroguiski
May 1999

CARUS

Responsible Care®
A Public Commitment

LIQUOX® is trademark of Carus Corporation.

MSDS Number: **S5230** * * * * * *Effective Date:* ***08/02/07*** * * * * * *Supercedes:* ***11/04/04***

24 Hour Emergency Telephone: 908-859-2151
CHEMTREC: 1-800-424-9300

National Response in Canada
CANUTEC: 613-996-6666

Outside U.S. and Canada
Chemtrec: 703-527-3887

NOTE: CHEMTREC, CANUTEC and National Response Center emergency numbers to be used only in the event of chemical emergencies involving a spill, leak, fire, exposure or accident involving chemicals.

MSDS *Material Safety Data Sheet*

From: Mallinckrodt Baker, Inc.
222 Red School Lane
Phillipsburg, NJ 08865

Mallinckrodt CHEMICALS J.T.Baker

All non-emergency questions should be directed to Customer Service (1-800-582-2537) for assistance.

SODIUM THIOSULFATE

1. Product Identification

Synonyms: Sodium thiosulfate, pentahydrate; thiosulfuric acid, disodium salt, pentahydrate

CAS No.: 7772-98-7 (Anhydrous) 10102-17-7 (Pentahydrate)
Molecular Weight: 248.17
Chemical Formula: $Na_2S_2O_3 \cdot 5H_2O$
Product Codes:
J.T. Baker: 3945, 3946, 3951
Mallinckrodt: 7763, 7802, 8100

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Sodium Thiosulfate	7772-98-7	100%	Yes

3. Hazards Identification

Emergency Overview

CAUTION! MAY BE HARMFUL IF SWALLOWED OR INHALED. MAY CAUSE IRRITATION TO SKIN, EYES, AND RESPIRATORY TRACT.

SAF-T-DATA$^{(tm)}$ Ratings (Provided here for your convenience)

Health Rating: 1 - Slight
Flammability Rating: 0 - None
Reactivity Rating: 1 - Slight
Contact Rating: 1 - Slight
Lab Protective Equip: GOGGLES; LAB COAT; PROPER GLOVES
Storage Color Code: Green (General Storage)

Potential Health Effects

Inhalation:
May cause irritation to the respiratory tract. Symptoms may include coughing and shortness of breath.
Ingestion:
Low level of toxicity by ingestion. Diarrhea may occur by ingestion of large quantities.
Skin Contact:
Irritation may occur from prolonged skin contact.
Eye Contact:
Contact may cause mechanical irritation.
Chronic Exposure:
Chronic exposure may cause skin effects.
Aggravation of Pre-existing Conditions:
No information found.

4. First Aid Measures

Inhalation:
Remove to fresh air. Get medical attention for any breathing difficulty.
Ingestion:
Induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person. Get medical attention.
Skin Contact:
Wash exposed area with soap and water. Get medical advice if irritation develops.
Eye Contact:
Wash thoroughly with running water. Get medical advice if irritation develops.

5. Fire Fighting Measures

Fire:

Not considered to be a fire hazard.
Explosion:
Not considered to be an explosion hazard.
Fire Extinguishing Media:
Use any means suitable for extinguishing surrounding fire.
Special Information:
Use protective clothing and breathing equipment appropriate for the surrounding fire.

6. Accidental Release Measures

Ventilate area of leak or spill. Wear appropriate personal protective equipment as specified in Section 8. Spills: Sweep up and containerize for reclamation or disposal. Vacuuming or wet sweeping may be used to avoid dust dispersal.

7. Handling and Storage

Keep in a tightly closed container, stored in a cool, dry, ventilated area. Protect against physical damage. Isolate from incompatible substances. Containers of this material may be hazardous when empty since they retain product residues (dust, solids); observe all warnings and precautions listed for the product.

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:
None established.
Ventilation System:
In general, dilution ventilation is a satisfactory health hazard control for this substance. However, if conditions of use create discomfort to the worker, a local exhaust system should be considered.
Personal Respirators (NIOSH Approved):
For conditions of use where exposure to dust or mist is apparent and engineering controls are not feasible, a particulate respirator (NIOSH type N95 or better filters) may be worn. If oil particles (e.g. lubricants, cutting fluids, glycerine, etc.) are present, use a NIOSH type R or P filter. For emergencies or instances where the exposure levels are not known, use a full-face positive-pressure, air-supplied respirator. WARNING: Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.
Skin Protection:
Wear protective gloves and clean body-covering clothing.
Eye Protection:
Safety glasses. Maintain eye wash fountain and quick-drench facilities in work area.

9. Physical and Chemical Properties

Appearance:
Monoclinic, colorless crystals.
Odor:
Odorless.
Solubility:
79g/100 ml water @ 4C (39F)
Density:
1.75
pH:
No information found.
% Volatiles by volume @ 21C (70F):
0
Boiling Point:
> 100C (> 212F)
Melting Point:
48C (118F) Loses water @ 100C (212F)
Vapor Density (Air=1):
No information found.
Vapor Pressure (mm Hg):
No information found.
Evaporation Rate (BuAc=1):
No information found.

10. Stability and Reactivity

Stability:
Stable under ordinary conditions of use and storage. Stability limited in solution.
Hazardous Decomposition Products:
Oxides of sulfur and hydrogen sulfide.
Hazardous Polymerization:
Will not occur.
Incompatibilities:
Sodium nitrate, halogens, and oxidizing agents. Reacts with acids to release sulfur dioxide.
Conditions to Avoid:
Incompatibles.

11. Toxicological Information

No LD50/LC50 information found relating to normal routes of occupational exposure.

--------\Cancer Lists\--

Ingredient	NTP Carcinogen Known	NTP Carcinogen Anticipated	IARC Category
Sodium Thiosulfate (7772-98-7)	No	No	None

12. Ecological Information

Environmental Fate:
No information found.
Environmental Toxicity:
No information found.

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be managed in an appropriate and approved waste disposal facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

14. Transport Information

Not regulated.

15. Regulatory Information

--------\Chemical Inventory Status - Part 1\---------------------------------

Ingredient	TSCA	EC	Japan	Australia
Sodium Thiosulfate (7772-98-7)	Yes	Yes	Yes	Yes

--------\Chemical Inventory Status - Part 2\---------------------------------

Ingredient	Korea	Canada DSL	Canada NDSL	Phil.
Sodium Thiosulfate (7772-98-7)	Yes	Yes	No	Yes

--------\Federal, State & International Regulations - Part 1\----------------

Ingredient	-SARA 302- RQ	-SARA 302- TPQ	------SARA 313------ List	------SARA 313------ Chemical Catg.
Sodium Thiosulfate (7772-98-7)	No	No	No	No

--------\Federal, State & International Regulations - Part 2\-----------------

Ingredient	CERCLA	-RCRA- 261.33	-TSCA- 8(d)
Sodium Thiosulfate (7772-98-7)	No	No	No

Chemical Weapons Convention: No TSCA 12(b): No CDTA: No
SARA 311/312: Acute: Yes Chronic: No Fire: No Pressure: No
Reactivity: No (Pure / Solid)

Australian Hazchem Code: None allocated.
Poison Schedule: None allocated.
WHMIS:
This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

16. Other Information

NFPA Ratings: Health: **1** Flammability: **0** Reactivity: **0**
Label Hazard Warning:
CAUTION! MAY BE HARMFUL IF SWALLOWED OR INHALED. MAY CAUSE IRRITATION TO SKIN, EYES, AND RESPIRATORY TRACT.
Label Precautions:
Avoid contact with eyes, skin and clothing.
Wash thoroughly after handling.
Avoid breathing dust.
Keep container closed.
Use with adequate ventilation.
Label First Aid:
If inhaled, remove to fresh air. Get medical attention for any breathing difficulty. In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes. Get medical attention if irritation develops or persists. If swallowed, induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person.
Product Use:
Laboratory Reagent.
Revision Information:
No Changes.
Disclaimer:
****

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Prepared by: Environmental Health & Safety
Phone Number: (314) 654-1600 (U.S.A.)

Material Safety Data Sheet

SECTION 1 PRODUCT AND COMPANY IDENTIFICATION

CHEVRON REGULAR UNLEADED GASOLINE

Product Number(s): CPS201000 [See Section 16 for Additional Product Numbers]
Synonyms: Calco Regular Unleaded Gasoline

Company Identification
Chevron Products Company
Marketing, MSDS Coordinator
6001 Bollinger Canyon Road
San Ramon, CA 94583
United States of America

Transportation Emergency Response
CHEMTREC: (800) 424-9300 or (703) 527-3887
Health Emergency
ChevronTexaco Emergency Information Center: Located in the USA. International collect calls accepted. (800) 231-0623 or (510) 231-0623
Product Information
Technical Information: (510) 242-5357

SPECIAL NOTES: This MSDS applies to: Federal Reformulated Gasoline, California Reformulated Gasoline, Wintertime Oxygenated Gasoline, Low RVP Gasoline and Conventional Gasoline.

SECTION 2 COMPOSITION/ INFORMATION ON INGREDIENTS

COMPONENTS	CAS NUMBER	AMOUNT
Gasoline	86290-81-5	100 %volume
Benzene	71-43-2	0.1 - 4.9 %volume
Ethyl benzene	100-41-4	0.1 - 3 %volume
Naphthalene	91-20-3	0.1 - 2 %volume
Ethanol	64-17-5	0 - 10 %volume
Methyl tert-butyl ether (MTBE)	1634-04-4	0 - 15 %volume
Tertiary amyl methyl ether (TAME)	994-05-8	0 - 17 %volume
Ethyl tert-butyl ether (ETBE)	637-92-3	0 - 18 %volume

Motor gasoline is considered a mixture by EPA under the Toxic Substances Control Act (TSCA). The refinery streams used to blend motor gasoline are all on the TSCA Chemical Substances Inventory. The appropriate CAS number for refinery blended motor gasoline is 86290-81-5. The product specifications of motor gasoline sold in your area will depend on applicable Federal and State regulations.

SECTION 3 HAZARDS IDENTIFICATION

****

EMERGENCY OVERVIEW

- EXTREMELY FLAMMABLE LIQUID AND VAPOR. VAPOR MAY CAUSE FLASH FIRE
- HARMFUL OR FATAL IF SWALLOWED - MAY CAUSE LUNG DAMAGE IF SWALLOWED
- VAPOR HARMFUL
- CAUSES SKIN IRRITATION
- CAUSES EYE IRRITATION
- LONG-TERM EXPOSURE TO VAPOR HAS CAUSED CANCER IN LABORATORY ANIMALS
- KEEP OUT OF REACH OF CHILDREN
- TOXIC TO AQUATIC ORGANISMS

****

IMMEDIATE HEALTH EFFECTS
Eye: Contact with the eyes causes irritation. Symptoms may include pain, tearing, reddening, swelling and impaired vision.
Skin: Contact with the skin causes irritation. Skin contact may cause drying or defatting of the skin. Symptoms may include pain, itching, discoloration, swelling, and blistering. Contact with the skin is not expected to cause an allergic skin response. Not expected to be harmful to internal organs if absorbed through the skin.
Ingestion: Because of its low viscosity, this material can directly enter the lungs, if swallowed, or if subsequently vomited. Once in the lungs it is very difficult to remove and can cause severe injury or death.
Inhalation: The vapor or fumes from this material may cause respiratory irritation. Symptoms of respiratory irritation may include coughing and difficulty breathing. Breathing this material at concentrations above the recommended exposure limits may cause central nervous system effects. Central nervous system effects may include headache, dizziness, nausea, vomiting, weakness, loss of coordination, blurred vision, drowsiness, confusion, or disorientation. At extreme exposures, central nervous system effects may include respiratory depression, tremors or convulsions, loss of consciousness, coma or death.

DELAYED OR OTHER HEALTH EFFECTS:
Reproduction and Birth Defects: This material is not expected to cause birth defects or other harm to the developing fetus based on animal data.
Cancer: Prolonged or repeated exposure to this material may cause cancer. Gasoline has been classified as a Group 2B carcinogen (possibly carcinogenic to humans) by the International Agency for Research on Cancer (IARC).

Contains benzene, which has been classified as a carcinogen by the National Toxicology Program (NTP) and a Group 1 carcinogen (carcinogenic to humans) by the International Agency for Research on Cancer (IARC).
Contains ethylbenzene which has been classified as a Group 2B carcinogen (possibly carcinogenic to humans) by the International Agency for Research on Cancer (IARC).
Contains naphthalene, which has been classified as a Group 2B carcinogen (possibly carcinogenic to humans) by the International Agency for Research on Cancer (IARC).

Whole gasoline exhaust has been classified as a Group 2B carcinogen (possibly carcinogenic to humans) by the International Agency for Research on Cancer (IARC).

Risk depends on duration and level of exposure. See Section 11 for additional information.

SECTION 4 FIRST AID MEASURES

Eye: Flush eyes with water immediately while holding the eyelids open. Remove contact lenses, if worn, after initial flushing, and continue flushing for at least 15 minutes. Get medical attention if irritation persists.
Skin: Wash skin with water immediately and remove contaminated clothing and shoes. Get medical attention if any symptoms develop. To remove the material from skin, use soap and water. Discard contaminated clothing and shoes or thoroughly clean before reuse.
Ingestion: If swallowed, get immediate medical attention. Do not induce vomiting. Never give anything by mouth to an unconscious person.
Inhalation: Move the exposed person to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention if breathing difficulties continue.
Note to Physicians: Ingestion of this product or subsequent vomiting may result in aspiration of light hydrocarbon liquid, which may cause pneumonitis.

SECTION 5 FIRE FIGHTING MEASURES

See Section 7 for proper handling and storage.

FIRE CLASSIFICATION:
OSHA Classification (29 CFR 1910.1200): Flammable liquid.

NFPA RATINGS: Health: 1 Flammability: 3 Reactivity: 0

FLAMMABLE PROPERTIES:
Flashpoint: (Tagliabue Closed Cup) < -45 °C (< -49 °F)
Autoignition: > 280 °C (> 536 °F)
Flammability (Explosive) Limits (% by volume in air): Lower: 1.4 Upper: 7.6

EXTINGUISHING MEDIA: Dry Chemical, CO2, AFFF Foam or alcohol resistant foam if >15% volume polar solvents (oxygenates).

PROTECTION OF FIRE FIGHTERS:
Fire Fighting Instructions: Use water spray to cool fire-exposed containers and to protect personnel. For fires involving this material, do not enter any enclosed or confined fire space without proper protective equipment, including self-contained breathing apparatus.
Combustion Products: Highly dependent on combustion conditions. A complex mixture of airborne solids, liquids, and gases including carbon monoxide, carbon dioxide, and unidentified organic compounds will be evolved when this material undergoes combustion.

SECTION 6 ACCIDENTAL RELEASE MEASURES

Protective Measures: Eliminate all sources of ignition in the vicinity of the spill or released vapor. If this material is released into the work area, evacuate the area immediately. Monitor area with combustible gas indicator.
Spill Management: Stop the source of the release if you can do it without risk. Contain release to prevent further contamination of soil, surface water or groundwater. Clean up spill as soon as possible, observing precautions in Exposure Controls/Personal Protection. Use appropriate techniques such as applying non-combustible absorbent materials or pumping. All equipment used when handling the product must be grounded. A vapor suppressing foam may be used to reduce vapors. Use clean non-sparking tools to collect absorbed material. Where feasible and appropriate, remove contaminated soil. Place contaminated materials in disposable containers and dispose of in a manner consistent with applicable regulations.
Reporting: Report spills to local authorities and/or the U.S. Coast Guard's National Response Center at (800) 424-8802 as appropriate or required. This material is covered by EPA's Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) Petroleum Exclusion. Therefore, releases to the environment may not be reportable under CERCLA.

SECTION 7 HANDLING AND STORAGE

Precautionary Measures: READ AND OBSERVE ALL PRECAUTIONS ON PRODUCT LABEL. This product presents an extreme fire hazard. Liquid very quickly evaporates, even at low temperatures, and forms vapor (fumes) which can catch fire and burn with explosive violence. Invisible vapor spreads easily and can be set on fire by many sources such as pilot lights, welding equipment, and electrical motors and switches. Never siphon gasoline by mouth.
Use only as a motor fuel. Do not use for cleaning, pressure appliance fuel, or any other such use. Do not store in open or unlabeled containers. Do not get in eyes, on skin, or on clothing. Do not taste or swallow. Do not breathe vapor or fumes. Wash thoroughly after handling. Keep out of the reach of children.
Unusual Handling Hazards: WARNING! Do not use as portable heater or appliance fuel. Toxic fumes may accumulate and cause death.
General Handling Information: Avoid contaminating soil or releasing this material into sewage and drainage systems and bodies of water.
Static Hazard: Electrostatic charge may accumulate and create a hazardous condition when handling this material. To minimize this hazard, bonding and grounding may be necessary but may not, by themselves, be sufficient. Review all operations which have the potential of generating an accumulation of electrostatic charge and/or a flammable atmosphere (including tank and container filling, splash filling, tank cleaning, sampling, gauging, switch loading, filtering, mixing, agitation, and vacuum truck operations) and use appropriate mitigating procedures. For more information, refer to OSHA Standard 29 CFR 1910.106, 'Flammable and Combustible Liquids', National Fire Protection Association (NFPA 77, 'Recommended Practice on Static Electricity', and/or the American Petroleum Institute (API) Recommended Practice 2003, 'Protection Against Ignitions Arising Out of Static, Lightning, and Stray Currents'. Improper filling of portable gasoline containers creates danger of fire. Only dispense gasoline into approved and properly labeled gasoline containers. Always place portable containers on the ground. Be sure pump nozzle is in contact with the container while filling. Do not use a nozzle's lock-open device. Do not fill portable containers that are inside a vehicle or truck/trailer bed.

General Storage Information: DO NOT USE OR STORE near heat, sparks or open flames. USE AND STORE ONLY IN WELL VENTILATED AREA. Keep container closed when not in use.
Container Warnings: Container is not designed to contain pressure. Do not use pressure to empty container or it may rupture with explosive force. Empty containers retain product residue (solid, liquid, and/or vapor) and can be dangerous. Do not pressurize, cut, weld, braze, solder, drill, grind, or expose such containers to heat, flame, sparks, static electricity, or other sources of ignition. They may explode and cause injury or death. Empty containers should be completely drained, properly closed, and promptly returned to a drum reconditioner or disposed of properly.

SECTION 8 EXPOSURE CONTROLS/PERSONAL PROTECTION

GENERAL CONSIDERATIONS:

Consider the potential hazards of this material (see Section 3), applicable exposure limits, job activities, and other substances in the work place when designing engineering controls and selecting personal protective equipment. If engineering controls or work practices are not adequate to prevent exposure to harmful levels of this material, the personal protective equipment listed below is recommended. The user should read and understand all instructions and limitations supplied with the equipment since protection is usually provided for a limited time or under certain circumstances.

ENGINEERING CONTROLS:

Use process enclosures, local exhaust ventilation, or other engineering controls to control airborne levels below the recommended exposure limits.

PERSONAL PROTECTIVE EQUIPMENT

Eye/Face Protection: No special eye protection is normally required. Where splashing is possible, wear safety glasses with side shields as a good safety practice.
Skin Protection: No special protective clothing is normally required. Where splashing is possible, select protective clothing depending on operations conducted, physical requirements and other substances in the workplace. Suggested materials for protective gloves include: Chlorinated Polyethylene (or Chlorosulfonated Polyethylene), Nitrile Rubber, Polyurethane, Viton.
Respiratory Protection: Determine if airborne concentrations are below the recommended exposure limits. If not, wear an approved respirator that provides adequate protection from measured concentrations of this

material, such as: Air-Purifying Respirator for Organic Vapors.
When used as a fuel, this material can produce carbon monoxide in the exhaust. Determine if airborne concentrations are below the occupational exposure limit for carbon monoxide. If not, wear an approved positive-pressure air-supplying respirator.
Use a positive pressure air-supplying respirator in circumstances where air-purifying respirators may not provide adequate protection.

Occupational Exposure Limits:

Component	**Limit**	**TWA**	**STEL**	**Ceiling**	**Notation**
Benzene	ACGIH_TLV	.5 ppm	2.5 ppm		Skin A1
Benzene	OSHA_PEL	1 ppm	5 ppm		
Benzene	OSHA_Z2	10 ppm		25 ppm	
Ethanol	ACGIH_TLV	1000 ppm			A4
Ethanol	OSHA_PEL	1000 ppm			
Ethyl benzene	ACGIH_TLV	100 ppm	125 ppm		A3
Ethyl benzene	OSHA_PEL	100 ppm	125 ppm		
Ethyl tert-butyl ether (ETBE)	ACGIH_TLV	5 ppm			
Gasoline	ACGIH_TLV	300 ppm	500 ppm		A3
Gasoline	OSHA_PEL	300 ppm	500 ppm		
Methyl tert-butyl ether (MTBE)	ACGIH_TLV	50 ppm			A3
Naphthalene	ACGIH_TLV	10 ppm	15 ppm		Skin A4
Naphthalene	OSHA_PEL	10 ppm	15 ppm		
Tertiary amyl methyl ether (TAME)	CHEVRON		50 ppm		

Refer to the OSHA Benzene Standard (29 CFR 1910.1028) and Table Z-2 for detailed training, exposure monitoring, respiratory protection and medical surveillance requirements before using this product.

SECTION 9 PHYSICAL AND CHEMICAL PROPERTIES

Attention: the data below are typical values and do not constitute a specification.

Color: Colorless to yellow
Physical State: Liquid
Odor: Petroleum odor
pH: NA
Vapor Pressure: 5 psi - 15 psi (Typical) @ 37.8°C (100°F)
Vapor Density (Air = 1): 3 - 4 (Typical)
Boiling Point: 37.8°C (100°F) - 204.4°C (400°F) (Typical)
Solubility: Insoluble in water; miscible with most organic solvents.
Freezing Point: NA
Melting Point: NA
Specific Gravity: 0.7 g/ml - 0.8 g/ml @ 15.6°C (60.1°F)
Viscosity: <1 SUS @ 37.8°C (100°F)

SECTION 10 STABILITY AND REACTIVITY

Chemical Stability: This material is considered stable under normal ambient and anticipated storage and handling conditions of temperature and pressure.
Incompatibility With Other Materials: May react with strong oxidizing agents, such as chlorates, nitrates, peroxides, etc.
Hazardous Decomposition Products: None known (None expected)
Hazardous Polymerization: Hazardous polymerization will not occur.

SECTION 11 TOXICOLOGICAL INFORMATION

IMMEDIATE HEALTH EFFECTS
Eye Irritation: The Draize eye irritation mean score in rabbits for a 24-hour exposure was: 0/110.
Skin Irritation: For a 4-hour exposure, the Primary Irritation Index (PII) in rabbits is: 4.8/8.0.
Skin Sensitization: This material did not cause sensitization reactions in a Modified Buehler guinea pig test.
Acute Dermal Toxicity: 24 hour(s) LD50: >3.75g/kg (rabbit).
Acute Oral Toxicity: LD50: >5 ml/kg (rat)
Acute Inhalation Toxicity: 4 hour(s) LD50: >2000ppm (rat).

ADDITIONAL TOXICOLOGY INFORMATION:
Gasolines are highly volatile and can produce significant concentrations of vapor at ambient temperatures. Gasoline vapor is heavier than air and at high concentrations may accumulate in confined spaces to present both safety and heath hazards. When vapor exposures are low, or short duration and infrequent, such as during refuelling and tanker loading/unloading, neither total hydrocarbon nor components such as benzene are likely to result in any adverse health effects. In situations such as accidents or spills where exposure to gasoline vapor is potentially high, attention should be paid to potential toxic effects of specific components. Information about specific components in gasoline can be found in Sections 2, 8 and 15 of this MSDS. More detailed information on the health hazard of specific gasoline components can be obtained calling the Chevron Emergency Information Center (see Section 1 for phone numbers).

NEUROTOXICITY: Pathological misuse of solvents and gasoline, involving repeated and prolonged exposure to high concentrations of vapor is a significant exposure on which there are many reports in the medical literature. As with other solvents, persistent abuse involving repeated and prolonged exposures to high concentrations of vapor has been reported to result in central nervous system damage and eventually, death. In a study in which ten human volunteers were exposed for 30 minutes to approximately 200, 500 or 1000 ppm concentrations of gasoline vapor, irritation of the eyes was the only significant effect observed, based on both subjective and objective assessments. In an inhalation study, groups of 6 Fischer rats (3 male. 3 female) were exposed to 2056 ppm of wholy vaporized unleaded gasoline for 6 hours perday, 5 day per week for up to 18 months. Histopathology of the peripheral nervous system and spinal cord revealed no distal axonal neuropthy of the type associated with exposure to n-hexane even though gasoline contained 1.9% n-hexane. The authors concluded that gasoline treatment may have amplified the incidence and prominence of some naturally occurring age-related (subclinical) in the nervous system. BIRTH DEFECTS AND REPRODUCTIVE TOXICITY: An inhalation study with rats exposed to 0, 400 and 1600 ppm of wholly vaporized unleaded gasoline, 6 hours per day on day 6 through 16 of gestation, showed no teratogenic effects nor indication of toxicity to either the mother or the fetus. Another inhalation study in rats exposed to 3000, 6000, or 9000 ppm of gasoline vapor, 6 hours per day on day 6 through 20 of gestation, also showed no teratogenic effects nor indications of toxicity to either the mother or the fetus.

CHRONIC TOXICITY/CANCER: Wholly vaporized unleaded gasoline was used in a 3 month inhalation study. Groups of 40 rats (20 males, 20 female) and 8 squirrel monkeys (4 male, 4 female) were exposed 6 hours per day and 5 days per week for 13 weeks to 384 or 1552 ppm gasoline. One group of each species served as unexposed controls. The initial conclusion of this study was that inhalation of gasoline at airborne concentrations of up to 1522 ppm caused no toxicity in rats or monkeys. However, further histopathological examination of male rat kidneys on the highest dose group revealed an increased incidence and severity of regenerative epithelium and dilated tubules containing proteinaceous deposits. Lifetime inhalation of wholly vaporized unleaded gasoline at 2056 ppm has caused increased liver tumors in female mice. The mechanism of this response is still being investigated but it is thought to be an epigenetic process unique to the female mouse.

This exposure also caused kidney damage and eventually kidney cancer in male rats. No other animal model studied has shown these adverse kidney effects and there is no physiological reason to believe that they would occur in man. EPA has concluded that mechanism by which wholly vaporzied unleaded gasoline causes kidney damage is unque to the male rat. The effects in that species (kidney damage and cancer) should not be used in human risk assesment. In their 1988 review of carcinogenic risk from gasoline, The International Agency for Research on Cancer (IARC) noted that, because published epidemiology studies did not include any exposure data, only occupations where gasoline exposure may have ocurred were reviewed. These included gasoline service station attendants and automobile mechanics. IARC also noted that there was no opportunity to separate effects of combustion products from those of gasoline itself. Although IARC allocated gasoline a final overall classification of Group 2B, i.e. possibly carcinogenic to humans, this was based on limited evidence in experimental animals plus supporting evidence including the presence in gasoline of benzene and 1, 3-butadiene. The actual evidence for carcinogenicity in humans was considered inadequate.

MUTAGENICITY: Gasoline was not mutagenic, with or without activation, in the Ames assay (Salmonella typhimurium), Saccharamyces cerevisesae, or mouse lymphoma assays. In addition, point mutations were not induced in human lymphocytes. Gasoline was not mutagenic when tested in the mouse dominant lethal assay. Administration of gasoline to rats did not cause chomosomal aberrations in their bone marrow cells. EPIDEMIOLOGY: To explore the health effects of workers potentially exposed to gasoline vapors in the marketing and distribution sectors of the petroleum industry, the American Petroleum Institute sponsored a cohort mortality study (Publication 4555), a nested case-control study (Publication 4551), and an exposure assessment study (Publication 4552). Histories of exposure to gasoline were reconstructed for cohort of more than 18,000 employees from four companies for the time period between 1946 and 1985. The results of the cohort mortality study indicated that there was no increased mortality from either kidney cancer or leukemia among marketing and marine distribution employees who were exposed to gasoline in the petroleum industry, when compared to the general population. More importantly, based on internal comparisons, there was no association between mortality from kidney cancer or leukemia and various indices of gasoline exposure. In particular, neither duration of employment, duration of exposure, age at first exposure, year of first exposure, job category, cumulative exposure, frequency of peak exposure, nor average intensity of exposure had any effect on kidney cancer or leukemia mortality. The results of the nested case-control study confirmed the findings of the original cohort study. That is, exposure to gasoline at the levels experienced by this cohort of distribution workers is not a significant risk factor for leukemia (all cell types), acute myeloid leukemia, kidney cancer or multiple myeloma.

SECTION 12 ECOLOGICAL INFORMATION

ECOTOXICITY

The 96 hour(s) LC50 for rainbow trout (Oncorhynchus mykiss) is 2.7 mg/l.
The 48 hour(s) LC50 for water flea (Daphnia magna) is 3.0 mg/l.
The 96 hour(s) LC50 for sheepshead minnow (Cyprinodon variegatus) is 8.3 mg/l.
The 96 hour(s) LC50 for mysid shrimp (Mysidopsis bahia) is 1.8 mg/l.
This material is expected to be toxic to aquatic organisms. Gasoline studies have been conducted in the laboratory under a variety of test conditions with a range of fish and invertebrate species. An even more extensive database is available on the aquatic toxicity of individual aromatic constituents. The majority of published studies do not identify the type of gasoline evaluated, or even provide distinguishing characteristics such as aromatic content or presence of lead alkyls. As a result, comparison of results among studies using open

and closed vessels, different ages and species of test animals and different gasoline types, is difficult.

The bulk of the available literature on gasoline relates to the environmental impact of monoaromatic (BTEX) and diaromatic (naphthalene, methylnaphthalenes) constituents. In general, non-oxygenated gasoline exhibits some short-term toxicity to freshwater and marine organisms, especially under closed vessel or flow-through exposure conditions in the laboratory. The components which are the most prominent in the water soluble fraction and cause aquatic toxicity, are also highly volatile and can be readily biodegraded by microorganisms.

ENVIRONMENTAL FATE

This material is expected to be readily biodegradable. Following spillage, the more volatile components of gasoline will be rapidly lost, with concurrent dissolution of these and other constituents into the water. Factors such as local environmental conditions (temperature, wind, mixing or wave action, soil type, etc), photo-oxidation, biodegradation and adsorption onto suspended sediments, can contribute to the weathering of spilled gasoline.

The aqueous solubility of non-oxygenated unleaded gasoline, based on analysis of benzene, toluene, ethylbenzene+xylenes and naphthalene, is reported to be 112 mg/l. Solubility data on individual gasoline constituents also available.

SECTION 13 DISPOSAL CONSIDERATIONS

Use material for its intended purpose or recycle if possible. This material, if it must be discarded, may meet the criteria of a hazardous waste as defined by US EPA under RCRA (40 CFR 261) or other State and local regulations. Measurement of certain physical properties and analysis for regulated components may be necessary to make a correct determination. If this material is classified as a hazardous waste, federal law requires disposal at a licensed hazardous waste disposal facility.

SECTION 14 TRANSPORT INFORMATION

The description shown may not apply to all shipping situations. Consult 49CFR, or appropriate Dangerous Goods Regulations, for additional description requirements (e.g., technical name) and mode-specific or quantity-specific shipping requirements.

DOT Shipping Name: GASOLINE
DOT Hazard Class: 3 (Flammable Liquid)
DOT Identification Number: UN1203
DOT Packing Group: II

SECTION 15 REGULATORY INFORMATION

SARA 311/312 CATEGORIES:		
	1. Immediate (Acute) Health Effects:	YES
	2. Delayed (Chronic) Health Effects:	YES
	3. Fire Hazard:	YES
	4. Sudden Release of Pressure Hazard:	NO
	5. Reactivity Hazard:	NO

REGULATORY LISTS SEARCHED:

4_I1=IARC Group 1

15=SARA Section 313

4_I2A=IARC Group 2A	16=CA Proposition 65
4_I2B=IARC Group 2B	17=MA RTK
05=NTP Carcinogen	18=NJ RTK
06=OSHA Carcinogen	19=DOT Marine Pollutant
09=TSCA 12(b)	20=PA RTK

The following components of this material are found on the regulatory lists indicated.

Benzene	15, 16, 17, 18, 20, 4_I1, 5, 6
Ethanol	17, 18, 20
Ethyl benzene	15, 17, 18, 20, 4_I2B
Gasoline	17, 18, 20
Methyl tert-butyl ether (MTBE)	15, 17, 18, 20, 9
Naphthalene	15, 16, 17, 18, 20, 4_I2B
Tertiary amyl methyl ether (TAME)	9

CERCLA REPORTABLE QUANTITIES(RQ)/SARA 302 THRESHOLD PLANNING QUANTITIES(TPQ):

Component	Component RQ	Component TPQ	Product RQ
Benzene	10 lbs	None	186 lbs
Ethanol	100 lbs	None	1961 lbs
Ethyl benzene	1000 lbs	None	34964 lbs
Methyl tert-butyl ether (MTBE)	1000 lbs	None	7513 lbs
Naphthalene	100 lbs	None	4000 lbs

CHEMICAL INVENTORIES:
CANADA: All the components of this material are on the Canadian DSL or have been notified under the New Substance Notification Regulations, but have not yet been published in the Canada Gazette.
UNITED STATES: All of the components of this material are on the Toxic Substances Control Act (TSCA) Chemical Inventory.

WHMIS CLASSIFICATION:
Class B, Division 2: Flammable Liquids
Class D, Division 2, Subdivision A: Very Toxic Material - Carcinogenicity
Class D, Division 2, Subdivision B: Toxic Material - Skin or Eye Irritation

SECTION 16 OTHER INFORMATION

NFPA RATINGS: Health: 1 Flammability: 3 Reactivity: 0

(0-Least, 1-Slight, 2-Moderate, 3-High, 4-Extreme, PPE:- Personal Protection Equipment Index recommendation, *- Chronic Effect Indicator). These values are obtained using the guidelines or published evaluations prepared by the National Fire Protection Association (NFPA) or the National Paint and Coating Association (for HMIS ratings).

Additional Product Number(s): CPS201023, CPS201054, CPS201055, CPS201075, CPS201090, CPS201105, CPS201106, CPS201120, CPS201121, CPS201122, CPS201126, CPS201128, CPS201131, CPS201136, CPS201141, CPS201142, CPS201148, CPS201153, CPS201158, CPS201161, CPS201162, CPS201168, CPS201181, CPS201185, CPS201186, CPS201188, CPS201216, CPS201217, CPS201218, CPS201236, CPS201237, CPS201238, CPS201266, CPS201267, CPS201268, CPS201277, CPS201278, CPS201279, CPS201286, CPS201287, CPS201289, CPS201296, CPS201297, CPS201298, CPS201849, CPS201850, CPS201855, CPS201856, CPS201857, CPS204000, CPS204001, CPS204002, CPS204003, CPS204010, CPS204011, CPS204022, CPS204023, CPS204046, CPS204047, CPS204070, CPS204071, CPS204088, CPS204089, CPS204104, CPS204105, CPS204116, CPS204117, CPS204140, CPS204141, CPS204164, CPS204165, CPS204188, CPS204189, CPS204200, CPS204201, CPS204212, CPS204213, CPS204224, CPS204225, CPS204248, CPS204249, CPS204272, CPS204273, CPS204290, CPS204291, CPS204322, CPS204323, CPS204324, CPS204350, CPS204352, CPS204354, CPS204356, CPS204358, CPS204359, CPS204364, CPS204365, CPS204370, CPS204371, CPS204376, CPS204377, CPS204382, CPS204383, CPS204388, CPS204389, CPS204394, CPS204395, CPS204400, CPS204401, CPS204406, CPS204407, CPS204412, CPS204413, CPS204418, CPS204419, CPS204424, CPS204425, CPS204430, CPS204431, CPS204436, CPS204437, CPS204442, CPS204446, CPS204450, CPS204454, CPS204458, CPS204462, CPS204466, CPS204467, CPS204484, CPS204485, CPS204502, CPS204503, CPS204520, CPS204521, CPS204538, CPS204539, CPS204556, CPS204557, CPS204574, CPS204575, CPS204592, CPS204593, CPS204610, CPS204611, CPS204628, CPS204629, CPS204646, CPS204647, CPS204664, CPS204665, CPS204682, CPS204690, CPS204691, CPS204696, CPS204697, CPS204702, CPS204703, CPS204708, CPS204709, CPS204721, CPS204722, CPS204727, CPS204728, CPS241765

REVISION STATEMENT: This revision updates the following sections of this Material Safety Data Sheet: Section 1 (Product Codes). This Material Safety Data Sheet has been prepared using the ProSteward MSDS system.

ABBREVIATIONS THAT MAY HAVE BEEN USED IN THIS DOCUMENT:

TLV - Threshold Limit Value
STEL - Short-term Exposure Limit
NDA - No Data Available
<= - Less Than or Equal To

TWA - Time Weighted Average
PEL - Permissible Exposure Limit
CAS - Chemical Abstract Service Number
NA - Not Applicable
>= - Greater Than or Equal To

Prepared according to the OSHA Hazard Communication Standard (29 CFR 1910.1200) and the ANSI MSDS Standard (Z400.1) by the ChevronTexaco Energy Research & Technology Company, 100 Chevron Way, Richmond, California 94802.

APPENDIX B

Forms

Parametrix

Confined Space Entry Permit

Permit date: / / **Expires:** / /

Time started:

Permit space to be entered (name and location of space):

Purpose of entry:

Names of trained, authorized individuals

- Entry attendant:
- Authorized entrants:
- Authorized entrants:

Emergency contact information

Emergency responder: City of Vancouver Phone number: 911

Contact person: N/A Time: N/A

Pre-entry requirements

Requirements	Yes	No	N/A	Requirements	Yes	No	N/A
Lockout - tagout/de-energize	☐	☒	☐	Hot work permit	☐	☒	☐
Pipes(s) broken or capped or blanked	☐	☒	☐	Fall arrest harness/lifeline/tripod	☐	☒	☐
Purge or flush or drain	☐	☐	☒	Personal protective equipment	☒	☐	☐
Ventilation (natural or mechanical)	☒	☐	☐	*Hardhat*	☐	☒	☐
Secure area	☒	☐	☐	*Gloves*	☒	☐	☐
Safe lighting	☐	☒	☐	*Safety glasses*	☒	☐	☐
Non-sparking tools	☐	☒	☐	*Respirator, type*	☐	☒	☐
Communication method	☐	☐	☒	*Other PPE: TyChem*	☒	☐	☐
Contractor employees involved	☐	☐	☐	*Other PPE:*	☐	☐	☐

Space-monitoring results

Space-monitoring results		Test 1	Test 2	Test 3	Test 4
Monitor at least every four hours	**Permissible entry levels**	Time: Initial:	Time: Initial:	Time: Initial:	Time: Initial:
Percent oxygen	19.5% to 23.5%				
Combustible gas	Less than 10% LEL				
Other toxic gas					
Other toxic gas					
Other toxic gas					

Entry permit (continued)

Possible atmospheric hazards	**Yes**	**No**	**N/A**
Lack of oxygen	☒	☐	☐
Combustible gases	☐	☒	☐
Combustible vapors	☐	☒	☐
Combustible dusts	☐	☒	☐
Toxic gases/vapors	☒	☐	☐
Possible non-atmospheric hazards			
Noise	☐	☒	☐
Chemical contact	☒	☐	☐
Electrical hazard	☒	☐	☐
Mechanical exposure	☐	☒	☐
Temperature extreme	☐	☒	☐
Engulfment	☐	☒	☐
Entrapment	☐	☒	☐
Other non-atmospheric hazard	☐	☒	☐

Pre-entry checklist

Do not enter this permit space until the following “needs action” conditions are corrected.

OK	Needs action	
☐	☐	Before entering the permit space, the supervisor or designee must notify the rescue team. IDLH conditions require at least one rescue team member located outside the space.
☐	☐	A minimum of two employees must be assigned to work involving permit space entry. One employee must remain outside the permit space at all times.
☐	☐	The surrounding area must be surveyed to show that it is free of hazards such as drifting vapors from tanks, piping, sewers, or vehicle exhaust.
☐	☐	Those responsible for operation of the gas monitor have been trained.
☐	☐	Gas monitor calibration tests and functional test (fresh air calibration) have been performed this shift on the gas monitor. If so, by whom? _____
☐	☐	The atmosphere will be continuously monitored while the space is occupied, if required by entry procedure.

This permit has been terminated for the following reason:

☐ Work completed ☐ Canceled Time: Note:

Attendant’s signature Time: Date: / /

Return this completed permit to ________________________________. Review, then file for one year.

PROJECT-SPECIFIC TRAINING ACKNOWLEDGEMENT FORM FOR HAZARDOUS WASTE OPERATIONS

Prior to the initiation of field activities, I attended a site-specific training for the Port of Vancouver project. The training included topics that are covered in the Parametrix Health and Safety Manual and the project-specific Health and Safety Plan (HASP). Additionally, I have been given an opportunity to read and question the contents of these documents.

By signature, I certify that I have read, understood, and agree to comply with the information and directions set forth in the aforementioned documents and site-specific training.

SITE-SPECIFIC OPERATIONS, POTENTIAL HAZARDS, AND CONTROL		
PRINTED NAME	**SIGNATURE**	**TRAINING DATE**

DATE:	**MEETING LOCATION:**
TRAINER:	**TITLE:**
COMMENTS/EXCEPTIONS/EXEMPTIONS:	
TRAINER SIGNATURE:	

PARAMETRIX
DAILY HEALTH AND SAFETY TAILGATE
MEETING LOG

DATE/TIME	NAME (PRINT)	NAME (SIGNATURE)	TOPIC

APPENDIX C

Standard Operating Procedures

PERSONAL PROTECTIVE EQUIPMENT

Prepared By: ______________________ Date: ____________
Health and Safety Committee Chair

Reviewed By: ______________________ Date: ____________
Corporate Health and Safety Officer

Approved By: ______________________ Date: ____________
Chief Operating Officer

1.0 Purpose

This Standard Operating Procedure (SOP) establishes guidelines for selection and use of Personal Protective Equipment (PPE) used to protect Parametrix employees from the risk of injury by creating a barrier against workplace hazards.

2.0 Scope

29 CFR 1910, Subpart I requires the use of PPE to reduce employees' exposures to hazards when engineering and administrative controls are not feasible or effective in reducing these exposures to acceptable levels. Employers are required to determine all exposures to hazards in their workplace and determine if PPE should be used to protect their workers. OSHA requires employers to conduct inspections of all workplaces to determine the need for PPE and to help in selecting the proper PPE for each task performed.

This SOP addresses eye, face, head, foot, hand, and body protection. Respiratory protection is discussed in SOP HS-003.

3.0 Responsibilities

There are specific responsibilities for Parametrix personnel in the care and use of PPE, depending on an individual’s role within the company or on a given project. These responsibilities are outlined below:

- **Corporate Health and Safety Officer (CHSO):** The Corporate Health and Safety Officer is responsible for developing the PPE Program and updating PPE procedures, as necessary.

- **Project Manager:** The Project Manager is responsible for field implementation of the PPE Program. This includes assurance that all personnel on site comply with the policy and that all on-site personnel have had proper training in using PPE.

- **Site-specific Health and Safety Officer (SHSO):** The Site-specific Health and Safety Officer is responsible for initial on-site coordination of the cold stress. The SHSO assures that all personal potentially exposed to potential environmental hazards have proper PPE.

- **Team Member:** Each Team Member is responsible for understanding and complying with all site requirements.

4.0 Requirements

Eye and Face Protection

Eye and face protection shall be used when employees are exposed to potential hazards from flying particles, molten metal, acids or caustic liquids, chemicals, or gases. Eye and face protection requirements include:

- Appropriate eye and face protection devices in hazardous environments for personnel who wear contact lenses.
- Side protectors when there is a hazard from flying objects.
- Goggles and face shields when there is a hazard from chemical splash.
- Face shields worn only over primary eye protection (safety glasses or goggles).
- Eye protectors that incorporate an employee's corrective eye prescription in the design or that fit properly over the prescription lenses.

Emergency eyewash facilities meeting the requirements of ANSI Z358.1 will be provided in all areas where the eyes of any employee may be exposed to corrosive materials. All such emergency facilities will be located where they are easily accessible in an emergency.

Protective eye and face devices purchased after July 5, 1994 shall comply with ANSI Z87.1-1989, "American National Standard Practice for Occupational and Educational Eye and Face Protection."

Head Protection

Head protection (hard hat) must be worn by all employees when overhead hazards from falling or fixed objects are present. Also, when an employee is near exposed electrical conductors that could come in contact with the head, the employee must wear a protective helmet designed to reduce electrical shock hazard.

Protective headgear shall comply with ANSI Z89.1-1986, "American National Standard for Personnel Protection-Protective Headwear for Industrial Workers-Requirements."

Foot Protection

Steel-toed boots or shoes must be worn in work areas where carrying or handling materials such as packages, objects, parts, or heavy tools could be dropped or fall onto the feet. Safety shoes or boots with puncture protection are required where sharp objects such as nails, wire, tacks, screws, large staples, scrap metal, etc., could be stepped on by employees and cause foot injury.

When working with hazardous chemicals or waste, chemical-resistant, steel-toed boots may be required.

All safety footwear shall comply with ANSI Z41-1991, "American National Standard for Personal Protection – Protective Footwear."

Hand Protection

Suitable gloves shall be worn when hazards from chemicals, cuts, lacerations, abrasions, punctures, burns, and other hazards to the hands are present. Glove selection shall be based on performance characteristics of the gloves, conditions, durations of use, and hazards present.

The first consideration in the selection of gloves for use against chemicals is to determine, if possible, the nature of the substances to be encountered. Employees must read instructions and warnings on chemical container labels and MSDSs before working with any chemical.

Body Protection

Suitable body protection (torso and legs) must be worn while completing job tasks. Depending on the hazards present, body protection may include coveralls, Tyvek or Saranex suits, totally encapsulating suits, etc. The type of body protection required to perform a specific task will be determined by the Corporate or Site-specific Health and Safety Officer, as necessary.

5.0 Training

Any worker required to wear PPE shall receive training in the proper use and care of PPE. The training shall include, but not necessarily be limited to, the following subjects:

- Determining when wearing PPE is necessary.
- Determining the appropriate and necessary PPE.
- Learning how to properly wear, adjust, and remove PPE.
- Understanding the limitations of PPE.
- Understanding the proper care, maintenance, and disposal of PPE.

6.0 References

U.S. Department of Labor, OSHA Standard 29 CFR 1910, Subpart I.

RESPIRATORY PROTECTION PROGRAM

Prepared By: ______________________ Date: ____________
Health and Safety Committee Chair

Reviewed By: ______________________ Date: ____________
Corporate Health and Safety Officer

Approved By: ______________________ Date: ____________
Chief Operating Officer

1.0 Purpose

To establish the minimum requirements for Parametrix, Inc. employees to use respiratory protection.

2.0 Scope

This Standard Operating Procedure (SOP) applies in its entirety to all Parametrix projects unless the Corporate Health and Safety Officer (CHSO) grants a variance.

3.0 Responsibilities

There are specific responsibilities for Parametrix personnel in complying with the Respiratory Protection Program, depending on an individual’s role within the company or on a given project. These responsibilities are outlined below:

- **Project Manager:** Overall responsible for establishing and ensuring compliance with this procedure.
- **Field Health and Safety Staff:** Responsible for implementing and/or monitoring activities associated with this procedure.
- **Managers and Supervisory Personnel:** Responsible for enforcing this procedure and ensuring that each employee is properly following the procedure.

4.0 General Requirements

Respirator wearers cannot be afforded protection from hazardous airborne contaminants when conditions prevent a complete gas-tight face seat. Facial hair, head hair, and eyeglasses are among these physical obstructions. While eyeglasses are in the category of obstructions that prevent a gas-tight face seal, primarily in the case of full-face supplied-air respirators, this problem is correctable by using mounting devices to hold the eyeglass frames inside the respirator face piece. The criteria state that there can be no obstruction of contact between the wearer's skin and the mask. Beard stubble constitutes a physical obstruction. Affected employees shall be required to be clean-shaven, as a condition of employment.

Candidates for employment who object to this policy shall be made aware that their versatility on work assignments may be limited and that this factor can affect their job assignments.

Parametrix shall provide respirators whenever a qualified person determines that such equipment is necessary to protect the health of the employee from significant inhalation exposure.

Only respirator equipment that has been jointly approved by the Mine Safety and Health Administration (MSHA) and the National Institute for Occupational Safety and Health (NIOSH) shall be provided.

Employees shall be instructed and trained in the need, use, sanitary care, and limitations of such respiratory equipment prior to being assigned to activities that require respiratory protection.

Parametrix shall provide, repair, or replace respiratory protective equipment as may be required due to wear and deterioration.

Means of cleaning all respiratory protective equipment shall be provided.

Only those employees who are trained and medically qualified to wear respirators shall be assigned to work requiring use of respirators.

5.0 Implementation

Respiratory Selection

When respirator use is required, only properly cleaned and maintained NIOSH/MSHA-approved respirators shall be used. Single-use respirators (dust masks) may only be used with specific approval by the Corporate Health and Safety Officer.

Employees shall be allowed to pick the most comfortable respirator from a selection, including respirators of various sizes from different manufacturers.

Selection of respirators shall be approved by the Field Health and Safety Staff in all cases, and shall be based on the following considerations:

- Nature of the Hazard – The chemical and physical properties, toxicity, and concentration of hazardous material or mixture of materials.

- Oxygen-deficient Atmospheres – Entry into oxygen-deficient atmospheres is prohibited without prior approval of the Corporate Health and Safety Officer.

- Immediate Dangerous to Life and Health (IDLH) Atmospheres – Entry into any IDLH atmosphere is prohibited without prior approval of the Corporate Health and Safety Officer.

- Irritant or Corrosive Atmospheres – Respirators selected must provide adequate face and eye protection. The contaminant or mixture of contaminants must have adequate warning properties (odor, irritation, or taste) to indicate respirator breakthrough if an air-purifying device is used.

- Regulated Materials – In all cases where OSHA has required that a specific respirator is used (carcinogen standards, etc.), the specified respirator, or one providing equal or better protection, shall be used.
- Air-purifying respirators shall NOT be used for protection against the materials listed below. Note that this is only a partial list; please contact the Field Health and Safety Staff for further information:

  Acrolein
  Aniline
  Arsine
  Bromine
  Carbon monoxide
  Ollsocyanates
  Dimethylaniline
  Dimethyl sulfate
  Hydrogen cyanide
  Hydrogen fluoride
  Hydrogen selenide
  Hydrogen sulfide
  Methanol
  Methyl bromide
  Methyl chloride
  Methylene chloride
  Nickel carbonyl
  Nitrobenzene
  Nitrogen oxides
  Nitroglycerine
  Nitromethane
  Ozone
  Phosgene
  Phosphine
  Phosphorus trichloride
  Stibine
  Sulfur chloride

Parametrix subcontracts most asbestos inspections and all asbestos abatement. Inspection personnel may use half-mask respirators in areas where asbestos is present if they are qualitatively-fit tested.

Full–facepiece, negative-pressure, air-purifying respirators are not acceptable for protection against asbestos exposure unless the wearer meets the quantitative fit testing requirement.

Use of Corrective Lens Eyewear with Respirators

The wearing of contact lenses in work environments that involve exposure to chemical fumes, vapors, splashes, intense heat, molten metals, or highly particulate-contaminated atmosphere is prohibited.

Management shall assess which employees in their operations wear eye glasses routinely, determine what respiratory protective masks (makes and models) are used, and assure that the appropriate frames or ophthalmic device hangers are obtained and provided at company expense.

Employee Training and Instruction

The basic respiratory training program shall include, as a minimum, the following:

- Instruction in the need for, use, sanitary care, and limitations of each respirator type.
- Opportunity for "hands-on" experience with respirators.
- Proper fitting, including demonstrations and practice in wearing, adjusting, and determining the fit of the respirator. A selection of respirators shall be available to determine the most comfortable respirator and the best fit.
- How to perform a positive and negative pressure test of the face piece to face seal.
- A familiarization period of wear in normal air.
- For negative pressure respirators, qualitative fit testing will be conducted by wearing the respirator in an irritant fume test atmosphere. A qualified person using the protocol found in Attachment A of this procedure shall perform all qualitative fit testing or other protocol, as designated by specific standards (e.g., asbestos, benzene). Powered air-purifying respirators (PAPRs) shall be worn in a test atmosphere with the power supply disconnected to evaluate fit in the negative pressure modes.
- Qualitative fit testing shall be performed annually, or more frequently as required by law. Quantitative fit testing may be required for some respirator or contaminants. The Field Health and Safety Staff will determine fit test requirements. Fit testing procedures are presented in Attachment A.
- Instruction in the nature of the respiratory hazards, whether acute, chronic, or both, and a description of potential health effects if the respirators are not used.
- Classroom and field training to recognize and cope with emergency situations (including respirator failure).

Training provided as part of this procedure shall be performed in accordance with applicable regulations.

Respirator Inspection, Cleaning, Maintenance, and Storage

General: The Field Health and Safety Staff will define and provide a program to area/facility management regarding maintenance and care of respirators, and which shall be adjusted to the type of facility, working conditions, and hazards involved. This program shall include the following basic elements:

- Inspection for defects and/or deterioration.
- Cleaning and disinfecting in accordance with manufacturers' instruction.
- Repair, as necessary.

- Establishment and maintenance of a record-keeping system to document respiratory inspection, repair, and maintenance.
- Proper storage.

Inspection, Maintenance, and Storage

Users shall inspect all respirators routinely before, during, and after each use. Any defects shall be reported to the supervisor. No defective respirators shall be issued or worn. Defective respirators shall be tagged and returned for repair.

Respirators maintained for emergency use (such as SCBA) shall be inspected and sanitized after each use and inspected at least monthly. A record of the most recent inspection shall be maintained on the respirator or the storage container and shall include the inspector's identification, the date, and a respirator identification number.

An individual who is qualified by experience or training shall regularly clean, inspect, and sanitize routinely-used respiratory equipment.

Other types of respiratory equipment shall be maintained according to the manufacturers' instructions.

Where respirators are assigned to individual employees, area management shall ensure compliance with cleaning and maintenance requirements by periodically inspecting respiratory equipment and conducting field audits.

Respiratory equipment shall not be passed from one person to another until it has been cleaned and sanitized.

When not in use, respirators shall be stored to protect against dust, sunlight, extreme temperatures, excessive moisture, damaging chemicals, and physical damage.

Air Purifying Respirators (APR)

Fit testing shall be accomplished In accordance with Attachment A of this procedure.

When APRs are worn, employees shall change the filter-cartridge elements daily, in the case of cartridges used for non-particulate contaminants, or sooner if "breakthrough" is occurring. For other filter cartridges, the filter-cartridge should be replaced whenever an increase in breathing resistance is detected.

Powered Air Purifying Respirators (PAPR)

When PAPRs are worn, employees shall change filter/cartridge elements dally, in the case of cartridges used for non-particulate contaminants, or sooner if "breakthrough" is occurring. For other filter cartridges, the filter-cartridge should be replaced if any of the following scenarios occur:

- Whenever an increase in breathing resistance is detected, or
- When airflow through filter elements decreases to an unacceptable level, as indicated by the manufacturer's test device.

Compressed Air Systems

- Air Quality
  - Compressed air used for respiration shall be of high purity, and shall meet, as a minimum, the requirements for the specification for Grade D or better breathing air as described in Compressed Gas Association Specification G-7.1 (ANSI Z86.1-1973). The supplier shall certify compliance with these requirements for each lot of breathing air supplied.
  - Breathing air shall be free from harmful dusts, fumes, mists, vapors, gases, or odors.
  - Oxygen shall NOT be used at any time in open-circuit SCBAs or in air-line respirators.
  - Mixed or blended air shall not be used for breathing purposes.

Compressed Air Cylinder Systems (Cascade)

Breathing air cylinders shall be legibly identified with the word AIR, by means of stenciling, stamping, or labeling as near to the valve end as practical.

Cascade systems shall be equipped with low-pressure warning bells or similar warning devices to indicate air pressure in the manifold below 500 psi.

When a cascade system is used to supply breathing air, one employee shall be assigned as a safety standby within audible range of the low- pressure alarm.

When a cascade system is used to recharge SCBA air cylinders, it shall be equipped with a high-pressure supply hose and a coupling rated at a capacity of at least 3,000 psi.

Air-line couplings shall be incompatible with outlets for other gas systems to prevent inadvertently supplying air-line respirators with non-respirable gases or oxygen.

The air pressure at the hose connection to positive pressure respiratory equipment shall be within the range specified in the approval of the equipment by the manufacturer.

Cylinders shall be stored and handled to prevent damage to the cylinder or valve. Cylinders shall be stored upright with the protective valve cover in place and, in such a way (e.g., supported with substantial rope or chain in the upper one-third of the cylinder, or in racks designed for this purpose) as to prevent the cylinder from falling. Cylinders shall not be dropped, dragged, rolled, or allowed to strike each other or to be struck violently. Cylinders shall never be exposed to temperatures exceeding 125°F. Cylinders with visible external damage, evidence of corrosion damage, or exposure to fire shall not be accepted or used.

Only cylinders within current hydrostatic test periods shall be used.

Compressor Supplied Breathing Air

All compressors used for supplying breathing air shall be equipped with the following safety and standby devices:

- Compressor intakes that are located to ensure that only respirable (uncontaminated) air is admitted. This requires attention to the location of the compressor intake with respect to compressor engine exhaust, chemical storage or use areas, and suitable intake screening or filtration.
- Alarms to indicate compressor failure (such as low-pressure air horns, etc.) shall be installed in the system.
- A receiver of sufficient capacity to enable the respirator wearer to exit from a contaminated atmosphere upon compressor failure shall be provided.
- Oil Lubricated Compressors – If an oil-lubricated compressor is used to supply breathing air, it shall be equipped with both of the following devices:
    - ➢ A continuous-reading carbon monoxide monitoring system that is set to alarm should the carbon monoxide concentration exceed 10 ppm.
    - ➢ A high-temperature alarm which will activate when the discharge air exceeds 110% of the normal operating temperature in degrees Fahrenheit,
- A designated employee shall be assigned as a safety standby and shall remain continuously within audible range of the alarms.
- An inline purifying filter assembly to remove oil, condensed water, particulate, odors, and organic vapors shall be used in conjunction with the air compressor.

Routine inspection and maintenance of the air compressor shall be performed in accordance with manufacturer's specifications.

Escape/Egress Units

These respirators are intended for use in areas where escape with a short-term (5-10 minute) air supply is necessary. They may be used as adjuncts to airline pressure demand respirators as a backup air supply; or as independent emergency devices in areas where respiratory protection is not normally required.

Appropriate training shall be accomplished and documented prior to assigning employees to tasks or locations subject to the use of these respirators.

Escape/egress units shall never be used as primary standby respirators for confined space entry.

Medical Screening

All potential candidates shall complete a medical questionnaire prior to respiratory use and once every three years. A more comprehensive medical evaluation may be required based on the results of the questionnaire.

No employee shall be assigned to a task that requires the use of a respirator unless it has been determined that the employee is physically able to perform the work while using the required respirator.

If an employee demonstrates difficulty in breathing during the fitting test or during use, the employee shall be re-examined by a physician to determine whether the employee can wear a respirator while performing the required duty.

Once a medical determination has been made to physical ability to wear a respirator, a review of the employee's health status shall be conducted annually, at a minimum.

ATTACHMENT A

PARAMETRIX MANDATORY QUALITATIVE RESPIRATOR FIT TEST PROTOCOL

NOTE: This protocol does not satisfy the fit test requirements for certain materials, including asbestos and benzene. Contact the Field Health and Safety Staff for assistance.

Respirator Selection

Respirators shall be selected as described in this procedure. The respirator shall be equipped with HEPA filters.

Fit Test

The test conductor shall review this protocol with the test subject before testing.

The test subject shall perform the following conventional positive and negative pressure fit checks:

- Negative Pressure Test – Cover the cartridge filter inlets with your palm and gently inhale, the face piece should collapse against the face.
- Positive Pressure Test – Cover the exhalation valve cover with your palm and gently exhale. The face piece should expand away from the face.
- If either test fails, loosen and readjust the respirator straps and check for obstructions to the sealing surface. Repeat both tests. If the test fails again, select an alternate respirator.

A test atmosphere shall be generated with irritant smoke.

The test subject shall be advised that the smoke can be irritating to the eyes and instructed to keep the eyes closed while the test Is being conducted (applies to half-mask respirators).

While wearing the selected respirator, the test subject shall enter the test atmosphere and perform the following exercises:

- Breathe normally.
- Breathe deeply. Be certain breaths are deep and regular.
- Turn head all the way from one side to the other. Be certain movement is complete. Inhale on each side. Do not bump the respirator against the shoulders.
- Nod head up and down. Be certain motions are complete and made every second. Inhale on each side. Do not bump the respirator against the shoulders.
- Nod head up and down. Be certain motions are complete and made every second. Inhale when head is in the full, up position (looking toward coiling). Do not bump the respirator against the chest.

- Talk aloud and slowly in a fashion that will generate a wide range of facial movements.
- Breathe normally.

The test subject shall indicate to the test conductor if the irritant smoke is detected. If smoke is detected, the test conductor shall stop the test. In this case, the tested respirator is rejected and another respirator shall be selected.

Each test subject passing the smoke test (i.e., without detecting the smoke) shall be given a sensitivity check of smoke from the same tube to determine if the test subject reacts to the smoke. This may be performed by cracking the mask and gently inhaling while inside the test atmosphere. Failure to evoke a response shall void the fit test. This may trigger an asthmatic response; verify before beginning.

The test shall not be conducted if there is any hair growth between the skin and the face-piece sealing surface.

If hair growth or apparel interferes with a satisfactory fit, then the obstruction(s) shall be altered or removed to eliminate interference and allow a satisfactory fit. If a satisfactory fit is still not attained, the test subject must use a positive-pressure respirator, such as a powered, air-purifying respirator, supplied air respirator, or self-contained breathing apparatus.

If a test subject exhibits difficulty in breathing during the tests, the subject shall be referred to a physician trained in respiratory diseases or pulmonary medicine to determine whether the test subject can wear a respirator while performing required duties.

Qualitative fit testing shall be repeated at least every year, or more often, as required by law. In addition, because the sealing of the respirator may be affected, qualitative fit testing shall be repeated immediately when the last subject has experienced:

- A weight change of 20 pounds or more.
- Significant facial scarring in the area of the face-piece seal.
- Significant dental changes (i.e., multiple extractions without prosthesis, or acquisition of dentures).
- Reconstructive or cosmetic surgery.
- Any other conditions that may interfere with face-piece sealing.

Record Keeping

The following fit test forms shall be maintained in each office for three years. The Corporate Health and Safety Officer shall maintain permanent records. The summary shall include:

- Name of test subject.
- Date of testing.
- Name of test conductor.
- Respirator selected (indicate manufacturer, model, size, and approval number).
- Testing agent.

CONFINED SPACE ENTRY

Prepared By: ______________________________ Date: ______________
Health and Safety Committee Chair

Reviewed By: ______________________________ Date: ______________
Corporate Health and Safety Officer

Approved By: ______________________________ Date: ______________
Chief Operating Officer

1.0 Purpose

To establish the minimum requirements for Parametrix employees to perform confined space entry; and to serve as the foundation of the mandatory, written, permit-required Confined Space Entry Program.

2.0 Scope

This Standard Operating Procedure (SOP) applies in its entirety to all Parametrix projects unless the Corporate Health and Safety Officer (CHSO) grants a variance from its requirements.

3.0 Responsibilities

There are specific responsibilities for Parametrix personnel in complying with the Confined Space Entry Program, depending on an individual's role within the company or on a given project. These responsibilities are outlined below:

- **Project Manager:** Overall responsibility for establishing that all affected personnel are adequately trained and ensuring compliance with this procedure.
- **Field Health and Safety Staff:** Responsibility for maintaining current training and implementing and/or monitoring activities associated with this procedure.
- **Managers and Supervisory Personnel:** Responsibility for enforcing this procedure and ensuring that each employee follows the procedure.

4.0 Definitions

Acceptable entry conditions means the conditions that must exist in a permit space to allow entry and to ensure that employees involved with a permit-required confined space entry can safely enter into and work within the space.

Attendant means an individual stationed outside one or more permit spaces who monitors the authorized entrants and who performs all attendant's duties assigned in the employer's permit-required Confined Space Entry Program.

Authorized entrant means an employee who is authorized by the employer to enter a permit-required space.

Confined space means a space that: 1) Is large enough and so configured that an employee can bodily enter and perform assigned work; 2) Has limited or restricted means for entry or exit (e.g., tanks, vessels, silos, storage bins, hoppers, vaults, and pits are spaces that may have limited means of entry); and 3) Is not designed for continuous employee occupancy.

Entry means the action by which a person passes through an opening into a permit-required confined space. Entry includes ensuing work activities in that space and is considered to have occurred as soon as any part of the entrant's body breaks the plane of an opening into the space.

Entry permit (permit) means the written or printed document that is provided by the employer to allow and control entry into a permit-required space.

Entry supervisor means the person (such as the employer, foreman, or crew chief) responsible for determining if acceptable entry conditions are present at a permit space where entry is planned, for authorizing entry and overseeing entry operations, and for terminating entry as required by this section. An Entry Supervisor also may serve as an attendant or as an authorized entrant, as long as that person is trained and equipped, as required by this section, for each role the person fills. Also, the duties of Entry Supervisor may be passed from one individual to another during the course of an entry operation.

Hazardous atmosphere means an atmosphere that may expose employees to the risk of death, incapacitation, impairment of ability to self-rescue (i.e., escape unaided from a permit space), injury, or acute illness from one or more of the following causes:

- Flammable gas, vapor, or mist in excess of 10 percent of its lower flammable limit (LFL).

- Airborne combustible dust at a concentration that meets or exceeds its LFL. This concentration may be approximated as a condition in which the dust obscures vision at a distance of 5 feet (1.52 m) or less.

- Atmospheric oxygen concentration below 19.5 percent or above 23.5 percent.

- Atmospheric concentration of any substance for which a dose or a permissible exposure limit is published in Subpart G, Occupational Health and Environmental Control, or in Subpart Z, Toxic and Hazardous Substances, of 29 CFR 1910, and which could result in employee exposure in excess of its dose or permissible exposure limit: An atmospheric concentration of any substance that is not capable of causing death, incapacitation, impairment of ability to self rescue, injury, or acute illness due to its health effects is not covered by this provision.

- Any other atmospheric condition that is immediately dangerous to life or health. For air contaminants for which OSHA has not determined a dose or permissible exposure limit, other sources of information, such as Material Safety Data Sheets that comply with the Hazard Communication Standard, 29 CFR 1910.1200, published information, and internal documents can provide guidance in establishing acceptable atmospheric conditions.

Immediately dangerous to life or health (IDLH) means any condition that poses an immediate or delayed threat to life, or that would cause irreversible adverse health effects, or that would interfere with an individual's ability to escape unaided from a permit space. Some materials (hydrogen fluoride gas and cadmium vapor, for example) may produce immediate transient effects that, even if severe, may pass without medical attention, but are followed by sudden, possibly fatal collapse 12 to 72 hours after exposure. The victim "feels normal" from the onset of exposure until collapse. Such materials in hazardous quantities are considered to be "immediately" dangerous to life or health.

Inerting means the displacement of the atmosphere in a permit space by a noncombustible gas (such as nitrogen) to such an extent that the resulting atmosphere is noncombustible. NOTE: this procedure produces an IDLH oxygen-deficient atmosphere.

Isolation means the process by which a permit space is removed from service and completely protected against the release of energy and introduction of material into the space by such means as: blanking or blinding; misaligning or removing sections of lines, pipes, or ducts; a double-block and bleed system; lockout or tagout of all sources of energy (see SOP HS-008); or blocking or disconnecting all mechanical linkages.

Non-permit confined space means a confined space that does not contain, with respect to atmospheric hazards, or have the potential to contain any hazards capable of causing death or serious physical harm.

Oxygen-deficient atmosphere means an atmosphere containing less than 19.5 percent oxygen by volume.

Oxygen-enriched atmosphere means an atmosphere containing more than 23.5 percent oxygen by volume.

Permit-required confined space (permit space) means a confined space that has one or more of the following characteristics:

- Contains, or has a potential to contain, a hazardous atmosphere.
- Contains a material that has the potential for engulfing an entrant.
- Has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls or by a floor that slopes downward and tapers to a smaller cross section.
- Contains any other recognized, serious safety or health hazards.

Prohibited condition means any condition in a permit space that is not allowed by the permit during the period when entry is authorized.

Rescue service means the personnel designated to rescue employees from permit spaces.

Retrieval system means the equipment (including a retrieval line, chest or full body harness, wristlets, if appropriate, and a lifting device or anchor) used for non-entry rescue of persons from permit spaces.

Testing means the process by which the hazards that may confront entrants of a permit space are identified and evaluated. Testing includes specifying the tests that are to be performed in the permit space. Testing enables employers to devise and implement adequate control measures for the protection of authorized entrants, and to determine if acceptable entry conditions are present immediately prior to, and during, entry.

5.0 General Requirements

The Project Manager shall have a competent person evaluate the workplace to determine if any spaces are permit-required confined spaces.

If the workplace contains permit spaces, the Project Manager shall inform exposed employees (and subcontractors, if applicable), by posting danger signs or by any other equally effective means, of the existence and location of, and the danger posed by the permit spaces. A sign reading DANGER PERMIT-REQUIRED CONFINED SPACE, DO NOT ENTER, or using other similar language would satisfy the requirement for a sign.

If permit spaces exist in the workplace, and employees will not be allowed to enter permit spaces, the Project Manager shall take effective measures to prevent employees from entering into permit spaces.

If non-permit spaces are modified or experience any change that causes an increased hazard to entrants, the Project Manager shall reevaluate that space and, if necessary, reclassify the space as a permit-required confined space.

If any subcontract employee is to enter a permit space prior to the initial entry, the Project Manager shall:

- Inform the subcontract employer that the workplace contains permit spaces, and that entry must comply with 29 CFR 1910.146.
- Inform the subcontract employer of the elements, including known hazards and experiences from any previous entries into the space, that classify the space as a permit space.
- Inform the subcontract employer of any controls or procedures implemented to protect employees near the subcontractor's work area.
- Coordinate entry operations among client, contractor, and subcontractor personnel when necessary.
- Debrief the subcontract employer at the conclusion of entry operations regarding the permit-required Confined Space Entry Program and any hazards or problems encountered during the entry operations.

6.0 Implementation

- Non-Permit Confined Spaces

  Entry into non-permit confined spaces will be subject to the following controls:

- ➢ The Project Manager (or designee) and the Project-specific Safety Officer shall be informed in advance of the planned entry.
- ➢ The entry shall be coordinated with any work activities near the non-permit space so that hazardous conditions will not be created in or around the space.
- ➢ The “buddy system” will be used for all entries.
- ➢ Entrants will immediately withdraw upon recognition of any hazardous condition.
- ➢ The Project Manager and the Project-specific Safety Officer will be advised of any unanticipated incidents related to the non-permit space entry.

- Permit-Required Confined Spaces

  Entry into permit-required confined spaces will be subject to the following controls:

  - ➢ Unauthorized entries shall be prohibited and measures shall be implemented to prevent such entries.
  - ➢ The Project Manager shall develop additional written program controls, which will specifically address the permit spaces and entries that are unique to the individual project scope of work and conditions.
  - ➢ Hazards shall be identified and evaluated prior to entry. Hazards to be addressed include:
    - Chemical exposure (via inhalation, ingestion, or dermal absorption) from the contents or residues of previous contents of the space, from chemicals introduced into the space as part of the entry operation, and from chemicals used near the space.
    - Oxygen deficiency or enrichment.
    - Discharge of steam, high-pressure air, water, or oil into the confined space, or against personnel working outside.
    - Structural failure of the space walls, roof, roof support members, swing-line cables, or other structural members.
    - Tools, debris, or other objects dropping from overhead.
    - Falls through or from the roof, or from scaffolds, stairs or ladders.
    - Tripping over hoses, pipes, tools, or equipment.
    - Slipping on wet, oily surfaces or colliding with objects in inadequately lighted interiors.

- Insufficient or faulty personal protective equipment (PPE).
- Insufficient or faulty operations equipment and tools.
- Noise in excess of acceptable levels.
- Temperature extremes that may require additional protection or shorter work periods.

The Project Manager shall develop procedures and practices to ensure safe conduct of entry operations. The following points shall be fully addressed:

- Acceptable entry conditions shall be specified (both chemical and physical conditions, and conditions that could arise as a result of operations performed outside the space, shall be considered).
- Procedures to fully isolate the space. Isolation of a space shall include the following steps as applicable:
  - Depressurizing the confined space.
  - Preventing accidental introduction into the confined space of hazardous materials through interconnecting equipment such as piping, ducts, vents, drains, or other means.
  - De-energizing, locking out, and tagging out machinery, mixers, agitators, or other equipment containing moving parts that are in the confined space.
  - Removing a valve, spool piece, or expansion joint in the piping to, and as close to as possible, the confined space, and blanking or capping the open end of the pipe leading to the confined space.
  - Inserting a suitable, full-pressure blank in the piping between the flanges nearest to the confined space.
  - Closing, locking, and tagging at least two valves in the piping leading to the confined space and, locking or tagging open to atmosphere a drain valve between the two closed valves, which shall be checked to ensure that it is not plugged.
  - In all cases, blanks or caps shall be of a material that is compatible with the liquid, vapor, or gas with which they are in contact.
  - The material shall have sufficient strength to withstand the maximum operating pressure, including surges, which can be built up in the piping.
  - In addition, all electrical and mechanical devices within or attached to the confined space shall be disconnected, or locked, and tagged to prevent accidental movement or energizing of such systems.

  - All employees who will be working in the confined space shall be informed of the isolation devices in use at the jobsite during safety meetings.

- Purge, render inert, flush, or ventilate the space, as necessary, to eliminate or control atmospheric hazards.

- Provide barriers to protect entrants from external hazards.

- Verify that conditions in the permit space are acceptable throughout the duration of the entry.

The following equipment shall be provided, maintained, and utilized whenever necessary for safe entry operations:

- Testing and monitoring equipment needed to perform specified atmospheric testing.

- Ventilating equipment needed to create and maintain acceptable entry conditions. Ventilation of permit spaces shall be performed as follows:

  - Prior to ventilating a confined space, a qualified person shall take positive steps to ensure that no pyrophoric materials that will ignite in the presence of air are present in the confined space.

  - All confined spaces shall be mechanically ventilated to remove and/or prevent the accumulation of hazardous atmospheres.

  - Air- or steam-driven air movers shall be used to ventilate confined spaces. Use of electric-powered ventilators is strictly limited to spaces that have not contained flammable or combustible materials.

  - Oxygen shall not be used to power air-driven ventilators or to ventilate any confined space location.

  - The Entry Supervisor shall check periodically to ensure that contaminated air from a confined space is exhausted to a location where it presents no hazard.

  - Whenever possible, air movers shall be used with ducting to increase the efficiency of ventilation in the confined space and to prevent recirculation of contaminated air resulting from ventilation "short circuiting."

  - When two or more air movers are used for ventilation, all such units should be operated in the same flow direction to maximize efficiency (i.e., all in the exhaust mode or all in the supply mode).

- Communications equipment necessary to permit immediate, understandable communications between the entrant(s) and the attendant(s).

- Personal protective equipment necessary to supplement feasible engineering and work practice controls.

- Lighting equipment necessary for safe operations and emergency exit. Temporary lighting used in confined spaces shall meet the following requirements:
  - All lighting shall be approved for use in Class I, Division I, Groups A, B, C, and D atmospheres.
  - Extension cords used for temporary lighting shall be equipped with connectors or switches approved for hazardous locations.
  - Temporary lighting shall be equipped with adequate guards to prevent accidental contact with the bulb.
  - The lighting shall not be suspended by the electric cords, unless designed for this method of suspension.
  - Electric cords shall be kept clear of working spaces and walkways or other locations in which they may be exposed to damage.
  - Temporary lighting and electric cords shall be inspected regularly for signs of damage to insulation and wiring.
- Specified barriers and shields.
- Equipment such as ladders needed for safe ingress and egress.
- Rescue and emergency equipment, unless provided by local rescue services.
- Any other equipment necessary for safe entry to and rescue from permit spaces.

Prior to authorizing entry, a competent person shall conduct tests to determine if acceptable entry conditions exist. When spaces are not fully isolated because of their size or design (sewers), pre-entry testing will be conducted to the extent feasible, and if entry is authorized, conditions shall be continuously monitored in the work area.

During the course of entry operations, a competent person shall test or monitor the permit space, as necessary, to determine if acceptable entry conditions are being maintained.

When testing for atmospheric hazards, test first for oxygen, then for combustible gases and vapors, and finally for toxic gases and vapors. Atmospheric testing conducted in accordance with Attachment A would satisfy these requirements.

At least one attendant shall be stationed outside the permit space for the duration of the entry operations. Attendants may be assigned to monitor more than one permit space, provided the duties described in Section 10 of this procedure can be effectively performed for each permit space that is monitored. Likewise, attendants may be stationed at any location outside the permit space to be monitored as long as the duties described in Section 10 of this procedure can be effectively performed for each permit space that is monitored.

If multiple spaces are to be monitored by a single attendant, include in the permit program the means and procedures to enable the attendant to respond to an emergency affecting one or more of the permit spaces being monitored. The attendant should be able to conduct this procedure without distracting from the attendant's responsibilities under Section 10 of this procedure.

The roles and duties of each person participating in an entry operation (as, for example, authorized entrants, attendants, Entry Supervisors, or persons who test or monitor the atmosphere in a permit space) shall be established and each person shall receive training commensurate with the duties assigned.

Procedures for summoning rescue and emergency services, for rescuing entrants from permit spaces, for providing necessary emergency services to rescued employees, and for preventing unauthorized personnel from attempting a rescue, shall be developed and implemented.

Procedures to coordinate entry operations among multi-employer workforces shall be developed and implemented.

The permit space shall be secured and entry-related documentation shall be completed and retained in project files for a period of at least one year.

The entry program shall be reviewed and any deficiencies corrected whenever evidence exists that employee protection is inadequate. Examples of circumstances requiring the review of the Permit-required Confined Space Program are any unauthorized entry of a permit space, the detection of a permit space hazard not covered by the permit, the detection of a condition prohibited by the permit, the occurrence of an injury or near miss during entry, a change in the use or configuration of a permit space, and employee complaints about the effectiveness of the program.

The Permit-required Confined Space Program shall be reviewed within one year after each entry and revised as necessary, to ensure that employees participating in entry operations are protected from permit space hazards. Employers may perform a single annual review covering all entries performed during a 12-month period. If no entry is performed during a 12-month period, no review is necessary.

- Alternate Entry Procedure

  A simpler, alternate procedure may be followed for permit-required space entry if all of the following conditions are met:

  - The only hazard posed by the permit space is from an existing, or potential hazardous atmosphere.
  - Continuous, forced-air ventilation alone is sufficient to maintain the space safe for entry.
  - Monitoring and inspection data supporting the above two conditions are collected and documented.
  - Supporting data is made available to each employee who enters the permit space under this alternate procedure.

The alternate entry procedure shall conform to the following:

- Any conditions making it unsafe to remove an entrance cover shall be eliminated before the cover is removed.
- When entrance covers are removed, the opening shall be promptly guarded by a railing, temporary cover, or other temporary barrier that will prevent an accidental fall through the opening and that will protect each employee working in the space from foreign objects entering the space.
- Before an employee enters the space, the internal atmosphere shall be tested, with a calibrated, direct reading instrument, for these conditions in the order given: (1) oxygen content, (2) flammable gases and vapors, and (3) potential toxic air contaminants.
- There may be no hazardous atmosphere within the space whenever any employee is inside the space.
- Continuous forced air ventilation shall be used when: (1) an employee may not enter the space until the forced air ventilation has eliminated any hazardous atmosphere; (2) the forced air ventilation shall be so directed as to ventilate the immediate areas where an employee is or will be present within the space and shall continue until all employees have left the space; or (3) the air supply for the forced air ventilation shall be from a clean source and may not increase the hazards in the space.
- The atmosphere within the space shall be periodically tested as necessary to ensure that the continuous forced air ventilation is preventing the accumulation of a hazardous atmosphere.
- If a hazardous atmosphere is detected during entry, (1) each employee shall leave the space immediately; (2) the space shall be evaluated to determine how the hazardous atmosphere developed; and (3) measures shall be implemented to protect employees from the hazardous atmosphere before any subsequent entry takes place.
- The employer shall verify that the space is safe for entry and that the measures required by Section 6 have been taken, through a written certification that contains the date, the location of the space, and the signature of the person providing the certification.
- The certification shall be made before entry and shall be made available to each employee entering the space.

7.0 Entry Permit System

Before authorization to enter is granted, the completion of hazard control measures specified in Section 6 above shall be documented on an entry permit (Attachment B).

The Entry Supervisor shall authorize the entry by signing the completed permit.

The signed permit shall be posted or otherwise made available to all authorized entrants so that they may confirm that all pre-entry preparations are in place.

The duration of the permit may not exceed the time required to complete the assigned purpose of the entry.

The Entry Supervisor will terminate the entry and cancel the permit when either of the following occurs:

- The operations covered by the permit have been completed.
- Any condition not allowed under the entry permit occurs in or near the permit space.

Canceled entry permits shall be retained for at least one year so that the program review required under Section 6 above may be performed. Any problems that occur during an entry shall be noted on the permit.

8.0 Entry Permit

The entry permit shall contain the following information:

- The permit space to be entered.
- The purpose of the entry.
- The date and the authorized duration of the entry permit.
- The authorized entrants within the permit space, by name or by such other means (for example, through the use of rosters or tracking systems) that will enable the attendant to determine quickly and accurately, for the duration of the permit, which authorized entrants are inside the permit space.
- The personnel, by name, currently serving as attendants.
- The individual, by name, currently serving as Entry Supervisor, with a space for the signature or initials of the Entry Supervisor who originally authorized entry.
- The hazards of the permit space to be entered.
- The measures used to isolate the permit space and to eliminate or control permit space hazards before entry. Those measures can include the lockout or tagging of equipment and procedures for purging, inerting, ventilating, and flushing permit spaces.
- The acceptable entry conditions.
- The results of initial and periodic tests performed under Section 6 of this procedure, accompanied by the names or initials of the testers and by an indication of when the tests were performed.

- The rescue and emergency services that can be summoned and the means (such as the equipment to use and the numbers to call) for summoning those services.

- The communication procedures used by authorized entrants and attendants to maintain contact during the entry.

- Equipment, such as personal protective equipment, testing equipment, communications equipment, alarm systems, and rescue equipment, to be provided for compliance with this section.

- Any other information whose inclusion is necessary, given the circumstances of the particular confined space, to ensure employee safety.

- Any additional permits, such as for hot work, that have been issued to authorize work in the permit space.

9.0 Training

The Project Manager shall ensure that all employees assigned to tasks under this procedure have been trained, and have the understanding, knowledge, and skills necessary for the safe performance of their duties.

Training shall be provided to each employee on the following occasions:

- Before the employee is first assigned duties under this procedure.

- Before there is a change in assigned duties.

- Whenever there is a change in permit space operations that presents a hazard about which an employee has not previously been trained.

- Whenever the employer has reason to believe that there are deviations from the permit space entry procedures required by Section 6 of this procedure, or that there are inadequacies in the employee's knowledge or use of these procedures.

The training shall establish employee proficiency in the duties required by this procedure and shall introduce new or revised practices, as necessary, for compliance with this procedure.

Training required by this section shall be certified. The certification shall contain each employee's name, the signatures or initials of the trainers, and the dates of training. The certification shall be available for inspection by employees and their authorized representatives.

10.0 Responsibilities

- **Authorized Entrants**

  The employer shall ensure that all authorized entrants:

- Know the hazards that may be faced during entry, including information on the mode, signs or symptoms, and consequences of the exposure.
- Properly use equipment, as required by Section 6 of this procedure.
- Communicate with the attendant, as necessary, to enable the attendant to monitor entrant status and to enable the attendant to alert entrants of the need to evacuate the space, as required by Section 10 of this procedure.
- Alert the attendant whenever:
  - The entrant recognizes any warning sign or symptom of exposure to a dangerous situation.
  - The entrant detects a prohibited condition.
- Exit from the permit space as quickly as possible whenever:
  - An order to evacuate is given by the attendant or the Entry Supervisor.
  - The entrant recognizes any warning sign or symptom of exposure to a dangerous situation.
  - The entrant detects a prohibited condition.
  - An evacuation alarm is activated.

- **Attendant**

The employer shall ensure that each attendant:

- Knows the hazards that may be faced during entry, including information on the mode, signs or symptoms, and consequences of the exposure.
- Is aware of possible behavioral effects of hazard exposure in authorized entrants.
- Continuously maintains an accurate count of authorized entrants in the permit space and ensures that the means used to identify authorized entrants under Section 8(a) of this procedure accurately identifies who is in the permit space at any given time.
- Remains outside the permit space during entry operations until relieved by another attendant.
- Communicates with authorized entrants, as necessary, to monitor entrant status and to alert entrants of the need to evacuate the space.
- Monitors activities inside and outside the space to determine if it is safe for entrants to remain in the space, and orders the authorized entrants to evacuate the permit space immediately under any of the following conditions:

    - If the attendant detects a prohibited condition.
    - If the attendant detects the behavioral effects of hazard exposure in an authorized entrant.
    - If the attendant detects a situation outside the space that could endanger the authorized entrants.
    - If the attendant cannot effectively and safely perform all the duties required.
  - Summons rescue and other emergency services as soon as the attendant determines that authorized entrants may need assistance to escape from permit space hazards.
  - Takes the following actions when unauthorized persons approach or enter a permit space while entry is underway:
    - Warn the unauthorized persons that they must stay away from the permit space.
    - Advise the unauthorized persons that they must exit immediately if they have entered the permit space.
    - Inform the authorized entrants and the Entry Supervisor if unauthorized persons have entered the permit space.
  - Performs non-entry rescues, as specified by the employer's rescue procedure.
  - Performs no duties that may interfere with the attendant's primary duty to monitor and protect the authorized entrants.

- **Entry Supervisor**

  The employer shall ensure that each Entry Supervisor:

  - Knows the hazards that may be faced during entry, including information on the mode, signs or symptoms, and consequences of the exposure.
  - Verifies, by checking that the appropriate entries have been made on the permit, that all tests specified by the permit have been conducted, and that all procedures and equipment specified by the permit are in place before endorsing the permit and allowing entry to begin.
  - Terminates the entry and cancels the permit, as required.
  - Verifies that rescue services are available and that the means for summoning them are operable.

- ➢ Removes unauthorized individuals who enter or who attempt to enter the permit space during entry operations.

- ➢ Determines, whenever responsibility for a permit space entry operation is transferred, and at intervals dictated by the hazards and operations performed within the space, that entry operations remain consistent with the terms of the entry permit and that acceptable entry conditions are maintained.

11.0 Rescue and Emergency Services

Parametrix personnel shall perform only non-entry rescue.

The following requirements apply to employers who have employees enter permit spaces to perform rescue services:

- The employer shall ensure that each member of the rescue service is provided with, and is trained to use properly, the personal protective equipment and rescue equipment necessary for making rescues from permit spaces.

- Each member of the rescue service shall be trained to perform the assigned rescue duties. Each member of the rescue service shall receive the training required of authorized entrants under Section 9 of this procedure.

- Each member of the rescue service shall practice making permit space rescues at least once every 12 months, by means of simulated rescue operations in which they remove dummies, manikins, or actual persons from the actual permit spaces or from representative permit spaces. Representative permit spaces shall, with respect to opening size, configuration, and accessibility, simulate the types of permit spaces from which rescues are to be performed.

- Each member of the rescue service shall be trained in basic First Aid and in cardiopulmonary resuscitation (CPR). At least one member of the rescue service holding current certifications in First Aid and CPR shall be available.

- When an employer (host employer) arranges to have persons other than the host employer's employees perform permit space rescue, the host employer shall:

    - ➢ Inform the rescue service of the hazards they may confront when called on to perform rescue at the host employer's facility.

    - ➢ Provide the rescue service with access to all permit spaces from which rescue may be necessary so that the rescue service can develop appropriate rescue plans and practice rescue operations.

To facilitate non-entry rescues, retrieval systems or methods shall be used whenever an authorized entrant enters a permit space, unless the retrieval equipment would increase the overall risk of entry or would not contribute to the rescue of the entrant. Retrieval systems shall meet the following requirements:

- Each authorized entrant shall use a chest or full body harness, with a retrieval line attached at the center of the entrant's back near shoulder level, or above the entrant's head. Wristlets may be used in lieu of the chest or full body harness if the employer can demonstrate that the use of a chest or full body harness is infeasible or creates a greater hazard, and that the use of wristlets is the safest and most effective alternative.

- The other end of the retrieval line shall be attached to a mechanical device or fixed point outside the permit space in such a manner that rescue can begin as soon as the rescuer becomes aware that rescue is necessary. A mechanical device shall be available to retrieve personnel from vertical-type permit spaces more than five feet deep.

- If an injured entrant is exposed to a substance for which a Material Safety Data Sheet (MSDS) or other similar written information is required to be kept at the worksite, that MSDS or written information shall be made available to the medical facility treating the exposed entrant.

12.0 Records

The Confined Space Entry Permit (Attachment B) is used for documenting activities associated with this procedure. The completed permits shall be maintained for a period of one year from the date of cancellation.

ATTACHMENT A

PROCEDURES FOR ATMOSPHERIC TESTING.

Atmospheric testing is required for two distinct purposes: (1) evaluation of the hazards of the permit space, and (2) verification that acceptable entry conditions for entry into that space exist.

Evaluation Testing: The atmosphere of a confined space should be analyzed using equipment of sufficient sensitivity and specificity to identify and evaluate any hazardous atmospheres that may exist or arise, so that appropriate permit entry procedures can be developed and that acceptable entry conditions can be stipulated for that space. Evaluation and interpretation of these data, and development of the entry procedure, should be performed by, or reviewed by, a technically qualified professional (e.g., certified industrial hygienist, marine chemist, registered safety engineer, certified safety professional), based on evaluation of all serious hazards.

Verification Testing: The atmosphere of a permit space that may contain a hazardous atmosphere should be tested for residues of all contaminants identified by evaluation testing using permit-specified equipment to determine that residual concentrations at the time of testing and entry are within the range of acceptable entry conditions. Results of testing (i.e., actual concentrations) should be recorded on the permit in the space provided adjacent to the stipulated acceptable entry condition.

Duration of Testing: Measurement of values for each atmospheric parameter should be determined for at least the minimum response time of the test instrument specified by the manufacturer.

Testing Stratified Atmospheres: When monitoring for entries involving a descent into atmospheres that may be stratified, the atmospheric envelope should be tested at a distance of approximately 4 feet (1.22 m) in the direction of travel and to each side. If a sampling probe is used, the entrant's rate of progress should be slowed to accommodate the sampling speed and detector response.

ATTACHMENT B
CONFINED SPACE ENTRY PERMIT

*** VALID FOR ONE SHIFT ONLY ***

PROJECT #	CLIENT	DATE	TIME
LOCATION OF SPACE			
PURPOSE OF ENTRY			
PRIOR CONTENTS OF SPACE		TYPE OF SPACE	

ATMOSPHERIC TESTING (TO BE DONE EVERY 2 HOURS)

COMPOUND	ACCEPTABLE RANGE	TIME	YES	NO	N/A
OXYGEN	>19.5% **AND** <23.5%				▨
LEL	<10%				▨
CO	<35 PPM				
H_2S	<10 PPM				
HYDROCARBONS	<1 PPM				
OTHER	< PEL				

HAZARD CONTROLS IMPLEMENTED

ACTION COMPLETED	YES	NO	N/A
SPACE FULLY ISOLATED			▨
SPACE EMPTIED AND FREE OF RESIDUE			
MECHANICAL VENTILATION OPERATING			
SPACE SECURE FROM ACCIDENTAL ENTRY			▨
SAFE ACCESS INTO/FROM SPACE AVAILABLE			▨
EQUIPMENT USED IN SPACE INTRINSICALLY SAFE			
ELECTRICAL GROUNDING AND BONDING IN PLACE			
ALL ENTRANTS, ATTENDANTS, AND SUPERVISORS TRAINED			▨
RESPIRATORY PROTECTION PROVIDED			
SKIN/BODY PROTECTION PROVIDED			
EYE, EAR, AND HEAD PROTECTION PROVIDED			
EMERGENCY RESCUE SERVICES AVAILABLE			▨

SIGNATURES

ALL ITEMS ABOVE MUST BE YES OR N/A

ENTRY AUTHORIZED BY: (ENTRY SUPERVISOR)	
ATTENDANT:	ATTENDANT:
ENTRANT:	ENTRANT:
ENTRANT:	ENTRANT:

HANDLING OF INVESTIGATION-DERIVED WASTE

Prepared By: ______________________ Date: ____________
Health and Safety Committee Chair

Reviewed By: ______________________ Date: ____________
Corporate Health and Safety Officer

Approved By: ______________________ Date: ____________
Chief Operating Officer

1.0 Purpose

Management of investigation-derived waste (IDW) minimizes the potential for the spread of hazardous waste on site or off site through investigation activities. The purpose of this Standard Operating Procedure (SOP) is to provide instructions for the proper management of contaminated materials derived from field investigations.

2.0 Scope

The procedures outlined are to be followed by all personnel who participate in site activities in areas where IDW is generated.

Materials that are known or suspected to be contaminated with hazardous substances through the actions of sample collection or personnel and equipment decontamination were said to be investigation-derived wastes. These wastes include decontamination solutions, disposable equipment, drill cuttings and fluids, and groundwater monitoring well development and purge waters. To the extent possible, the Site Manager will attempt to minimize the generation of these wastes through careful design of decontamination schemes and groundwater sampling programs. Testing conducted on soil and water investigation-derived wastes will show if they were also hazardous wastes as defined by RCRA. This will determine the proper handling and ultimate disposal requirements.

The criteria for designating a substance as a hazardous waste, according to RCRA, is provided in 40 CFR 261.3 if investigation-derived wastes meet these criteria, RCRA requirements must be followed for packaging, labeling, transporting, storing and record keeping as described in 40 CFR 262 34. Those wastes judged to potentially meet the criteria for hazardous wastes, shall be stored in Department of Transportation-approved, 55-gallon steel drums.

Wastes that can be shown not to be RCRA-designated hazardous wastes may be handled and disposed on site or off site to municipal wastewater and/or solid waste systems at the direction of the EPA RPM. Investigation-derived waste is assumed to be RCRA-designated hazardous waste unless analytical evidence indicates otherwise.

3.0 Investigation-Derived Waste Management

Procedures that minimize the potential for the spread of hazardous waste include minimizing the volume of waste generated, waste segregation, appropriate storage, and disposal, according to RCRA requirements.

Waste Minimization

Within the absolute constraints demanded by worker health and safety and project quality assurance/quality control, the generation of investigation-derived wastes is to be limited. In the development of the investigation work plan, each aspect of the investigation is to be reviewed to identify areas where excess waste generation can be eliminated. General procedures that will eliminate waste include avoidance of unnecessary exposure of materials to hazardous waste, and coordination of sampling schedules to avoid repetitious purging of wells and use of sampling equipment.

Waste Segregation

Waste storage and handling procedures to be used depend on the type of generated waste. For this reason, investigation-derived hazardous wastes described below are segregated into separate, 55-gallon storage drums. Waste materials that are known to be free of hazardous waste contamination (such as broken sample bottles or equipment containers and wrappings), must be collected separately for disposal to municipal systems. Large plastic garbage or lawn and leaf bags are useful for collecting this trash.

Decontamination Solutions

Decontamination solutions are generated from washing and rinsing of personal protective equipment (PPE) and sampling equipment. Solutions considered investigation-derived wastes range from detergents, organic solvents, and acids used to decontaminate small hand samplers to steam cleaning rinsate used to wash drill rigs and other large equipment. These solutions are to be stored in 55-gallon drums with bolt-sealed lids.

Soil Cuttings and Drilling Mud

Soil cuttings are solid to semisolid soils generated during trenching activities, drilling for the collection of subsurface soil samples, or the installation of monitoring wells. Depending on the type of drilling, drilling fluids known as “muds” may be used to remove soil cuttings. Drilling fluids flushed from boreholes must be directed into a settling section of a mud pit. This allows reuse of the decanted fluids after removal of the settled sediments. Drill cuttings, whether generated with or without drilling fluids, are to be removed with a flat-bottomed shovel and stored in 55-gallon drums with bolt-sealed lids.

Well Development and Purge Water

Well development and purge waters consists of groundwater removed from monitoring wells to repair damage to the aquifer following well installation, obtain characteristic aquifer groundwater samples, or measure aquifer hydraulic properties. The volume of groundwater to be generated will determine the appropriate storage procedure. These activities can generate significant volumes of groundwater depending on the well yield and the duration of the test or activity. Use of drums or large–volume, portable tanks such “Baker Tanks” should be considered for temporary storage of purge water.

Disposable Equipment

Disposable equipment includes used personal protective equipment such as Tyvek coveralls, gloves, booties and APR cartridges, and some inexpensive sampling equipment such as trowels or disposable bailers. This equipment is assumed to be contaminated if it was used at a hazardous waste site because it is impractical to submit these items for analysis. These materials should be stored on site in 55-gallon drums, pending final disposal.

Waste Storage

The wastes that accumulate through investigations must be stored on site prior to disposal. An on-site waste staging area should be designated to provide secure and controlled storage for the drums. Per RCRA requirements, storage cannot exceed 90 days for materials presumed or shown to be RCRA-designated hazardous wastes. Waste that is known not to be RCRA–designated, should be promptly disposed to municipal waste systems.

Storage Containers

Containers shall be DOT-approved (DOT 17H 18/16GA OH unlined), open top, steel drums. The lids should lift completely off the drum, and be secured by a bolt ring. Enough drums should be ordered to store all anticipated waste, including extra drums for solid waste and decontamination water. Solid and liquid wastes are not to be mixed in the drums.

Pallets are often required to allow transport of filled drums to the staging area with a forklift. Normal pallets are 3′ x 4′ and will hold two to three, 55-gallon drums, depending on the filled weight. If pallets are required for drum transport or storage, Parametrix field personnel are responsible for ensuring that the empty drums are placed on pallets before they are filled and that the lids are sealed on the drums with the bolt tighten ring after the drums are filled. Because the weight of one drum can exceed 500 pounds, under no circumstances should Parametrix personnel attempt to move the drums by hand. In addition, Parametrix personnel should not operate forklifts as part of their regular field activities. Removal of drums to the staging area is normally the responsibility of the client, unless other arrangements have been made.

Drum Labeling

Each drum that is used will be assigned a unique number that will remain with that drum for the life of the drum. This number will be written in permanent marker on the drum itself. Do not label drum lids. Drum labels shall contain the following information:

- Waste accumulation start date.
- Well number or boring number, if applicable.
- Drum number.
- Contents matrix (soil, water. slurry, etc.).

- Generation location.
- Project name.

4.0 Waste Disposal

Responsibility for the final disposal of investigation-derived waste will be determined before field activities are begun and shall be described in the investigation work plan. Disposal or long-term storage (over 90 days) of RCRA-designated hazardous wastes requires procedures that are beyond the scope of this SOP. The Parametrix Hazardous Waste Management Program is presented in SOP HS-005.

DECONTAMINATION

Prepared By:	Health and Safety Committee Chair	Date:	
Reviewed By:	Corporate Health and Safety Officer	Date:	
Approved By:	Chief Operating Officer	Date:	

1.0 Purpose

This Standard Operating Procedures (SOP) provides instructions for personnel and equipment decontamination that are to be followed during field operations.

2.0 Scope

Decontamination is the process of removing or neutralizing contaminants that have accumulated on personnel and/or equipment at hazardous waste sites. Decontamination is required to protect personnel from the potential effects of hazardous substances and to minimize the spread of those substances. Decontamination methods include physical removal of contaminants, detoxification, and disinfection/ sterilization.

This SOP describes decontamination responsibilities and procedures to be implemented at hazardous waste sites. The procedures outlined are to be followed by all personnel who participate in site activities in areas that may contain hazardous substances. The scenarios of decontamination procedures presented here will not necessarily all be appropriate for a given site. Project procedures may be prepared as part of the Site-specific Health and Safety Plan (HSP) that focus on site-specific conditions and incorporate the appropriate procedures presented in this SOP.

This procedure applies in its entirety to all Parametrix projects unless the Corporate Health and Safety Manager (CHSO) grants a variance. Modifications to these procedures may be appropriate on a project-specific basis.

3.0 Responsibilities

There are specific responsibilities for Parametrix personnel in complying with the required decontamination procedures, depending on an individual's role within the company or on a given project. These responsibilities are outlined below:

- **Site-specific Health and Safety Officer:** The Site-specific Health and Safety Officer (SHSO) is responsible for maintaining and enforcing the project decontamination program. HSP decontamination procedures for all projects shall be reviewed and authorized by the

CHSO. All modifications and/or changes must be noted in the field logbook, documented as HSP revisions, and initialed by all field personnel.

- **Site Manager:** The Site Manager is responsible for assuring that all site personnel become familiar with and follow the decontamination procedures described in this SOP or in the Site-specific HSP.

4.0 Personnel Decontamination Procedures

Contamination avoidance is the best way to prevent the spread of contaminants. Direct contact with contaminants should be minimized by not leaning against objects, and not kneeling or sitting on the ground; through the use of remote sample-handling and container-opening techniques, wherever appropriate; and through the use of disposable equipment, wherever appropriate.

Decontamination Program Planning

The SHSO shall research the background information on a particular site when planning decontamination procedures for the fieldwork at that site. The physical, chemical, toxicological, and pathogenic properties (if any), as well as the amounts and concentrations of each contaminant present at the site, are the determining factors in selecting the levels of protection for personnel and the extent of decontamination required. Sources of information for the characterization of hazardous waste sites include site records, state and federal agency files, and interviews with knowledgeable people. Hazardous and toxicological references, industrial process references, and manufacturers' handbooks are also good sources of information. Topography, local meteorological conditions (most probable wind direction. rainfall, etc.), and other site-specific features, are factors to consider in defining decontamination measures.

Decontamination Station Layout

When site conditions require, a dedicated area shall be established as a decontamination station. The decontamination station shall be located upwind of the Exclusion Zone. This is especially important when airborne contaminants are detected at above-background levels, or when such a potential exists. This is to prevent the airborne contamination of the Contamination Reduction Zone (CRZ) and the Support Zone. Exclusion, CRZ, and Support Zones are depicted in Figure I and defined as follows:

- **Exclusion Zone:** The zone encompassing the contaminated area that must be large enough to prevent the spread of contaminants beyond its boundaries. The extent of the Exclusion Zone will depend on:
    - ➢ Toxicity of the contaminants.
    - ➢ Physical form of the contaminants (solid, liquid, or gas).
    - ➢ Amounts and concentrations of the contaminants.
    - ➢ Fire and explosive potential of contamination.
    - ➢ Site-specific conditions such as topography and meteorology, and potential and active migration pathways to air, water, and soil.

- **Contamination Reduction Zone (CRZ):** The area between the Exclusion and Support Zones where contamination is controlled and/or removed. A contamination reduction corridor is an area within the CRZ that is the point of entry and exit for personnel to and from the Exclusion Zone.

- **Support Area:** The Support Area is separated from the CRZ by the contamination control line (CCL). The Support Area must be free from all contamination at all times.

The boundaries of the decontamination station should be clearly visible to all field personnel. The decontamination line should be set up along a straight line to facilitate identifying each station in the decontamination process. Movements to and from the exclusion zone will only be via the decontamination corridor.

Site-specific conditions to consider when locating the decontamination station are the location(s) of field investigation activities, accessibility to site personnel, and site terrain and safety. The decontamination station should be moved if site investigation activities are moved significantly.

The SHSO will determine if gross contamination has spread beyond the Exclusion Zone if wind direction changes (when airborne contaminants are suspected), inclement weather develops, or other site-specific factors arise.

Multiple decontamination stations may be deemed necessary by the SHSO, depending on the particular project.

Decontamination equipment materials and supplies are generally selected on the basis of availability and compatibility with contaminants encountered. Other considerations include ease of equipment decontamination, disposability, and site-specific requirements. Recommended equipment for a decontamination station includes the following:

- Plastic sheeting, or other suitable materials, on which the decontamination tubs, clean equipment, and contaminated equipment can be set down.

- Long-handled, soft-bristled wire or other scrub brushes to help scrub off contaminants.

- Large plastic or steel tubs or other suitable tubs. These should be large enough for a worker to step in.

- Paper towels for drying protective clothing and equipment.

- DOT-approved drums with lids for contaminated wash and rinse solutions, for contaminated disposal items and for trash cans.

- Washcloths, soap, and towels for hand rinse.

- Pressurized spray cans for deionized/distilled water.

- Portable shower facilities for full-body wash (it needed).

- Folding chairs and tables.

- Pocket knife.
- Stakes and rope for marking the hot zone limits.
- First Aid kit.
- Decontamination solutions and detergents.
- Distilled and deionized water. Potable tap water for decontamination.

Personnel Decontamination Solutions

Personnel will generally use household soap and water. The detergents Alconox or Liquinox and water are the preferred surfactants for most decontamination procedures relating to equipment. Selection of specific solvents and decontamination solutions are to be defined in the site work plan.

The effectiveness of decontamination solutions will be continuously verified. Visual observations of discoloration, stains, and arid substances adhering to objects, are indications that the decontamination solution is not effective in removing contamination. Decontamination solutions must be replenished frequently with use, to ensure their continued effectiveness.

The quality of rinse water used in the decontamination process shall be verified. A distilled/deionized rinse is the final step in the decontamination of equipment and in removing all traces of contaminants.

Personnel Decontamination

Personnel decontamination procedures depend on the level of personal protection worn by the field crew, as required by the Site-specific Health and Safety Plan, and upon the degree of contamination the crewmembers experience. The objective of personal decontamination is to protect the health of all crewmembers and to prevent the spread of contamination from the site. Therefore, the following procedures should be extended and modified by the SHSO until all field personnel are satisfied that complete decontamination has been accomplished. In the event of an emergency, the SHSO may judge it necessary to curtail these decontamination procedures to evacuate the site or initiate First Aid.

- **Level B Decontamination:** Level B personal protection equipment (PPE) includes chemical-resistant disposable coveralls, SCBA, hardhat, steel-toe/shank boots, boot covers, and inner and outer gloves. Level B decontamination procedures also can be divided into four sublevels: (1) highly-contaminated personnel exiting the Exclusion Zone, (2) minimally-contaminated personnel exiting the Exclusion Zone, (3) highly-contaminated personnel crossing the hot line to exchange SCBA tank, and (4) minimally-contaminated personnel crossing the hot line to exchange SCBA tank. These distinctions are noted in the decontamination station descriptions below.
  - ➢ <u>Station 1 – Segregated Equipment Drop (All Sublevels)</u>: Before crossing the hot line, personnel returning from the field must deposit all equipment and/or sample bottles in segregated areas on plastic sheeting. Highly-contaminated equipment, such as samplers and sample containers, are kept separate from minimally-contaminated and difficult-to-clean equipment, such as air monitoring equipment.

- <u>Station 2 – Boot Cover and Outer Glove Wash, Rinse, and Removal</u>: Personnel must step into a washtub containing a detergent solution. Boot covers and outer gloves are scrubbed with a long-handled, soft-bristled brush. All surfaces of the boots and gloves are washed, including boot soles and duct tape used to seal covers and gloves to coverall. Boot covers, including soles and outer gloves, are rinsed with a long-handled, soft-bristled brush. Tape is removed from boat covers and outer gloves and deposited into a plastic-lined disposal drum. Boot covers, and outer gloves are removed and deposited into a plastic-lined disposal drum. A knife may be used to aid in the removal of tight-fitting boot covers.

- <u>Station 3 – Coverall, SCBA, and Safety Boot Wash and Rinse</u>: At this station, all exposed surfaces of PPE are washed with the detergent solution. Personnel must step into a washtub containing a detergent solution. All gear is scrubbed with a long-handled, soft-bristled brush. All surfaces of gear should be scrubbed, including boot soles, until visible contamination is removed. All exposed surfaces of PPE are rinsed to remove detergent.

  Personnel must step into a washtub containing tap water. All gear is rinsed with a long-handled, soft-bristled brush. Pressure sprayers containing tap water may be used to aid in rinsing.

- <u>Station 4 – Safety Boot, SCBA Backpack, and Chemically-Resistant Overall Removal</u>: Boots must be removed and set on plastic sheeting. While still wearing the face-piece, the SCBA backpack is removed and set on a chair or table. The air supply hose is disconnected from the regulator valve. Chemically-resistant overalls are removed and disposed to a plastic-lined disposal drum.

- <u>Station 5 – Inner Glove Wash and Rinse and SCBA Face Piece Removal</u>: Inner gloves are scrubbed by rubbing hands together with a detergent solution then rinsed in tap water. The SCBA face piece is removed without touching inner gloves to face. Deposit face piece on plastic sheeting.

- <u>Station 6 – Inner Glove Removal</u>: Inner gloves are removed and disposed to a plastic-lined disposal drum.

- <u>Station 7 – Field Wash/Field Shower</u>: Hands and face are washed with hand soap, then rinsed and dried with paper towels. If highly–toxic, skin-corrosive, or skin-absorbable materials are at the site, shower entire body.

- **Level C Decontamination:** Level C personal protection includes chemical-resistant disposable coverall, APR, hardhat, steel-toe/shank boots, boot covers, and inner and outer gloves. Depending on exposure hazards, boot covers and outer gloves may not be required, and Tyvek coveralls may be substituted for chemical-resistant coveralls. Station decontamination activities include the following:

  - <u>Station 1 – Segregated Equipment Drop</u>: Before crossing the hot line, personnel returning from the field must deposit all equipment and/or sample bottles in segregated areas on plastic sheeting. Highly-contaminated equipment, such as samplers and sample containers, are kept separate from minimally-contaminated and difficult-to-clean equipment, such as air monitoring equipment.

- Station 2 – Boot Covers and Outer Glove Wash, Rinse, and Removal: Personnel must step into a wash tub containing a detergent solution. Boot covers and outer gloves are scrubbed with a long-handled, soft-bristled brush. All surfaces of the boots and gloves are washed including boot soles and duct tape used to seal covers and gloves to coveralls.

  Personnel must step into a washtub containing tap water. Boot covers, including bottoms and outer gloves, are rinsed with a long-handled, soft-bristled brush. Tape that seals boot covers and outer gloves is removed and deposited into a plastic-lined disposal drum. Boot covers and outer gloves are removed and deposited into a plastic-lined disposal drum. A knife may be used to aid in the removal of tight-fitting boot covers.

- Station 3 – Safety Boots and Coveralls Wash, Rinse, and Removal: Personnel must step into a wash tub containing a detergent solution. Boots are scrubbed with a long-handled, oft-bristled brush. If leather safety boots are worn, the soles are scrubbed and the upper surfaces are wiped with a paper towel dipped in detergent solution. If waterproof coveralls are worn, they are scrubbed also. All surfaces of gear, including boot soles, are scrubbed until visible contamination is removed.

  Personnel must step into a washtub containing a tap water. Boots and coveralls are rinsed with a long-handled, soft-bristled brush. Boots are removed and set on plastic sheeting. Coveralls are removed and disposed to a plastic-lined disposal drum.

- Station 4 – Inner Glove Wash and Rinse: Inner gloves are scrubbed by rubbing hands together with a detergent solution. Finish with a rinse in tap water.

- Station 5 – APR and Inner Glove Removal: The APR is removed without touching inner gloves to face, and then deposited on plastic sheeting. Inner gloves are removed and disposed to a plastic-lined disposal drum.

- **Level D Decontamination:** Level D is the lowest level of personal protection and is worn when exposure to contaminants is not expected. Level D personal protection includes hardhat and steel-toe/shank leather boots. Depending on the anticipated activities, Level D may also include Tyvek coveralls and gloves. Station decontamination activities include the following:

  - Station 1 – Segregated Equipment Drop: Personnel returning from the field must deposit all equipment and/or sample bottles in segregated areas on plastic sheeting. Highly-contaminated equipment, such as samplers and sample containers, are kept separate from minimally-contaminated and difficult-to-clean equipment, such as air-monitoring meters.

  - Station 2 – Safety Boot Wash, Rinse, and Removal: Boot soles must be scrubbed with a long-handled, soft-bristled brush. All surfaces of gear, including boot soles, must be scrubbed until visible contamination is removed. Boot soles are rinsed with tap water using a long-handled, soft-bristled brush. Boots are removed and set on plastic sheeting.

- Station 3 – Coveralls Removal (if needed): If worn, remove coveralls and dispose to a plastic-lined disposal drum.

- Station 4 – Glove Wash, Rinse, and Removal (if needed): If worn, inner gloves are scrubbed by rubbing hands together with a detergent solution. Finish with a rinse in tap water. Gloves are removed and disposed to a plastic-lined disposal drum.

Priorities for Worker Decontamination

The following members of the work team returning from the Exclusion Zone shall have priority over others when being decontaminated.

- A worker who is in need of First Aid, or is in physical discomfort.
- A worker who is low on air or whose SCBA is malfunctioning.
- A worker who has been highly contaminated.
- A worker who did the major part of physical activity required on site.

It is the responsibility of the SHSO to decide which workers receive priority.

Emergency Decontamination

In an emergency, the primary concern shall be to prevent the loss of life or severe injury to personnel. If immediate administration of medical treatment is required to prevent further deterioration of health, then decontamination may be eliminated, modified, or performed later when the condition has stabilized. The SHSO and the team leader must weigh the consequences of delaying, modifying, or eliminating decontamination against the consequences of delaying treatment, before making a decision on a case-by-case basis.

First Aid equipment shall be readily available in the Support Area and, as specified in the Site-specific HSP. At least one response team member shall be trained in First Aid and CPR.

Arrangements shall be made to advise medical personnel on the nature of contaminants to which the patient was exposed and the extent of decontamination. In some cases, the SHSO will need to contact nearby emergency response medical facilities in advance to alert them of the possibility of a problem. This will help the medical facility to prepare for the specific sort of health care that may be required in an emergency.

Cold Weather Decontamination

In freezing temperatures, a small quantity of ethanol can be added to the washtubs containing decontamination and tap water to prevent freezing. Deionized water and distilled water containers shall be kept warm in the heated van or car for use when needed. Orchard sprayers shall also be kept in a warm place when not in use.

5.0 Decontamination of Equipment

Protection of Monitoring Instruments

All equipment and monitoring instruments shall be protected from contamination while in use by wrapping them in clean plastic bags and sealing them with tape.

Heavy Equipment

Heavy equipment like bulldozers, trucks and drilling equipment are difficult to decontaminate. Decontamination shall consist of either steam cleaning or washing with suitable detergent solutions and then water under high pressure. Decontamination equipment that may be needed include long-handled brushes, pressurized sprayers, curtains and enclosures to contain splashes from pressurized sprayers, and wire brushes. A decontamination pad lined with heavy-duty plastic sheeting may be needed for the decontamination of heavy equipment.

Tools/Sampling Equipment

Disposable tools shall be used wherever possible. Typically, decontamination of tools will include brushing with decontamination solution followed by tap water. This procedure shall be followed by spraying with distilled water and then deionized water. The tools shall be segregated and wrapped in clean plastic bags and taped securely.

Decontamination of sampling equipment such as split spoons, stainless steel buckets, and filtration transfer vessels shall be in accordance with the following steps:

- Set up clean tubs or buckets to collect wash and rinse solutions.
- Scrub item with Alconox or Liquinox and water until visually clean. Use Liquinox when phosphate is an analytical parameter.
- Rinse with tap water.
- Rinse with distilled or deionized water, the variety that can be found in any grocery store. A garden sprayer or squirt bottles may be used.

6.0 Level of Protection for Decontamination Team

Decontamination workers who initially come into contact with personnel and equipment returning from the Exclusion Zone shall be required to wear the same level of protection as the returning team, or one level lower. The level of protection for decontamination workers can be progressively decreased, without compromising worker safety, the further away the stations are located from the hot line. The SHSO shall determine the level of protection required for the decontamination team.

7.0 Investigation-Derived Waste

SOP HS-006 contains more detail on disposal of decontamination solutions and other decontaminated items such as paper towels and Tyvek. Typically, the wash tubs containing decontamination solution and rinse water shall be emptied into DOT-approved drums. The wash tubs shall be sprayed with decontamination solution and tap water, and then also emptied into the drums. All solid waste shall be double-bagged and disposed of in drums. The drums shall be securely fastened and labeled as "decontamination water" or "solid waste." Include the name of the site, the date, the company name, and the level of fullness.

HEAT STRESS

Prepared By: ______________________ Date: ____________
Health and Safety Committee Chair

Reviewed By: ______________________ Date: ____________
Corporate Health and Safety Officer

Approved By: ______________________ Date: ____________
Chief Operating Officer

1.0 Purpose

This Standard Operating Procedure (SOP) establishes guidelines to protect all employees from the effects of heat stress (hyperthermia) when working in hot environments.

2.0 Scope

Adverse climatic conditions are important considerations in planning and conducting site operations. High ambient temperature can result in health effects ranging from transient heat fatigue, physical discomfort, reduced efficiency, personal injury, increased accident probability, and the like, to serious illness or death. Heat stress is of particular concern when chemical protective garments are worn, since these garments prevent evaporative body cooling. Wearing personal protective equipment (PPE) puts a worker at considerable risk of developing heat stress.

Heat stress is caused by a number of interacting factors, including environmental conditions, clothing, workload, and the individual characteristics of the worker. Because heat stress is probably one of the most common (and potentially serious) illnesses at sites, regular monitoring and other preventive precautions are vital.

Note

Chemical protective clothing is defined as, but not limited to:

- Uncoated Tyvek coveralls.
- Polyethylene-coated Tyvek coveralls.
- Saranex-coated Tyvek coveralls.
- Medium-weight polyvinyl chloride (PVC) coveralls.
- Sigel suits (heavyweight PVC) and fully-encapsulating suits.

3.0 Responsibilities

The responsibilities of various personnel on the project site for monitoring and responding to various types of heat stress are provided below:

- **Site-specific Health and Safety Officer:** The Site-specific Health and Safety Officer (SHSO) is responsible for initial on-site coordination of the heat stress policy. The SHSO establishes work/rest regimens from the Wet Bulb Globe Thermometer (WBGT) readings and conducts physiological monitoring when on site.

- **Project Manager:** The Project Manager is responsible for field implementation of the heat stress policy. This includes assurance that all personnel on site comply with the policy. The Project Manager shall be responsible for establishing and monitoring safe work practices. He/she will ensure that all personnel potentially exposed to heat have proper training and that the on-site Project Supervisor implements the program in his/her absence.

- **Project Supervisor:** The Project Supervisor is responsible for ensuring that work crews comply with all site requirements, including the heat stress policy. In the absence of the Site-specific Health and Safety Officer, the Project Supervisor is also responsible for physiological monitoring.

- **Team Member:** Team Members are responsible for understanding and complying with all site requirements, including the heat stress policy. Team members shall also observe their fellow workers for signs of heat stress.

Project Managers, Project Supervisors, and SSHOs will plan for heat by providing shaded break areas, time for acclimatization, and plenty of palatable beverages for personnel.

4.0 Procedures

Recommended Guidelines

Note that the guidelines discussed in this section are intended to be used only as a means of establishing an initial work/rest regimen. The Site-specific Health and Safety Officer is responsible for evaluating the conditions at a specific operation and making final determinations of the work/rest regimen. Physiological monitoring, as discussed in the following section, will be used to establish more stringent regimens.

Standard guidelines for physiological monitoring of specific types of project personnel are provided below:

- **Unacclimatized Workers:** The total heat exposure to unacclimatized workers not wearing protective clothing shall not exceed the guidelines given in Figure 1 (located at the end of this SOP). Note that it generally takes an employee 7 to 10 days to become acclimated to heat.

- **Acclimatized Workers:** The total heat exposure to acclimatized healthy workers not wearing protective clothing shall not exceed the guidelines given in Figure 2 (located at the end of this SOP).

- **Workers Not Wearing Chemical-protective Clothing:** The guidelines shown in Figures 1 and 2 are for workers who are not wearing chemical-protective clothing. In the event workers are wearing chemical-protective clothing, the guidelines in Figures 1 and 2 should be changed to 4°F. In other words, add 4°F to the WBGT reading and use this adjusted WBGT in Figures 1 and 2. The metabolic heat rate shall be estimated using Table 1 (located at the end of this SOP).

Physiological Monitoring

For operations at which workers are wearing chemical-protective clothing, physiological monitoring is necessary when the ambient temperature exceeds 78°F (25.5°C).

After the initial work/rest regimen is established, it is necessary to perform physiological monitoring to determine if the established work/rest regime should be adjusted. The following guidelines shall be used to adjust the regimen:

- **Baseline Information:** Determine a baseline heart rate and oral temperature for each employee prior to on-site activities by counting the radial pulse and using a clinical thermometer to measure oral temperature.

- **Increasing Work Rate:** If a worker's heart rate and oral temperature do not increase, or only increase slightly (10 percent or less for the heart rate and 0.5° or less for the oral temperature) from the baseline readings after the first work cycle, the work period (according to the established work/rest regimen) can be increased by 20 percent.

  The worker shall be monitored closely after the next work cycle period, and if there are still no significant increases in heart rate and oral temperature, the work period can be increased by an additional 10 percent, and the rest period remains the same.

  Increases in the work period can be made throughout the shift if there are no significant increases in the physiological monitoring indices.

  Note that the increases to the work period are made based on the work/rest regimen established from WBGT readings. These WBGT readings will change throughout the day as the temperature rises or falls.

- **Decreasing Work Rate**

  - Pulse:

    - Count the radial pulse as early as possible in the rest period.

    - If a worker's heart rate exceeds 110 beats per minute immediately after a work period, shorten the next work cycle by 30 percent and keep the rest period the same.

    - If the heart rate still exceeds the 110 beats per minute after the next work period, shorten the following work cycle by 30 percent.
    - Continue to shorten the employee's work cycle until the heartbeat is below 110 beats per minute.

- Temperature:
    - Use a clinical thermometer or similar device to measure the oral temperature at the end of a work period (before drinking).
    - If the oral temperature exceeds 99.6°F (37.6°C), shorten the next work cycle by 30 percent without changing the rest period.
- If the oral temperature still exceeds 99.6°F at the beginning of the next rest period, shorten the following work cycle by 30°percent.
- Do not permit a worker to return to a work area when the worker's oral temperature exceeds 100.6°F (38.1°C).

Prevention

Establish a work/rest regimen according to the guidelines presented in this policy.

Adequate liquids must be provided to replace lost body fluids. Employees must replace water and salt lost from sweating. Employees must be encouraged to drink more than the amount required to satisfy thirst. Thirst satisfaction is not an accurate indicator of adequate salt and fluid replacement.

Replacement fluids can be a commercial mix, such as Gatorade or similar, or a combination of these with fresh water.

The replacement fluid temperature should be kept cool.

Cooling devices, such as vortex tubes or cooling vests, can be worn beneath protective garments. If cooling is worn, only physiological monitoring will be used to determine work activity.

All breaks are to be taken in a cool, shaded rest area.

Employees shall open or remove chemical-protective garments during rest periods.

Employees shall not be assigned other tasks during rest periods.

All employees shall be informed of the importance of adequate rest and proper diet in the prevention of heat stress.

Employees shall be informed of the harmful effects of excessive alcohol consumption in the prevention of heat stress.

Training

Those personnel (including contractor employees) potentially exposed to heat stress conditions shall receive the following training:

- **Parametrix Employees**
    - Sources of heat stress, the influence of protective clothing, and the importance of acclimatization.
    - How the body handles heat.
    - Heat-related illnesses.
    - Preventive/corrective measures.
    - First Aid procedures.
- **Parametrix Supervisors**
    - Measurement methods and calculation of WBOT and physiological monitoring.

5.0 References

Threshold Limit Values and Biological Exposure indices for 1985/1986. American Conference of Governmental Industrial Hygienists.

Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities. NIOSH/OSHA/USCG/EPA, Health and Human Services, Public Health Service, Center for Disease Control, NIOSH.

Criteria for a Recommended Standard, Occupational Exposure to Hot Environments, Revised Criteria 1986, U.S. Department of Health and Human Services, Public Health Service, Center for Disease Control, NIOSH.

INSERT FIGURE 1 – RECOMMENDED HEAT STRESS GUIDELINES FOR ACCLIMATED WORKERS IN HOT ENVIRONMENTS

INSERT FIGURE 2 – RECOMMENDED HEAT STRESS GUIDELINES FOR UNACCLIMATED WORKERS IN HOT ENVIRONMENTS

Table 1. Assessment of Employee Work Load in Hot Environments

Body Position and Movement		**kcal per hour**
Sitting		18
Standing		36
Walking		120-180
Walking Uphill		Add 48 per meter rise
Type of Work	**Average kcal per minute**	**Range kcal per hour**
Hand Work		
• Light	24	12-72
• Heavy	54	
Work One Arm		
• Light	60	42-150
• Heavy	108	
Work Both Arms		
• Light	90	60-210
• Heavy	150	
Work Whole Body		
• Light	210	150-540
• Moderate	300	
• Heavy	420	
• Very Heavy	540	
Basal Metabolism	**60**	
Sample Calculation	**Average kcal per minute**	
Assembling Work with Heavy Hand Tools		
• Standing	36	
• Two-Arm Work	210	
• Basal Metabolism	60	
Total:	**306 kcal per hour**	

COLD STRESS

Prepared By: ______________________ Date: __________
Health and Safety Committee Chair

Reviewed By: ______________________ Date: __________
Corporate Health and Safety Officer

Approved By: ______________________ Date: __________
Chief Operating Officer

1.0 Purpose

This Standard Operating Procedure (SOP) establishes guidelines to protect workers from the effects of cold stress (hypothermia) and cold injury.

2.0 Scope

Most cold-related worker fatalities have resulted from failure to escape low environmental air temperatures or from immersion in low temperature water. The single most important aspect of life-threatening hypothermia is a fall in the deep core temperature of the body.

Hypothermia occurs when a person's body loses heat faster than it can be produced. The body's "normal" deep body temperature is 99.6°F. If your body temperature drops to 95°F, uncontrollable shivering occurs. If cooling continues, other symptoms, listed below, or even death may occur:

- Vague, slow, slurred speech.
- Forgetfulness, memory lapses.
- Inability to use hands.
- Frequent stumbling.
- Drowsiness.
- Unconsciousness.

Hypothermia can occur at temperatures above freezing. Cold, wet, windy conditions make prime hypothermia weather.

Hypothermia impairs judgment. A worker may not be able to make good decisions about his/her situation. Preventing hypothermia is the best way to avoid being a victim.

Frostbite is the freezing of some part of the body. Fingers, toes, and whole arms and legs can be lost as a result of frostbite.

Pain in the hands and feet is felt only when the temperature of the tissue is changing rapidly. There may be no pain with gradual freezing.

Loss of the sensations of touch, pressure, and pain may occur without awareness of any numbness or other sensation. Therefore, it is important to test these sensations often and to wear clothing that is loose and does not restrict the flow of blood to the limbs.

Exposed parts of the body should be inspected routinely. This is done best by a partner. Just before freezing, the skin, especially the face, becomes bright red. Then, small patches of white appear as freezing occurs.

At the same time, the skin also becomes less elastic. This is best noted in the finger pads, which remain pitted when touched or squeezed. Any further cooling will surely result in frostbite.

Serious freezing is most common in the feet because of less awareness of them, poor circulation and sensation, and inadequate foot gear. Hands are second to feet in order of serious injury. Exposed hands are less likely to become frostbitten than feet because they are conditioned to exposure and have a better blood supply.

Next to the extent of freezing, inadequate or improper treatment of a frozen part of the body is the most common cause of serious loss of tissue. If a worker experiences frostbite, the worker should seek medical attention immediately.

3.0 Responsibilities

Project Managers, Supervisors, and SHSOs shall prepare for work in cold environments by providing heated break areas, adequate protective clothing, the availability of warm beverages, and shelter or clothing to keep site personnel dry.

The responsibilities of various personnel on the project site for monitoring and responding to various types of cold stress are provided below:

- **Site-specific Health and Safety Officer:** The Site-specific Health and Safety Officer (SHSO) is responsible for initial on-site coordination of the cold stress. The SHSO ensures that all personnel potentially exposed to cold have had proper training, that suitable warm clothing is available, and that an on-site supervisor can implement the program in his/her absence.

- **Project Manager:** The Project Manager is responsible for field implementation of the cold stress policy. This includes assurance that all personnel on site comply with the policy. The Project Manager shall also be responsible for taking temperatures, selecting proper clothing, and establishing work practices in the absence of the Site-specific Health and Safety Officer.

- **Team Member:** Team Members are responsible for understanding and complying with all site requirements.

4.0 Requirements

Workers shall be provided with warm clothing, such as mittens, heavy socks, etc., when the air temperature is below 40–45°F. Chemical-protective clothing may be used to protect the employee from cold.

When the air temperature is below 30–40°F (depending on employee comfort), clothing for warmth, in addition to chemical-protective clothing, shall be provided. This will include:

- Insulated suits, such as whole-body thermal underwear.
- Wool or polypropylene socks to keep moisture off the feet if there is a potential for work activity that would cause sweating.
- Insulated gloves (when air temperatures are extremely low (less than 5–10°F), gloves with reflective surfaces, which reflect body heat back to the hand, should be used).
- Boots.
- Insulated head covers, such as knit caps (ski caps).
- At air temperatures below 35°F, the following work practices must be followed:
    - If the clothing of an employee becomes wet on a project site, the outer layer of the clothing must be impermeable to water.
    - If an employee's underclothing (socks, mittens, etc.) becomes wet in any way, the employee must change into dry clothing immediately. If the clothing becomes wet from sweating, the employee may finish the task that caused the sweating before changing into dry clothing.
    - Employees must be provided a warm area (65°F or above) to change from work clothing into street clothing.
    - Employees must be provided a warm break area (60°F or above).
    - If appropriate, space heaters may be provided in the work area to warm the hands, feet, etc. Necessary fire and electrical safety practices shall be observed when using space heaters. Space heaters shall be shut off when the site is not occupied.
    - Hot liquids, such as soups, warm, sweet drinks, and the like, shall be provided in the break area. The intake of caffeinated beverages shall be limited because of diuretic and circulatory effects.
    - The “buddy system” shall be practiced at all times. Any employee who is observed with severe shivering shall leave the cold area immediately.
    - Employees should layer their clothing (i.e., wear thinner, lighter clothing next to the body, with heavier clothing layered outside the inner clothing).

  - Avoid overdressing when going into warm areas or when performing activities that are strenuous. This could lead to heat stress problems.
  - Auxiliary-heated versions of hand wear, footwear, etc., can be used in lieu of mittens, insulated socks, and the like, if extremely cold conditions exist and if they are compatible with hazards in the work area.
  - Employees handling evaporator liquids (gasoline, hexane. alcohol. etc.) shall take special precautions to avoid soaking clothing or gloves with the liquids because of the added danger of cold injury resulting from evaporative cooling.
  - Work shall be arranged in such a way that sitting still or standing for long periods is minimized.

- All employees who may work in cold areas shall be trained in:
  - Proper First Aid treatment.
  - Proper clothing practices.
  - Proper eating and drinking habits.
  - Recognition of impending, adverse health effects.
  - Safe work practices.

Clothing for warmth, which is worn under chemical-protective clothing, can be laundered in a normal fashion, without the wash water being collected as contaminated water so long as the chemical-protective clothing remains intact. If there is a rip or tear in the chemical protective clothing in a contaminated area, the clothing for warmth must be handled as potentially contaminated, and the water in which it is washed must be collected as potentially-contaminated water. More rigorous steps may be required if materials handled are extremely toxic (e.g., dioxin).

5.0 Procedure – First Aid Treatment

Treatment of Hypothermia

Employees must be trained to adequately understand the symptoms and treatments for hypothermia, at least to include the following:

- Be able to recognize the symptoms of hypothermia in yourself and others. Victims may deny they are in trouble. Even mild symptoms demand attention.
- Get the victim out of wet and windy weather.
- Remove all wet clothing.

- If the person is only mildly affected:
  - Give warm drinks.
  - Place the victim into dry clothing and a warm sleeping bag.
- If more seriously affected (very clumsy, confused, unable to shiver):
  - Treat the person gently.
  - Place the victim naked into a warm sleeping bag.
  - Place a rescuer, also naked, into the same sleeping bag. If you have a double bag, place the victim between two naked rescuers. Warmth from skin-to-skin contact is the safest method of rewarming. Any warm objects, such as rocks, hot water bottles, or heat packs, should be wrapped in towels or clothing. Arrange for evacuation. Do not give warm drinks until the victim has regained a clear level of consciousness, the ability to swallow, and is already starting to warm up.

Early Treatment of Frostbite

Next to the extent of freezing, inadequate or improper treatment of a frozen part of the body is the most common cause of serious loss of tissue.

For proper rewarming, the following additional procedures should be considered:

- In many cases, rewarming cannot be accomplished without the part again becoming frozen. For example, removing clothing from other parts of the body to warm a frozen part may only result in the loss of more body heat, greater extent of injury, and the ultimate refreezing of the afflicted part. Thawing and refreezing should always be avoided. It is best to continue, even if it means walking on a frozen foot, until shelter is available and rewarming can be done satisfactorily.

- Limbs should be rewarmed in stirred water just above normal body temperature (about 100-105°F). Using a thermometer is the only accurate way to measure this temperature. Never try to thaw in cold water or snow. Since feeling is lost, fires, stoves, exhaust pipes, etc., should never be used. Serious damage to the tissue could result.

- If a major part of a limb is frozen when rewarming begins, deep-body temperature will fall as the cooled blood begins to flow throughout the body. To prevent such cooling, warm liquids by mouth should be given. Even total immersion of the body in a warm bath may be necessary.

- Rewarming is an acutely painful experience and medication to alleviate pain should be given, if available. After thawing, a deep aching pain may persist for several days, depending upon severity of the injury. Pain is actually a good sign, since it indicates that nerve function is still present.

- The afflicted part should be moved gently and voluntarily during rewarming.
- A dull, purple color indicates more serious injury and requires medical attention. Swelling or blisters also indicate more serious problems. Other means for improving circulation are available but must be administered by medical personnel.

6.0 References

Threshold Limit Values and Biological Exposure Indices for 1985 1986, American Conference of Governmental Industrial Hygienists.

Alaska Department of Labor, *Physical Agent Data Sheet Cold Stress*, December 1987.

APPENDIX D

Map and Directions to the Hospital

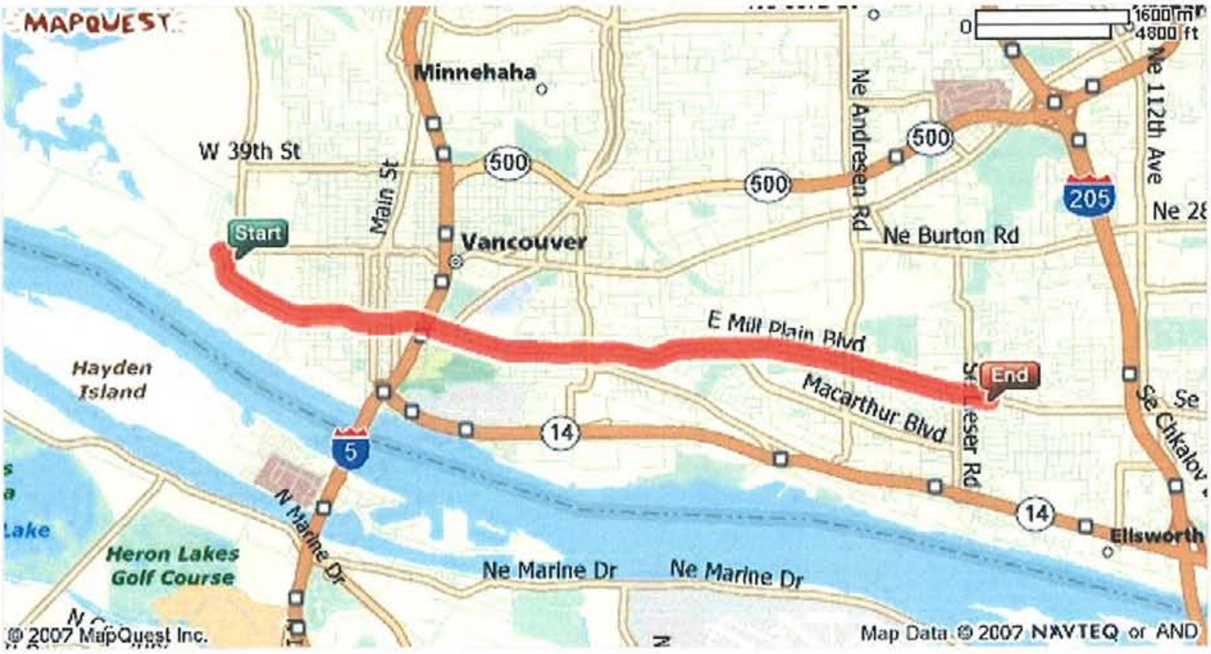
MAPQUEST.

Start: **2001 W Fourth Plain Blvd**
Vancouver, WA 98660-1313, US

End: **400 Ne Mother Joseph Pl**
Vancouver, WA 98664-3200, US

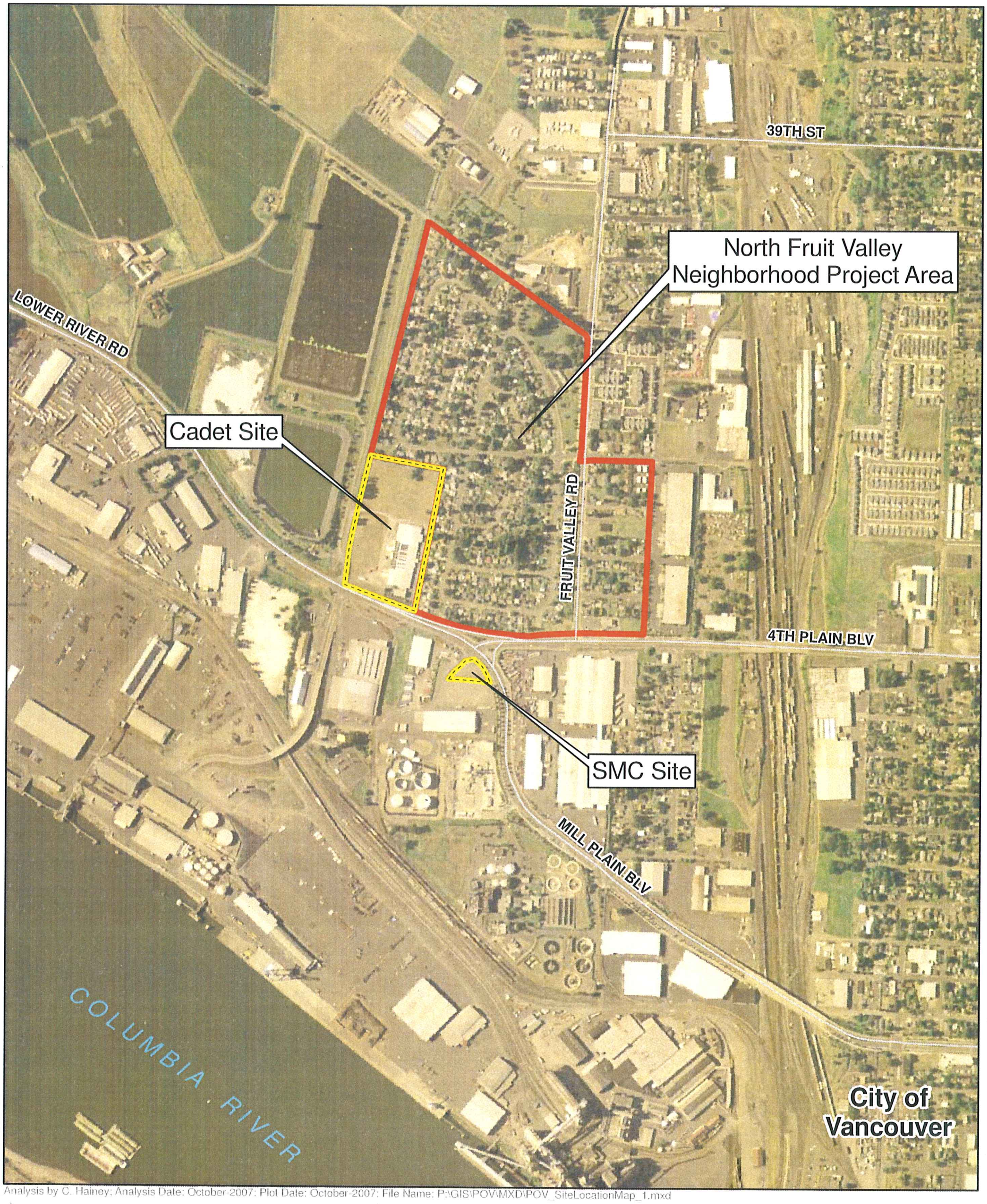
Notes:
Directions to Southwest Washington Medical Center

Directions		**Distance**
	Total Est. Time: 14 minutes **Total Est. Distance:** 6.14 miles	
START	**1:** Start out going WEST on W FOURTH PLAIN BLVD toward NW LOWER RIVER RD / WA-501.	0.1 miles
←	**2:** Turn LEFT onto W MILL PLAIN BLVD / WA-501 E. Continue to follow W MILL PLAIN BLVD.	5.9 miles
←	**3:** Turn LEFT onto NE MOTHER JOSEPH PL.	<0.1 miles
END	**4:** End at **400 Ne Mother Joseph Pl** Vancouver, WA 98664-3200, US	
	Total Est. Time: 14 minutes **Total Est. Distance:** 6.14 miles	

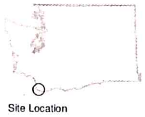


Start:
2001 W Fourth Plain Blvd
Vancouver, WA 98660-1313, US

End:
400 Ne Mother Joseph Pl
Vancouver, WA 98664-3200, US



Analysis by C. Hainey; Analysis Date: October-2007; Plot Date: October-2007; File Name: P:\GIS\POV\MXD\POV_SiteLocationMap_1.mxd



Parametrix

Figure 1-1
Site Location Map

SMC and Cadet sites
Port of Vancouver

APPENDIX C

Sampling and Analysis Plan

Draft Project Sampling and Analysis Plan
SMC and Cadet Sites

Prepared for

Port of Vancouver
PO Box 1180
Vancouver, WA 98666

Prepared by

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November 16, 2007 │ 275-1940-006

CITATION

Parametrix. 2007. Draft Project Sampling and Analysis Plan SMC and Cadet Sites. Prepared by Parametrix, Portland, Oregon. November 16, 2007.

CERTIFICATION

The technical material and data contained in this document were prepared under the supervision and direction of the undersigned, whose seal, as a professional hydrogeologist licensed to practice as such, is affixed below.

Prepared by John Howland, LG
Parametrix Geologist

Checked by Rick Wadsworth, PE
Parametrix Senior Engineer

State of Washington
Hydrogeologist
397
Licensed Geologist
Richard Roché

Approved by Richard Roché, LHG
Parametrix Senior Project Manager

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ACRONYMS

AS/SVE	air sparging/soil vapor extraction
CFR	Code of Federal Regulations
COC	contaminant of concern
1,1-DCA	1,1-Dichloroethane
1,1-DCE	1,1-Dichloroethene
DOE	Department of Ecology
DOH	Department of Health
EPA	United States Environmental Protection Agency
HSP	Project Health and Safety Plan
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
MS	matrix spike
MSD	matrix spike duplicate
µg/m^3	micrograms per cubic meter
µg/L	micrograms per liter
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
3MP	Multi-Media Monitoring Plan
NFVN	North Fruit Valley Neighborhood
OSHA	Occupational Safety and Health Administration
O&M	operation and maintenance
PCE	Tetrachloroethylene
QA/QC	Quality Assurance/Quality Control
RGRW	re-circulation groundwater remediation wells
RI/FS	remedial investigation/feasibility study
SAP	Sampling and Analysis Plan
SMC	Swan Manufacturing Company
SOP	Standard Operating Procedure
SVV	soil vapor vacuum
1,1,1-TCA	1,1,1-Trichloroethane
TCE	Trichloroethylene
VOCs	volatile organic compounds

1. INTRODUCTION

On behalf of the Port of Vancouver, U.S.A. (the Port), Parametrix has prepared this Project Sampling and Analysis Plan (SAP) for the former Swan Manufacturing Company (SMC) and Cadet Manufacturing sites (project sites). The SMC site is adjacent to and west of the intersection of Fourth Plain Boulevard (or Lower River Road) and Mill Plain Boulevard in Vancouver, Washington (Figure 1-1). The Cadet site is just west of the intersection on the north side of Fourth Plain Boulevard (Figure 1-1).

Since 1998, the Port has been conducting a remedial investigation and feasibility study (RI/FS) at the SMC site to address trichloroethylene (TCE) and other related volatile organic compounds (VOCs) in soil and groundwater.

The Cadet site is also a known source of TCE and related VOCs in groundwater beneath the facility and the adjacent North Fruit Valley Neighborhood (NFVN). Contamination from this source has commingled with the plume of VOC contamination originating from the SMC site in the Port area to the east of the SMC site. From 1999 through May 2006, Cadet conducted numerous investigations and remedial actions at this site. The investigation was conducted under an Agreed Order (No. 00TCPVA-847) between the Washington State Department of Ecology (DOE) and Cadet.

The Port acquired the Cadet property on May 29, 2006 as part of a settlement agreement, and assumed responsibility for cleanup of the Cadet site at that time. As a result, the sampling activities associated with the Cadet and SMC sites have been combined into a single monitoring program.

This SAP presents procedures for performing soil, groundwater, soil gas, and air sampling and analysis for these sites.

1.1 PURPOSE

The purpose of this document is to provide an overall SAP for field activities which may be completed during the course of the interim action. Field activities include collecting and analyzing air, soil gas, soil, and groundwater samples during site investigation and monitoring activities.

The following table summarizes the relationship of the SAP to other planning documents.

Table 1-1: Summary of Planning Documents Pertaining to the SAP

Document	Summary
Interim Action Work Plan	Summarizes the selection of the interim action technology, presents a conceptual design of the interim action, and outlines the engineering design and permitting process elements that will be required prior to implementing the action.
Multi-Media Monitoring Plan	The Multi-Media Monitoring Plan will guide the evaluation of changes in the distribution of VOC concentrations in groundwater caused by implementation of the groundwater interim treatment action.
Health and Safety Plan (HSP)	Descriptions of procedures to be followed in the field to conform to OSHA regulations. The HSP is included in Appendix B of the Interim Action Work Plan.

1.2 DURATION OF PLANNED FIELD ACTIVITIES

Field activities have been conducted at the SMC site since 1998 and the Cadet site since 1999, and are ongoing. Based on the current schedule (see Appendix A), construction of the interim action is expected to commence in late 2008. Construction of the extraction well, treatment plant, and piping is expected to be completed by early 2009. Startup and testing of the interim action will be completed in early 2009. A comprehensive groundwater monitoring event will be completed in August 2008 and performance monitoring (groundwater, soil gas, indoor air, treatment system monitoring) will continue throughout the operation of the interim action.

2. PROJECT MANAGEMENT

This section summarizes the management program for completing the SAP at the project sites.

2.1 PROJECT COMMUNICATIONS

The following table summarizes the project team members and responsibilities for the SAP.

Table 2-1: Project Team Members and Responsibilities for Project Site Activities

Team Member	Project Role
Port of Vancouver	
Patty Boyden	Manager of Environmental Affairs and Capital Projects
Parametrix Staff	
Richard Roché, LHG	Senior Project Manager
Rick Wadsworth, PE	Senior Engineer
John Howland, LG	Senior Geologist
Ingmar Saul, LG	Field Geologist
DOE Staff	
Craig Rankine	DOE Project Manager
DOH Staff	
Barbara Trejo	DOH Project Manager

The primary contacts for the Port project sites are Patty Boyden (the Port), Richard Roché (Parametrix), Craig Rankine (DOE), and Barbara Trejo (Department of Health [DOH]). Informal and formal meetings will be held as necessary throughout the project to share information, track progress, brainstorm, and resolve outstanding issues.

Parametrix will prepare progress reports as needed to summarize work completed during the project activities, future actions, and current analytical results.

2.2 PARAMETRIX PROJECT PERSONNEL

2.2.1 Parametrix Project Manager

The Parametrix Project Manager for the project is Richard Roché. The responsibilities of the Parametrix Project Manager include:

- Overall management of all contract requirements, including ensuring the availability of resources for field activities
- Coordination of all project activities with the client, subconsultants, and Parametrix staff

2.2.2 Parametrix Field Team Leader

The Parametrix Field Team Leader for the project is Ingmar Saul (designated alternate - Adam Romey). The responsibilities of the Parametrix Field Team Leader include day-to-day onsite coordination of all project-related field activities.

3. SITE DESCRIPTION

3.1 SMC SITE

Site: Former Building 2220 site.

Address: 2001 West Fourth Plain Boulevard, Vancouver, WA, and adjacent properties.

Location: The portion of the Mill Plain Extension that transects the Port property leased to Automotive Services, Inc. (ASI).

Approximate Size of Site: Approximately 10+ acres.

The property is relatively flat. The property is currently undeveloped and overlain by gravel. The site is accessed via Francis Avenue. Figure 1-1 shows the location of the site.

3.2 CADET SITE

Site: Cadet Manufacturing site.

Address: 2500 West Fourth Plain Boulevard, Vancouver, WA, and adjacent properties.

Location: The Cadet site and portion of the North Fruit Valley Neighborhood.

Approximate Size of Site: Approximately 15,750 square feet (Cadet property).

The property is relatively flat. The property is currently developed and contains one building, asphalt and gravel parking areas, and landscaping. The site is accessed via Fourth Plain Boulevard. Figure 1-1 includes the site location.

4. KNOWN OR SUSPECTED CHEMICALS OF CONCERN

This section presents information on the known or suspected chemicals of concern (COCs) present at the project sites. A summary of general types of COCs associated with the compounds at the project sites is summarized below.

4.1 VOLATILE ORGANIC COMPOUNDS

Investigations conducted at the project sites have identified TCE and related compounds such as tetrachloroethylene (PCE), 1,1,1-trichlorethane (1,1,1-TCA), 1,1-dichloroethene (1,1-DCE), cis-1,2-dichloroethene, and 1,1-dichloroethane (1,1-DCA) as the primary COCs. Additional details regarding the above COCs and their potential hazards are detailed in Section 3 of the Health and Safety Plan, included in Appendix B of the *Groundwater Pump and Treat Interim Action SMC/Cadet Commingled Plume Draft Work Plan* (Parametrix 2007) (Interim Action Work Plan).

5. SAMPLING AND ANALYSIS PLAN

5.1 SAMPLING METHODS AND PROCEDURES

This section presents the sampling methods and procedures to be used during the completion of the interim action activities.

5.1.1 Soil Sampling

Although soil samples are not expected to be collected during the interim action, soil sampling is included in this SAP to cover unknown activities such as verification samples during construction or testing of excavated material. Soil samples may be collected using hand augers, Shelby tubes, continuous core samplers, split-spoon samplers, or excavation equipment.

Shallow subsurface soil samples from depths of 15 centimeters to 3 meters (6 inches to 10 feet) may be collected using hand augers. Hand auger samples are generally of poorer quality than samples collected by split-spoon, Shelby tube, or continuous core samplers since the sample is disturbed during the sampling process. Split-spoon and Shelby tube samplers are typically used in conjunction with Hollow Stem Auger (HSA), air rotary, mud rotary, dual rotary, and cable tool drilling equipment. Continuous core samplers are typically used in conjunction with push-probe drilling technology. Sonic drilling equipment utilizes plastic tube bags for sample collection. Soil samples may also be collected from test pits and other excavations using an excavator bucket. The size and construction material of sampling devices should be selected based on project specific analytical objectives. Soil sampling procedures are detailed in Appendix A, Standard Operating Procedures (SOP): *Soil Sampling*.

5.1.2 Groundwater Sampling

Groundwater samples will be collected from monitoring wells using the low stress (low flow) sampling method.

The low flow sampling method uses dual-valve pumps modified with bladders and bladder pumps that are dedicated to each monitoring well. Low stress pumping minimizes stress on the formation and groundwater drawdown on the water column, to avoid changes to the water chemistry. The low flow purge rate should be between 0.2 to 0.5 liters per minute (lpm), with an overall drawdown of less then 0.1 meters (0.33 feet). Stability should be achieved on groundwater drawdown by measuring parameters as quickly as possible to limit stressing the formation and mobilizing solids. Procedures specific to low flow sampling are detailed in Appendix A, SOP: *Low Stress (Low Flow) Pumping and Sampling with Dedicated Monitoring Well Pumps*.

5.1.3 Soil Gas Sampling

Soil gas samples will be collected from soil gas monitoring wells using the Summa™ canister sampling method.

Soil gas samples are collected into 6-liter Summa™ canisters that are under a laboratory-prepared vacuum of at least approximately -28.5 inches of mercury (inHg). Included with each canister is a flow control device that is calibrated by the laboratory to fill the canister at a rate of approximately one-half liter per minute. After purging ambient air from a well using a vacuum pump, the canister with the flow control device attached is connected to the well by Teflon™-coated tubing, and the control valve on the canister is opened and the vacuum in the canister draws the sample in. After approximately 12 minutes and when the vacuum in the canister is between -0.1 and -9 inHg, the canister valve is closed, the canister is disconnected from the well, the flow control device is removed from the canister, and the canister is labeled for shipment to the project laboratory for analysis. Procedures for collecting soil gas samples from soil gas monitoring wells are included in Appendix A, SOP: *Soil Gas Well Sampling*.

5.1.4 Air Sampling

Time-integrated indoor and outdoor air samples will be collected from the breathing zones of potentially impacted structures and outdoor areas. Air samples will be collected into 6-liter Summa™ canisters that are under a laboratory prepared vacuum of at least -28.5 inHg. Included with each canister is a flow control device that is calibrated by the laboratory to fill the canister at a rate of approximately one-quarter liter per hour. Each sample will be collected over a 24-hour period. The indoor air samples will be collected from the subbasement, crawl space, and/or living space areas in potentially impacted structures. Outdoor air samples will be collected from outdoor areas within the boundaries of the subsurface contamination plume and outside of the contamination plume.

The canister with the flow control device attached is placed in the desired location, the control valve on the canister is opened, and the vacuum in the canister draws the sample in. After approximately 24 hours and when the vacuum in the canister is between approximately -0.1 and -9 inHg, the canister valve is closed, the canister is removed from the sample location, the flow control device is removed from the canister, and the canister is labeled for shipment to the project laboratory for analysis. Procedures for the collection of indoor and outdoor air samples are included in Appendix A, SOPs: *Indoor Air Sampling* and *Outdoor Air Sampling*.

5.1.5 Decontamination

Decontamination of all non-disposable tools and equipment will be conducted prior to each sampling event and between each sampling location. Decontamination procedures are included in Appendix A, SOP: *Decontamination*.

5.1.6 Investigation-Derived Waste

All disposable sampling materials and personal protective equipment, such as gloves and paper towels used in sample processing will be placed inside polyethylene bags or other appropriate containers. Disposable materials will be placed in a normal refuse container and disposed of as normal solid waste. Handling of investigation-derived waste is included in Appendix A, SOP: *Handling of Investigation-Derived Waste*.

5.2 SAMPLE HANDLING AND CUSTODY

This section describes protocols for sample labeling, packaging, transportation, and sample chain-of-custody to be used for this project. These procedures ensure that the quality and integrity of the samples are maintained during their collection, transportation, storage, and analysis.

The samples will be transported by the field team or shipped to the project laboratories along with laboratory-supplied chain-of-custody forms.

5.2.1 Sampling Identification and Labeling

Each sample sent to the project laboratories will be assigned a unique sample number. The same number is used for multiple containers of the same sample. The following formats will be used:

- Groundwater – monitoring well identification (ID) (e.g. MW-01 or similar for SMC wells and CM-MW-01s or similar for Cadet wells)
- Soil – boring or excavation ID and sample depth (e.g. B1-10.0 or similar for borings and TP1-10.0/EX1-10.0 for test pits/excavations)
- Soil Gas – boring or well ID and depth (e.g. POV-SG-2-10 or similar for SMC wells and CM-SG-2-10 or similar for Cadet wells)
- Air – address, street number or initials, indoor air (IA) or outdoor air (OA) designation, and location (basement [BS], crawl space [CS], or living space [LS]) or similar (e.g. 2809-UN-IA-BS)

Each sample label should include: project name, sample identification, sample date and time, requested analysis, and initials of the sampler. Sample identification numbers will be entered on the Sampling Field Data Sheets.

5.2.2 Sample Storage, Packaging, and Transportation

Soil and groundwater samples will be placed in a cooler following collection and stored at a temperature of 4^{o} centigrade (C). Air samples will be placed in shipping containers following collection. Following completion of sampling activities, all samples will be transported or shipped to the appropriate project analytical laboratory by the field team.

All samples must be clearly labeled as the identification number needs to be readable for laboratory login and data completion auditor tracking.

5.2.3 Sample Custody

The chain-of-custody procedures used for this project will use laboratory supplied chain-of-custody forms to provide an accurate record that can be used to trace the possession of each sample from the time each is collected until the completion of all required analyses.

A chain-of-custody form will be completed for each cooler and shipping container to be transported to the project laboratories. The chain-of-custody form must include all samples in the cooler and shipping container. Each form should include the project name and number, sample date and time, sample identification, sample matrix, sampler name, and desired analysis. A copy of the chain-of-custody form should be made before sealing it in the cooler and shipping container for delivery or shipment to the appropriate project laboratory.

5.3 ANALYTICAL METHODS

All collected samples will be submitted to the appropriate project laboratory for chemical analysis. The samples will be analyzed for VOCs. In addition, samples will periodically be collected from select locations for possible additional analyses. The following table summarizes analytical methods, possible additional analyses, and quantitation limits.

Table 5-1: Analytical Methods, Possible Additional Analyses, and Quantitation Limits

Analysis	Analysis Method	Maximum Quantitation Limit *	Units
Soil			
Volatile Organic Compounds	EPA 5035A	0.0051 – 0.01	mg/kg
Groundwater			
Volatile Organic Compounds	EPA 8260B	0.5 – 5.0	µg/L
Dissolved Metals	EPA 200 Series	0.002 – 0.1	mg/L
Total Metals	EPA 200 Series	0.002 – 0.1	mg/L
Dissolved Organic Carbon	EPA 415.2	1.0	mg/L
Total Organic Carbon	EPA 415.2	1.0	mg/L
Hardness	SM2340B	0.662	mg/L
pH	EPA 150.1	na	pH Units
Soil Gas			
Volatile Organic Compounds	TO-15	1.0 – 1.3	µg/m^3
Air (Indoor and Outdoor)			
Volatile Organic Compounds	TO-15 SIM	0.025 – 0.051	µg/m^3

* = These limits are approximate
mg/kg = milligrams per kilogram
mg/L = milligrams per liter
na = not applicable
µg/L = micrograms per liter
µg/m^3 = micrograms per cubic meter

5.4 QUALITY ASSURANCE/QUALITY CONTROL

Quality Assurance/Quality Control (QA/QC) checks consist of measurements performed in the field and laboratory. The analytical methods referenced in Section 5.3 specify routine methods required to evaluate data precision and accuracy and to determine whether the data are within the QC limits.

The following table summarizes guidelines for minimum samples for field QA/QC sampling and laboratory analysis.

Table 5-2: Guidelines for Minimum QA/QC Samples for Field Sampling

Field				Laboratory			
Media	Field Duplicate	Equipment Blank	Laboratory or Trip Blank	MS	MSD[b]	Method Blank	LCS[c]
Soil	1 in 20[a]	1 per day	1 per cooler	1 in 20	1 in 20	1 in 20	1 in 20
Groundwater	1 in 20[a]	NA[d]	1 per Cooler	1 in 20	1 in 20	1 in 20	1 in 20
Soil Gas/Indoor and Outdoor air	1 in 20[a]	NA[d]	2 per sampling event	NA[e]	NA[e]	1 in 20	1 LCS/LCSD pair in 20

[a] = All frequencies of 1 in 20 or 1 per batch, when the batch is less than 20 samples.

[b] = Matrix spike duplicate (MSD) analyzed for VOCs.

[c] = Laboratory Control Sample.

[d] = Not applicable. Dedicated sample equipment.

[e] = Not applicable. MS/MSD preparation is not possible in Summa™ canisters; therefore, LCS/LCSD samples will be prepared instead.

Field Duplicate

A minimum of one blind field duplicate will be analyzed to verify the precision of laboratory and sampling methodology. The samples will be coded so the laboratory cannot discern which sample is the field duplicate.

Equipment Blank

One equipment blank will be collected from non-disposable equipment used for sampling. An equipment blank consists of the deionized water used to rinse the sampling equipment after decontamination. The equipment blank will be analyzed for all chemical constituents identified for analysis in normal samples collected.

Laboratory or Trip Blank

A minimum of two laboratory or trip blanks will be analyzed to assess possible laboratory contamination or contamination during shipment. The laboratory or trip blank will be analyzed for all chemical constituents identified for analysis in normal samples collected.

Matrix Spike

A minimum of one laboratory matrix spike (MS) will be analyzed to assess sample matrix interferences, and to ensure that analytical accuracy is acceptable. The laboratory MS will follow United States Environmental Protection Agency (EPA) MS Guidelines.

Matrix Spike Duplicate

A minimum of one laboratory matrix spike duplicate (MSD) will be analyzed to assess sample matrix interferences and to ensure that analytical accuracy and precision (in conjunction with the corresponding MS results) are acceptable. The laboratory MSD will follow EPA MSD Guidelines.

Laboratory Control Sample

A minimum of one laboratory control sample (LCS) will be analyzed for VOCs to assess analytical accuracy independent of matrix effects. The laboratory LCS will follow EPA Guidelines.

6. REPORTING

Following reception of validated analytical data, Parametrix will prepare reports, as necessary, documenting field observations and activities, analytical data evaluation, conclusions, and recommendations.

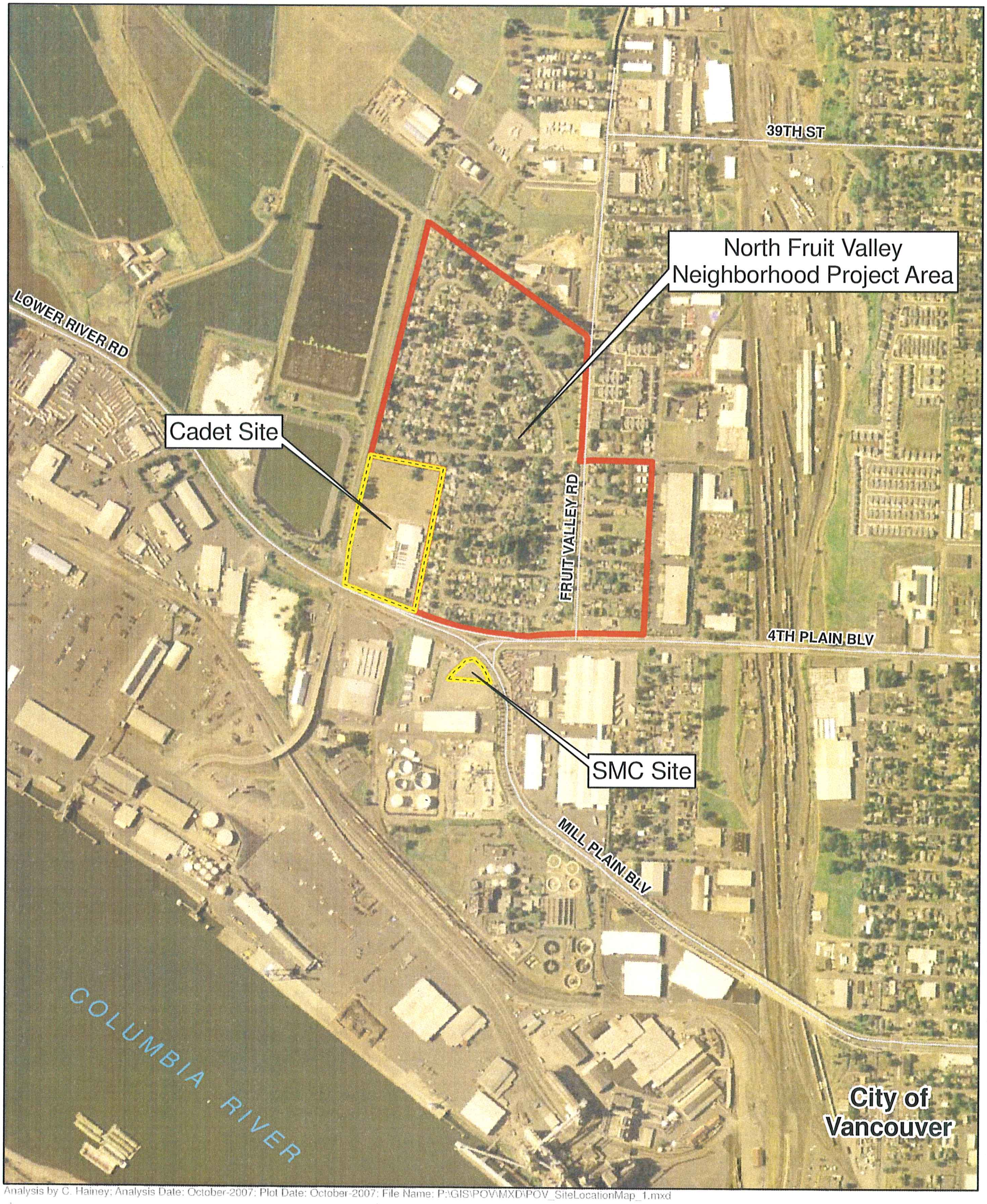
7. REFERENCES

Parametrix. 2006. Draft Remedial Investigation Update, Former Building 2220 Site.

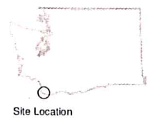
Parametrix. 2007. Final Remedial Investigation Report, Former Building 2220 Site, (a.k.a. Swan Manufacturing Company Site). March 30, 2007.

Parametrix. 2007. Draft Groundwater Pump and Treat Interim Action Work Plan, SMC/Cadet Commingled Plume. November 2007.

FIGURES



Analysis by C. Hainey; Analysis Date: October-2007; Plot Date: October-2007; File Name: P:\GIS\POV\MXD\POV_SiteLocationMap_1.mxd



Parametrix

Figure 1-1
Site Location Map

SMC and Cadet sites
Port of Vancouver

APPENDIX A

Standard Operating Procedures

DECONTAMINATION

Prepared By:	______________________ Health and Safety Committee Chair	Date:	______________
Reviewed By:	______________________ Corporate Health and Safety Officer	Date:	______________
Approved By:	______________________ Chief Operating Officer	Date:	______________

1.0 Purpose

This Standard Operating Procedures (SOP) provides instructions for personnel and equipment decontamination that are to be followed during field operations.

2.0 Scope

Decontamination is the process of removing or neutralizing contaminants that have accumulated on personnel and/or equipment at hazardous waste sites. Decontamination is required to protect personnel from the potential effects of hazardous substances and to minimize the spread of those substances. Decontamination methods include physical removal of contaminants, detoxification, and disinfection/ sterilization.

This SOP describes decontamination responsibilities and procedures to be implemented at hazardous waste sites. The procedures outlined are to be followed by all personnel who participate in site activities in areas that may contain hazardous substances. The scenarios of decontamination procedures presented here will not necessarily all be appropriate for a given site. Project procedures may be prepared as part of the Site-specific Health and Safety Plan (HSP) that focus on site-specific conditions and incorporate the appropriate procedures presented in this SOP.

This procedure applies in its entirety to all Parametrix projects unless the Corporate Health and Safety Manager (CHSO) grants a variance. Modifications to these procedures may be appropriate on a project-specific basis.

3.0 Responsibilities

There are specific responsibilities for Parametrix personnel in complying with the required decontamination procedures, depending on an individual’s role within the company or on a given project. These responsibilities are outlined below:

- **Site-specific Health and Safety Officer:** The Site-specific Health and Safety Officer (SHSO) is responsible for maintaining and enforcing the project decontamination program. HSP decontamination procedures for all projects shall be reviewed and authorized by the

CHSO. All modifications and/or changes must be noted in the field logbook, documented as HSP revisions, and initialed by all field personnel.

- **Site Manager:** The Site Manager is responsible for assuring that all site personnel become familiar with and follow the decontamination procedures described in this SOP or in the Site-specific HSP.

4.0 Personnel Decontamination Procedures

Contamination avoidance is the best way to prevent the spread of contaminants. Direct contact with contaminants should be minimized by not leaning against objects, and not kneeling or sitting on the ground; through the use of remote sample-handling and container-opening techniques, wherever appropriate; and through the use of disposable equipment, wherever appropriate.

Decontamination Program Planning

The SHSO shall research the background information on a particular site when planning decontamination procedures for the fieldwork at that site. The physical, chemical, toxicological, and pathogenic properties (if any), as well as the amounts and concentrations of each contaminant present at the site, are the determining factors in selecting the levels of protection for personnel and the extent of decontamination required. Sources of information for the characterization of hazardous waste sites include site records, state and federal agency files, and interviews with knowledgeable people. Hazardous and toxicological references, industrial process references, and manufacturers' handbooks are also good sources of information. Topography, local meteorological conditions (most probable wind direction. rainfall, etc.), and other site-specific features, are factors to consider in defining decontamination measures.

Decontamination Station Layout

When site conditions require, a dedicated area shall be established as a decontamination station. The decontamination station shall be located upwind of the Exclusion Zone. This is especially important when airborne contaminants are detected at above-background levels, or when such a potential exists. This is to prevent the airborne contamination of the Contamination Reduction Zone (CRZ) and the Support Zone. Exclusion, CRZ, and Support Zones are depicted in Figure I and defined as follows:

- **Exclusion Zone:** The zone encompassing the contaminated area that must be large enough to prevent the spread of contaminants beyond its boundaries. The extent of the Exclusion Zone will depend on:
    - ➢ Toxicity of the contaminants.
    - ➢ Physical form of the contaminants (solid, liquid, or gas).
    - ➢ Amounts and concentrations of the contaminants.
    - ➢ Fire and explosive potential of contamination.
    - ➢ Site-specific conditions such as topography and meteorology, and potential and active migration pathways to air, water, and soil.

- Pocket knife.
- Stakes and rope for marking the hot zone limits.
- First Aid kit.
- Decontamination solutions and detergents.
- Distilled and deionized water. Potable tap water for decontamination.

Personnel Decontamination Solutions

Personnel will generally use household soap and water. The detergents Alconox or Liquinox and water are the preferred surfactants for most decontamination procedures relating to equipment. Selection of specific solvents and decontamination solutions are to be defined in the site work plan.

The effectiveness of decontamination solutions will be continuously verified. Visual observations of discoloration, stains, and arid substances adhering to objects, are indications that the decontamination solution is not effective in removing contamination. Decontamination solutions must be replenished frequently with use, to ensure their continued effectiveness.

The quality of rinse water used in the decontamination process shall be verified. A distilled/deionized rinse is the final step in the decontamination of equipment and in removing all traces of contaminants.

Personnel Decontamination

Personnel decontamination procedures depend on the level of personal protection worn by the field crew, as required by the Site-specific Health and Safety Plan, and upon the degree of contamination the crewmembers experience. The objective of personal decontamination is to protect the health of all crewmembers and to prevent the spread of contamination from the site. Therefore, the following procedures should be extended and modified by the SHSO until all field personnel are satisfied that complete decontamination has been accomplished. In the event of an emergency, the SHSO may judge it necessary to curtail these decontamination procedures to evacuate the site or initiate First Aid.

- **Level B Decontamination:** Level B personal protection equipment (PPE) includes chemical-resistant disposable coveralls, SCBA, hardhat, steel-toe/shank boots, boot covers, and inner and outer gloves. Level B decontamination procedures also can be divided into four sublevels: (1) highly-contaminated personnel exiting the Exclusion Zone, (2) minimally-contaminated personnel exiting the Exclusion Zone, (3) highly-contaminated personnel crossing the hot line to exchange SCBA tank, and (4) minimally-contaminated personnel crossing the hot line to exchange SCBA tank. These distinctions are noted in the decontamination station descriptions below.
    - Station 1 – Segregated Equipment Drop (All Sublevels): Before crossing the hot line, personnel returning from the field must deposit all equipment and/or sample bottles in segregated areas on plastic sheeting. Highly-contaminated equipment, such as samplers and sample containers, are kept separate from minimally-contaminated and difficult-to-clean equipment, such as air monitoring equipment.

- Station 2 – Boot Cover and Outer Glove Wash, Rinse, and Removal: Personnel must step into a washtub containing a detergent solution. Boot covers and outer gloves are scrubbed with a long-handled, soft-bristled brush. All surfaces of the boots and gloves are washed, including boot soles and duct tape used to seal covers and gloves to coverall. Boot covers, including soles and outer gloves, are rinsed with a long-handled, soft-bristled brush. Tape is removed from boat covers and outer gloves and deposited into a plastic-lined disposal drum. Boot covers, and outer gloves are removed and deposited into a plastic-lined disposal drum. A knife may be used to aid in the removal of tight-fitting boot covers.

- Station 3 – Coverall, SCBA, and Safety Boot Wash and Rinse: At this station, all exposed surfaces of PPE are washed with the detergent solution. Personnel must step into a washtub containing a detergent solution. All gear is scrubbed with a long-handled, soft-bristled brush. All surfaces of gear should be scrubbed, including boot soles, until visible contamination is removed. All exposed surfaces of PPE are rinsed to remove detergent.

  Personnel must step into a washtub containing tap water. All gear is rinsed with a long-handled, soft-bristled brush. Pressure sprayers containing tap water may be used to aid in rinsing.

- Station 4 – Safety Boot, SCBA Backpack, and Chemically-Resistant Overall Removal: Boots must be removed and set on plastic sheeting. While still wearing the face-piece, the SCBA backpack is removed and set on a chair or table. The air supply hose is disconnected from the regulator valve. Chemically-resistant overalls are removed and disposed to a plastic-lined disposal drum.

- Station 5 – Inner Glove Wash and Rinse and SCBA Face Piece Removal: Inner gloves are scrubbed by rubbing hands together with a detergent solution then rinsed in tap water. The SCBA face piece is removed without touching inner gloves to face. Deposit face piece on plastic sheeting.

- Station 6 – Inner Glove Removal: Inner gloves are removed and disposed to a plastic-lined disposal drum.

- Station 7 – Field Wash/Field Shower: Hands and face are washed with hand soap, then rinsed and dried with paper towels. If highly–toxic, skin-corrosive, or skin-absorbable materials are at the site, shower entire body.

- **Level C Decontamination:** Level C personal protection includes chemical-resistant disposable coverall, APR, hardhat, steel-toe/shank boots, boot covers, and inner and outer gloves. Depending on exposure hazards, boot covers and outer gloves may not be required, and Tyvek coveralls may be substituted for chemical-resistant coveralls. Station decontamination activities include the following:

  - Station 1 – Segregated Equipment Drop: Before crossing the hot line, personnel returning from the field must deposit all equipment and/or sample bottles in segregated areas on plastic sheeting. Highly-contaminated equipment, such as samplers and sample containers, are kept separate from minimally-contaminated and difficult-to-clean equipment, such as air monitoring equipment.

  - Station 2 – Boot Covers and Outer Glove Wash, Rinse, and Removal: Personnel must step into a wash tub containing a detergent solution. Boot covers and outer gloves are scrubbed with a long-handled, soft-bristled brush. All surfaces of the boots and gloves are washed including boot soles and duct tape used to seal covers and gloves to coveralls.

    Personnel must step into a washtub containing tap water. Boot covers, including bottoms and outer gloves, are rinsed with a long-handled, soft-bristled brush. Tape that seals boot covers and outer gloves is removed and deposited into a plastic-lined disposal drum. Boot covers and outer gloves are removed and deposited into a plastic-lined disposal drum. A knife may be used to aid in the removal of tight-fitting boot covers.

  - Station 3 – Safety Boots and Coveralls Wash, Rinse, and Removal: Personnel must step into a wash tub containing a detergent solution. Boots are scrubbed with a long-handled, oft-bristled brush. If leather safety boots are worn, the soles are scrubbed and the upper surfaces are wiped with a paper towel dipped in detergent solution. If waterproof coveralls are worn, they are scrubbed also. All surfaces of gear, including boot soles, are scrubbed until visible contamination is removed.

    Personnel must step into a washtub containing a tap water. Boots and coveralls are rinsed with a long-handled, soft-bristled brush. Boots are removed and set on plastic sheeting. Coveralls are removed and disposed to a plastic-lined disposal drum.

  - Station 4 – Inner Glove Wash and Rinse: Inner gloves are scrubbed by rubbing hands together with a detergent solution. Finish with a rinse in tap water.

  - Station 5 – APR and Inner Glove Removal: The APR is removed without touching inner gloves to face, and then deposited on plastic sheeting. Inner gloves are removed and disposed to a plastic-lined disposal drum.

- **Level D Decontamination:** Level D is the lowest level of personal protection and is worn when exposure to contaminants is not expected. Level D personal protection includes hardhat and steel-toe/shank leather boots. Depending on the anticipated activities, Level D may also include Tyvek coveralls and gloves. Station decontamination activities include the following:

  - Station 1 – Segregated Equipment Drop: Personnel returning from the field must deposit all equipment and/or sample bottles in segregated areas on plastic sheeting. Highly-contaminated equipment, such as samplers and sample containers, are kept separate from minimally-contaminated and difficult-to-clean equipment, such as air-monitoring meters.

  - Station 2 – Safety Boot Wash, Rinse, and Removal: Boot soles must be scrubbed with a long-handled, soft-bristled brush. All surfaces of gear, including boot soles, must be scrubbed until visible contamination is removed. Boot soles are rinsed with tap water using a long-handled, soft-bristled brush. Boots are removed and set on plastic sheeting.

- Station 3 – Coveralls Removal (if needed): If worn, remove coveralls and dispose to a plastic-lined disposal drum.

- Station 4 – Glove Wash, Rinse, and Removal (if needed): If worn, inner gloves are scrubbed by rubbing hands together with a detergent solution. Finish with a rinse in tap water. Gloves are removed and disposed to a plastic-lined disposal drum.

Priorities for Worker Decontamination

The following members of the work team returning from the Exclusion Zone shall have priority over others when being decontaminated.

- A worker who is in need of First Aid, or is in physical discomfort.
- A worker who is low on air or whose SCBA is malfunctioning.
- A worker who has been highly contaminated.
- A worker who did the major part of physical activity required on site.

It is the responsibility of the SHSO to decide which workers receive priority.

Emergency Decontamination

In an emergency, the primary concern shall be to prevent the loss of life or severe injury to personnel. If immediate administration of medical treatment is required to prevent further deterioration of health, then decontamination may be eliminated, modified, or performed later when the condition has stabilized. The SHSO and the team leader must weigh the consequences of delaying, modifying, or eliminating decontamination against the consequences of delaying treatment, before making a decision on a case-by-case basis.

First Aid equipment shall be readily available in the Support Area and, as specified in the Site-specific HSP. At least one response team member shall be trained in First Aid and CPR.

Arrangements shall be made to advise medical personnel on the nature of contaminants to which the patient was exposed and the extent of decontamination. In some cases, the SHSO will need to contact nearby emergency response medical facilities in advance to alert them of the possibility of a problem. This will help the medical facility to prepare for the specific sort of health care that may be required in an emergency.

Cold Weather Decontamination

In freezing temperatures, a small quantity of ethanol can be added to the washtubs containing decontamination and tap water to prevent freezing. Deionized water and distilled water containers shall be kept warm in the heated van or car for use when needed. Orchard sprayers shall also be kept in a warm place when not in use.

5.0 Decontamination of Equipment

Protection of Monitoring Instruments

All equipment and monitoring instruments shall be protected from contamination while in use by wrapping them in clean plastic bags and sealing them with tape.

Heavy Equipment

Heavy equipment like bulldozers, trucks and drilling equipment are difficult to decontaminate. Decontamination shall consist of either steam cleaning or washing with suitable detergent solutions and then water under high pressure. Decontamination equipment that may be needed include long-handled brushes, pressurized sprayers, curtains and enclosures to contain splashes from pressurized sprayers, and wire brushes. A decontamination pad lined with heavy-duty plastic sheeting may be needed for the decontamination of heavy equipment.

Tools/Sampling Equipment

Disposable tools shall be used wherever possible. Typically, decontamination of tools will include brushing with decontamination solution followed by tap water. This procedure shall be followed by spraying with distilled water and then deionized water. The tools shall be segregated and wrapped in clean plastic bags and taped securely.

Decontamination of sampling equipment such as split spoons, stainless steel buckets, and filtration transfer vessels shall be in accordance with the following steps:

- Set up clean tubs or buckets to collect wash and rinse solutions.
- Scrub item with Alconox or Liquinox and water until visually clean. Use Liquinox when phosphate is an analytical parameter.
- Rinse with tap water.
- Rinse with distilled or deionized water, the variety that can be found in any grocery store. A garden sprayer or squirt bottles may be used.

6.0 Level of Protection for Decontamination Team

Decontamination workers who initially come into contact with personnel and equipment returning from the Exclusion Zone shall be required to wear the same level of protection as the returning team, or one level lower. The level of protection for decontamination workers can be progressively decreased, without compromising worker safety, the further away the stations are located from the hot line. The SHSO shall determine the level of protection required for the decontamination team.

7.0 Investigation-Derived Waste

SOP HS-006 contains more detail on disposal of decontamination solutions and other decontaminated items such as paper towels and Tyvek. Typically, the wash tubs containing decontamination solution and rinse water shall be emptied into DOT-approved drums. The wash tubs shall be sprayed with decontamination solution and tap water, and then also emptied into the drums. All solid waste shall be double-bagged and disposed of in drums. The drums shall be securely fastened and labeled as “decontamination water” or “solid waste.” Include the name of the site, the date, the company name, and the level of fullness.

HANDLING OF INVESTIGATION-DERIVED WASTE

Prepared By: ______________________ Date: __________
Health and Safety Committee Chair

Reviewed By: ______________________ Date: __________
Corporate Health and Safety Officer

Approved By: ______________________ Date: __________
Chief Operating Officer

1.0 Purpose

Management of investigation-derived waste (IDW) minimizes the potential for the spread of hazardous waste on site or off site through investigation activities. The purpose of this Standard Operating Procedure (SOP) is to provide instructions for the proper management of contaminated materials derived from field investigations.

2.0 Scope

The procedures outlined are to be followed by all personnel who participate in site activities in areas where IDW is generated.

Materials that are known or suspected to be contaminated with hazardous substances through the actions of sample collection or personnel and equipment decontamination were said to be investigation-derived wastes. These wastes include decontamination solutions, disposable equipment, drill cuttings and fluids, and groundwater monitoring well development and purge waters. To the extent possible, the Site Manager will attempt to minimize the generation of these wastes through careful design of decontamination schemes and groundwater sampling programs. Testing conducted on soil and water investigation-derived wastes will show if they were also hazardous wastes as defined by RCRA. This will determine the proper handling and ultimate disposal requirements.

The criteria for designating a substance as a hazardous waste, according to RCRA, is provided in 40 CFR 261.3 if investigation-derived wastes meet these criteria, RCRA requirements must be followed for packaging, labeling, transporting, storing and record keeping as described in 40 CFR 262 34. Those wastes judged to potentially meet the criteria for hazardous wastes, shall be stored in Department of Transportation-approved, 55-gallon steel drums.

Wastes that can be shown not to be RCRA-designated hazardous wastes may be handled and disposed on site or off site to municipal wastewater and/or solid waste systems at the direction of the EPA RPM. Investigation-derived waste is assumed to be RCRA-designated hazardous waste unless analytical evidence indicates otherwise.

3.0 Investigation-Derived Waste Management

Procedures that minimize the potential for the spread of hazardous waste include minimizing the volume of waste generated, waste segregation, appropriate storage, and disposal, according to RCRA requirements.

Waste Minimization

Within the absolute constraints demanded by worker health and safety and project quality assurance/quality control, the generation of investigation-derived wastes is to be limited. In the development of the investigation work plan, each aspect of the investigation is to be reviewed to identify areas where excess waste generation can be eliminated. General procedures that will eliminate waste include avoidance of unnecessary exposure of materials to hazardous waste, and coordination of sampling schedules to avoid repetitious purging of wells and use of sampling equipment.

Waste Segregation

Waste storage and handling procedures to be used depend on the type of generated waste. For this reason, investigation-derived hazardous wastes described below are segregated into separate, 55-gallon storage drums. Waste materials that are known to be free of hazardous waste contamination (such as broken sample bottles or equipment containers and wrappings), must be collected separately for disposal to municipal systems. Large plastic garbage or lawn and leaf bags are useful for collecting this trash.

Decontamination Solutions

Decontamination solutions are generated from washing and rinsing of personal protective equipment (PPE) and sampling equipment. Solutions considered investigation-derived wastes range from detergents, organic solvents, and acids used to decontaminate small hand samplers to steam cleaning rinsate used to wash drill rigs and other large equipment. These solutions are to be stored in 55-gallon drums with bolt-sealed lids.

Soil Cuttings and Drilling Mud

Soil cuttings are solid to semisolid soils generated during trenching activities, drilling for the collection of subsurface soil samples, or the installation of monitoring wells. Depending on the type of drilling, drilling fluids known as “muds” may be used to remove soil cuttings. Drilling fluids flushed from boreholes must be directed into a settling section of a mud pit. This allows reuse of the decanted fluids after removal of the settled sediments. Drill cuttings, whether generated with or without drilling fluids, are to be removed with a flat-bottomed shovel and stored in 55-gallon drums with bolt-sealed lids.

Well Development and Purge Water

Well development and purge waters consists of groundwater removed from monitoring wells to repair damage to the aquifer following well installation, obtain characteristic aquifer groundwater samples, or measure aquifer hydraulic properties. The volume of groundwater to be generated will determine the appropriate storage procedure. These activities can generate significant volumes of groundwater depending on the well yield and the duration of the test or activity. Use of drums or large–volume, portable tanks such “Baker Tanks” should be considered for temporary storage of purge water.

Disposable Equipment

Disposable equipment includes used personal protective equipment such as Tyvek coveralls, gloves, booties and APR cartridges, and some inexpensive sampling equipment such as trowels or disposable bailers. This equipment is assumed to be contaminated if it was used at a hazardous waste site because it is impractical to submit these items for analysis. These materials should be stored on site in 55-gallon drums, pending final disposal.

Waste Storage

The wastes that accumulate through investigations must be stored on site prior to disposal. An on-site waste staging area should be designated to provide secure and controlled storage for the drums. Per RCRA requirements, storage cannot exceed 90 days for materials presumed or shown to be RCRA-designated hazardous wastes. Waste that is known not to be RCRA–designated, should be promptly disposed to municipal waste systems.

Storage Containers

Containers shall be DOT-approved (DOT 17H 18/16GA OH unlined), open top, steel drums. The lids should lift completely off the drum, and be secured by a bolt ring. Enough drums should be ordered to store all anticipated waste, including extra drums for solid waste and decontamination water. Solid and liquid wastes are not to be mixed in the drums.

Pallets are often required to allow transport of filled drums to the staging area with a forklift. Normal pallets are 3′ x 4′ and will hold two to three, 55-gallon drums, depending on the filled weight. If pallets are required for drum transport or storage, Parametrix field personnel are responsible for ensuring that the empty drums are placed on pallets before they are filled and that the lids are sealed on the drums with the bolt tighten ring after the drums are filled. Because the weight of one drum can exceed 500 pounds, under no circumstances should Parametrix personnel attempt to move the drums by hand. In addition, Parametrix personnel should not operate forklifts as part of their regular field activities. Removal of drums to the staging area is normally the responsibility of the client, unless other arrangements have been made.

Drum Labeling

Each drum that is used will be assigned a unique number that will remain with that drum for the life of the drum. This number will be written in permanent marker on the drum itself. Do not label drum lids. Drum labels shall contain the following information:

- Waste accumulation start date.
- Well number or boring number, if applicable.
- Drum number.
- Contents matrix (soil, water. slurry, etc.).

- Generation location.
- Project name.

4.0 Waste Disposal

Responsibility for the final disposal of investigation-derived waste will be determined before field activities are begun and shall be described in the investigation work plan. Disposal or long-term storage (over 90 days) of RCRA-designated hazardous wastes requires procedures that are beyond the scope of this SOP. The Parametrix Hazardous Waste Management Program is presented in SOP HS-005.

INDOOR AIR SAMPLING

Prepared By: ______________________ Date: __________

Reviewed By: ______________________ Date: __________

Approved By: ______________________ Date: __________

1.0 Purpose and Scope

The objective for this Standard Operating Procedure (SOP) is to define the method for the performance of the collection of indoor air samples. This SOP describes the collection of time-integrated samples from the breathing zones of potentially impacted structures, in a manner consistent with sampling and data quality objectives. The samples will be collected from basement, crawl space, and/or living space areas. The length of time to collect the sample is approximately 24 hours.

MATERIALS

- Atmospheric pressure meter (barometer)
- Temperature meter
- Humidity meter
- Calibrated 6-liter Summa™ canister(s) and designated time-integrated flow controller(s) (supplied by laboratory)
- 9/16” wrench
- Calibrated vacuum gauge
- Field notebook and indoor air sample collection field form
- Timepiece (to record start and end sample collection times)

INDOOR AIR SAMPLING PROCEDURES

The following procedures are adhered to during indoor air sampling using a 24-hour flow controller on a Summa™ canister that has been properly evacuated and pressurized by the laboratory.

Prior to Collection of the Sample

1. Using a 9/16” wrench, remove the brass cap above the valve on top of the Summa™ canister.

2. Attach a vacuum gauge to the canisters to ensure a vacuum of at least -28.5 inches of mercury (inHg) when deployed. Any vacuum less than -28.5 inHg indicates a possible leak and should not be used. The canister should be kept out of direct sunlight. A duplicate sample canister, if necessary, should be placed at the same time and follow the same procedures for both sample canisters. Document the initial canister pressure on the sample collection field form (field form).
3. Attach the laboratory supplied 24-hour flow control device to the top of the canister. Ensure connected fittings are finger tight followed by a 1/4” turn with the 9/16” wrench.
4. Site the canister at locations within the structure where representative sampling will occur in the breathing zone. Consider the occupants and uses of the building. Buildings containing small children should be sampled closer to the ground.

Sample Collection

1. When ready to begin sampling, open the valve to the canister by turning the valve control knob approximately 1 and 1/4 turns counterclockwise.
2. Document the sample location, sample date and time, canister and 24-hour flow control device serial/ barcode numbers, as well as the barometric pressure, temperature, and humidity of the sample location on the field form. Record any notes on the field form regarding the sample location that could potentially influence sample results (i.e.: cleaning product usage, open doors or windows, tobacco smoking, auxiliary air circulation (fans), or chemical occurrences near the sample location).
3. 24 hours after opening the canister, shut-off the control valve by turning clockwise. Check the barometric pressure, temperature, and humidity of the sample location again and record on the field form.
4. Remove the 24-hour flow control device and measure the canister pressure with the vacuum gauge. Document the final canister pressure on the field form. Sampled canisters should have some remaining vacuum, preferably between approximately -0.1 and -9 inHg. Replace the brass cap and tighten gently.
5. Record on the sample tag the sample date and time, client name, sample location/ name, and requested analysis and attach to the canister.
6. Document on the field form the project name and number, the sample date and time, atmospheric readings/weather conditions, personnel onsite, any problems or corrective actions, and any other information that will allow reconstruction of pertinent field activities.
7. Record the sample location, date, time, canister serial number, flow controller serial number, sample volume, and desired analysis on the chain-of-custody form.
8. Filled Summa™ canisters are transported to the project analytical laboratory under chain-of-custody procedures.

LOW STRESS (LOW FLOW) PUMPING AND SAMPLING WITH DEDICATED MONITORING WELL PUMPS

Prepared By:	______________________	Date:	__________
Reviewed By:	______________________	Date:	__________
Approved By:	______________________	Date:	__________

1.0 Purpose and Scope

The objective of this document is to describe the method used to sample groundwater monitoring wells using low stress (low flow) pumping procedures using bladder pumps or dual-valve pumps modified with bladders that are dedicated to each monitoring well. Low stress pumping is used to minimize stress on the formation and groundwater drawdown on the groundwater column so as to avoid changes to the groundwater chemistry. The low flow purge rate should be between 0.2 to 0.5 liters per minute (lpm), with an overall drawdown of less then 0.1 meters (0.33 feet). Stability should be achieved during groundwater drawdown by measuring parameters as quickly as possible to limit stressing the formation and mobilizing solids.

MATERIALS

The following materials are used during low stress groundwater sampling:

- Electronic water level indicator
- Dedicated bladder pump
- 1/4 inch Teflon™-lined polyethylene tubing
- Nitrogen gas cylinder
- Two calibrated 5-gallon plastic buckets
- pH meter
- Specific conductivity meter
- Temperature meter
- Dissolved oxygen meter

- Oxygen-reduction potential meter
- Turbidity meter
- Flow through cell for field meters
- Field data sheets
- Decontamination supplies
- Sample Jars
- Sample labels
- Field notebook and indoor air sample collection field form
- Timepiece (to record start and end sample collection times)

SAMPLING PROCEDURE

1. Open monitoring well monument and cap and allow for groundwater to equalize in monitoring well. Once groundwater has equalized, measure depth to groundwater using electronic water level indicator. Write groundwater level depth down on field data sheet.

2. Calibrate all field meters and write down results on sample collection field form.

3. Connect nitrogen input line (from control box) to port on well cap. Connect Teflon™-lined polyethylene discharge tubing (disposable 2 to 3 foot section) to dedicated pump discharge port on well cap and influent port on the flow through cell. Connect all field meters and pump effluent tubing to flow through cell. Place effluent tubing from flow through cell into calibrated 5-gallon bucket.

4. Place water level meter back into well. Start purging by activating the pump to the appropriate setting of approximately 0.4 pounds per inch (psi) per foot of lift (e.g. 40 psi for a 100 foot lift).

5. Monitor depth to groundwater for minimum drawdown and groundwater flow rate. Write down depth to groundwater and flow rate on field form every 3 to 5 minutes.

6. Collect water-quality indicator parameters every 3 to 5 minutes and record on field form. The water-quality indicators are dissolved oxygen, specific conductivity, turbidity, pH, oxidation-reduction potential, and temperature. Groundwater quality is stable when three consecutive readings are within the following criteria:

Parameters	**Stabilization Criteria**
pH	+/- 0.1 pH units
Temperature	3%
Specific conductivity	+/- 3% S/cm
Oxidation-reduction potential	+/- 10 millivolts
Turbidity	10% for values > 1 NTU, otherwise 1 NTU
Dissolved oxygen	10% or 0.5 mg/L (whichever is greater)

7. Once the groundwater quality parameters have stabilized, sample collection can take place.

8. Disconnect the tubing from the flow through cell intake but leave connected to the dedicated pump discharge port. For volatile organic compounds, collect sample slowly to minimize volatilization from the dedicated pump discharge tubing into laboratory-supplied hydrochloric acid-preserved 40-milliliter glass vials with Teflon™ septum lids and place into a cooler. The cooler should be refrigerated to 4 degrees (^{o}) centigrade (C) using ice. Collect samples for other analyses into appropriate laboratory-supplied containers and place into cooler with ice (samples for metals analysis do not require refrigeration).

9. After sampling is completed, disconnect discharge tubing and nitrogen line, recap monitoring well and bolt monument cover to monument.

10. Samples for chemical analysis are labeled at the time of collection. The labels should include project name, sample date and time, sample identification, requested analysis, and initials of the sampler.

11. Document on the field form the project name and number, the sample date and time, weather conditions, personnel onsite, any problems or corrective actions, and any other information that will allow reconstruction of pertinent field activities.

12. The labeled samples will be stored in an insulated cooler at 4^{o} C. Record the project name and number, sample date and time, sample identification, sample matrix, sampler name, and desired analysis on the chain-of-custody form.

13. The samples will be shipped or hand carried under chain-of-custody procedures to the analytical laboratory.

DECONTAMINATION PROCEDURES

Decontaminate all non-dedicated equipment in direct contact with groundwater prior to commencing sampling activities. Clean all non-dedicated equipment using the method described in the Decontamination Standard Operating Procedure.

OUTDOOR AIR SAMPLING

Prepared By: ______________________ Date: __________

Reviewed By: ______________________ Date: __________

Approved By: ______________________ Date: __________

1.0 Purpose and Scope

The objective for this Standard Operating Procedure (SOP) is to define the method for the performance of the collection of outdoor air samples. This SOP describes the collection of time-integrated samples from the breathing zones of potentially impacted areas, in a manner consistent with sampling and data quality objectives. The length of time to collect the sample is approximately 24 hours.

MATERIALS

- Atmospheric pressure meter (barometer)
- Temperature meter
- Humidity meter
- Calibrated 6-liter Summa™ canister (s) and designated time-integrated flow controller(s) (supplied by laboratory)
- 9/16 inch wrench
- Calibrated vacuum gauge
- Field notebook or outdoor air sample collection field form
- Timepiece (to record start and end sample collection times)

OUTDOOR AIR SAMPLING PROCEDURES

The following procedures are adhered to during outdoor air sampling using a 24-hour flow controller on a Summa™ canister that has been properly evacuated and pressurized by the laboratory.

Prior to Collection of the Sample

1. Using a 9/16” wrench, remove the brass cap above the valve on top of the Summa™ canister.

2. Attach a vacuum gauge to the canister to ensure a vacuum of at least -28.5 inches of mercury (inHg) when deployed. Any vacuum less than -28.5 inHg indicates a possible leak and should not be used. The canister should be kept out of direct sunlight. A duplicate sample canister, if necessary, should be placed at the same time and follow the same procedures for both sample canisters. Document the initial canister pressure on the sample collection field form (field form).

3. Attach the laboratory supplied 24-hour flow control device to the top of the canister. Ensure connected fittings are finger tight followed by a 1/4” turn with the 9’16” wrench.

4. Place the canisters at locations where representative sampling will occur. Site the canister where it is protected from severe weather (i.e.: heavy rain, freezing, high winds).

Sample Collection

1. When ready to begin sampling, open the valve to the canister by turning the valve control knob approximately 1 and 1/4 turns counterclockwise.

2. Document the sample location, sample date and time, canister and 24-hour flow control device serial/ barcode numbers, as well as the barometric pressure, temperature, and humidity of the sample location on the field form. Record any notes on the field form regarding the sample location that could potentially influence sample results (i.e.: any chemical odors, cigarette smoke, or car exhaust fumes occurring near the sample location).

3. 24 hours after opening the canister, shut-off the control valve by turning clockwise. Check the barometric pressure, temperature, and humidity of the sample location again and record on the field form.

4. Remove the 24-hour flow control device and measure the canister pressure with the vacuum gauge. Document the final canister pressure on the field form. Sampled canisters should have some remaining vacuum, preferably between approximately -0.1 and -9 inHg. Replace the brass cap and tighten gently.

5. Record on the sample tag the sample date and time, client name, sample location/ name, and requested analysis and attach to the canister.

6. Document on the field form the project name and number, the sample date and time, atmospheric readings/weather conditions, personnel onsite, any problems or corrective actions, and any other information that will allow reconstruction of pertinent field activities.

7. Record the sample location, date, time, canister serial number, flow controller serial number, sample volume, and desired analysis on the chain-of-custody form.

8. Filled Summa™ canisters are transported to the project analytical laboratory under chain-of-custody procedures.

SOIL GAS WELL SAMPLING

Prepared By: ______________________ Date: __________

Reviewed By: ______________________ Date: __________

Approved By: ______________________ Date: __________

1.0 Purpose and Scope

The objective of this document is to describe the methods used to collect samples from soil gas monitoring wells. This SOP describes the collection of time-integrated samples from soil gas wells in a manner consistent with sampling and data quality objectives. Soil gas monitoring well sampling procedures are detailed in the following sections.

MATERIALS

The following materials are used during soil gas well installation and sampling:

- Atmospheric pressure meter
- Temperature meter
- Humidity meter
- Calibrated 6-Liter Summa™ canister(s) and designated time-integrated flow control device(s) (supplied by laboratory)
- 9/16 inch wrench
- Calibrated vacuum gauge
- Vacuum pump
- Teflon™-lined polyethylene tubing
- Field notebook and indoor air sample collection field form
- Timepiece (to record start and end sample collection times)

SOIL GAS SAMPLING

The following procedures are adhered to during soil gas sampling using a flow control device calibrated to a flow rate of approximately one-half liter per minute attached to a Summa™ canister that has been properly evacuated and pressurized by the laboratory.

1. Soil gas samples are collected by attaching one end of Teflon™-lined polyethylene tubing to the PVC well casing adapter and sampling port and the other end to the vacuum pump.

2. Approximately 5 soil gas well volumes are withdrawn prior to sample collection using the vacuum pump to purge the well casing of all ambient air.

3. Following purging activities, soil gas samples are collected into 6-liter Summa™ canisters.

4. To collect a sample, use a 9/16” wrench and remove the brass cap above the valve on top of the canister.

5. Attach a vacuum gauge to the canister to ensure a vacuum of at least -28.5 inches of mercury (inHg) when deployed. Any vacuum less than -28.5 inHg indicates a possible leak and should not be used. The canister should be kept out of direct sunlight. A duplicate sample canister, if necessary, should be collected using the same procedures. Document the initial canister pressure on the sample collection field form (field form).

6. Attach the laboratory supplied and calibrated flow control device to the top of the canister. Ensure connected fittings are finger tight followed by a 1/4” turn with the 9/16” wrench. Care should be taken during sample collection to ensure that air from the surface is not being inadvertently sampled (resulting from well seal failure) and desorption of contaminants does not occur. To minimize the potential desorption of contaminants from soil, the flow control valve has been calibrated so that the canister is filled at a rate of approximately one-half liter per minute (L/min).

7. Connect the Teflon™-lined polyethylene tubing to the well sample port and the flow control device.

8. When ready to begin sampling, open the valve to the canister by turning the valve control knob approximately 1 and 1/4 turns counterclockwise.

9. Approximately 12 minutes after opening the canister, shut-off the control valve by turning clockwise. Check the barometric pressure, temperature, and humidity of the sample location again and record on the field form.

10. Remove the flow control device and measure the canister pressure with the vacuum gauge. Document the final canister pressure on the field form. Sampled canisters should have some remaining vacuum, preferably between approximately -0.1 and -9 inHg. Replace the brass cap and tighten gently.

11. Record on the sample tag the sample date and time, client name, sample identification, and requested analysis and attach to the canister.

12. Document on the field data form the project name and number, the sample date and time, atmospheric readings/weather conditions, personnel onsite, any problems or corrective actions, and any other information that will allow reconstruction of pertinent field activities.

13. Record the sample location, date, time, canister serial number, flow control device serial number, sample volume, and desired analysis on the chain-of-custody form.

14. Filled Summa™ canisters are transported to the project analytical laboratory under chain-of-custody procedures.

SOIL SAMPLING

Prepared By: ______________________ Date: __________

Reviewed By: ______________________ Date: __________

Approved By: ______________________ Date: __________

1.0 Purpose

The objective of this Standard Operating Procedure (SOP) is to describe a method for the performance of collecting soil samples. The following procedures include the use of hand augers, Shelby tubes, continuous core samplers, split-spoon samplers, and excavation equipment.

2.0 Scope

Shallow subsurface soil samples at depths of 15 centimeters (cm) to 3 meters (m) (6 inches [in] and 10 feet [ft]) may be collected using hand augers. Hand auger samples are generally of poorer quality than samples collected by split-spoon, Shelby tube, or continuous core samplers since the sample is disturbed during the sampling process. Split-spoon and Shelby tube samplers are typically used in conjunction with Hollow Stem Auger (HSA), air rotary, mud rotary, dual rotary, and cable tool drilling equipment. Continuous core samplers are typically used in conjunction with push-probe drilling technology. Sonic drilling equipment utilizes plastic tube bags for sample collection. Soil samples may also be collected from test pits and other excavations using an excavator bucket. The size and construction material of sampling devices should be selected based on project specific and analytical objectives and defined in site-specific plans.

MATERIALS

- Site specific work plan
- Global Positioning System (GPS) unit, if available
- Field notebook, boring log form, and indelible ink pens
- Appropriate sample jars as described in the site work plan
- Standard En Core T-Handle® or similar
- 5 gram En Core® samplers or similar
- 2-ounce or 40-milliliter (mL) jars

- Insulated cooler(s)
- Ice or “Blue ice”
- Latex or Nitrile disposable gloves
- Plastic zip top bags
- Appropriate personal protective equipment (PPE) and clothing as defined in the work plan
- Stainless steel and/ or Teflon™-lined: bowls, trowels, or spoons.
- Decontamination supplies
    - Alconox®
    - Tap water
    - Deionized water
    - Scrub brush
    - Decontamination bucket

METHOD

The following methods describe the performance of collecting soil samples with push-probe, test pitting, hollow Stem Auger (HAS), air rotary, mud rotary, dual rotary, and cable tool drilling equipment

PREPARATION

1. Don the required PPE as defined in the work plan and/ or Health and Safety Plan.
2. Locate the sampling locations in accordance with the work plan and/or scope of work and document in the field notebook. Clear the sampling location for underground utilities by contacting the one-call utility notification center 24-hours prior to commencing drilling activities. Utilities typically cleared by one-call are from public areas to the metered private property. Clear underground utilities on private property with a private utility identification company.
3. Measure the sample location. Record sample location in reference to existing site buildings or features and/or use a Global Positioning System (GPS) device to collect sample location coordinates. Use of a GPS device is the preferable method.
4. Prepare an area next to the sample location for laying out cuttings and sampling equipment by laying out plastic sheeting on the ground or on work tables.
5. If decontamination is required, prepare a decontamination area in accordance with the decontamination SOP.

SAMPLE COLLECTION

1. Volatile Organic Compound (VOC) samples or samples that may be degraded by disturbance and/or aeration are collected first and with the least disturbance possible.
2. Sampling information is recorded in the field logbook and/or the boring log form. Describe lithology according to the guidelines set forth by USCS and/or ASTM D2488-90.
3. Prevent the cross-contamination and misidentification of samples by paying close attention to decontamination procedures and sample collection procedures.
4. Sample containers containing samples for VOC analysis are filled completely to minimize headspace.

SURFACE SOIL SAMPLING

1. Soil samples are collected from shallow depths (less than 1 ft) using hand tools such as stainless steel spoons or trowels.
2. Remove top soil with the spoon or trowel to the desired sampling depth.
3. Soil samples collected for chemical analysis are collected using a stainless steel trowel and placed directly into labeled sampling containers provided by the analytical laboratory.
4. Additional soil can be placed in a self-sealing bag for in-field headspace analysis.

TEST PIT SAMPLING

1. Excavate the sample location to the desired sample depth.
2. Soil samples are collected from the base and sidewalls of excavated test pits. Specific sampling depth is selected by the field geologist based on site conditions. A decontaminated stainless steel spoon or trowel is used to collect soil from the excavator bucket derived from a 0.5 ft radius of the designated sampling point. In an area not in direct contact with the bucket, approximately six inches of the bucket contents are scraped away and then the sample is collected. The soil samples collected for chemical analysis are placed directly into labeled sampling containers provided by the analytical laboratory.
3. Soil samples are logged by a qualified geologist using the Unified Soil Classification System (USCS) and/or ASTM D2488-90. Sampling locations are measured to approximately the nearest 1 ft with the GPS unit and plotted on the site map.
4. Additional soil can be placed in a self-sealing bag for in-field headspace analysis.

SOIL PROBE SAMPLING

1. A soil probe rig is used to collect subsurface soil samples. This technique uses *direct-push technology* to drive a 2-inch diameter steel core barrel sampler to pre-selected depths for collection of soil samples. The probe consists of a section of hollow steel rod attached to a five-foot long macro core sample barrel. The macro core sample barrel is lined with acetate or PVC sleeve liners.

2. Soil samples are collected using hollow 1-inch diameter probe rods with a probe-driven macro core sample barrel attached to the end that retrieves discrete soil cores approximately 2 inches in diameter and 5 feet in length. A section of the steel rod is advanced in each boring to specific sampling depths, the sampler, lined with acetate or PVC liners, is attached to the macro core sample barrel.

3. The sampler remains sealed by a piston tip at the end of the sample tube while it is pushed or driven to the desired depth. A piston stop-pin at the opposite end of the sampler is removed by means of extension rods inserted into the probe rods, and the sampler is driven to depth. This enables the piston to retract into the sample tube while the sampler is being advanced.

4. Samples are collected in the disposable acetate or PVC sleeve liners. After sample collection, the probe rods are retracted from the hole and the sample is extruded from the sampler while it remains inside the sleeve. The sleeves and end caps preserve bedding characteristics and soil moisture and can be cut into sections to produce samples from discrete intervals, or cut length-wise to produce composite samples.

5. Soil cores are logged and classified by a qualified geologist using the Unified Soil Classification System (USCS) and/or ASTM D2488-90. Boring locations are measured to approximately the nearest 1 ft with the GPS unit and plotted on the site map.

6. The soil sample material is placed directly into labeled sampling containers provided by the analytical laboratory.

7. Additional soil can be placed in a self-sealing bag for in-field headspace analysis.

SOIL SAMPLING DURING MONITORING WELL INSTALLATION

1. Soil samples are collected during drilling of monitoring well borings using the hollow stem auger air rotary, mud rotary, dual rotary, and cable tool drilling techniques. Discrete samples are collected at a minimum of every 5-ft or as otherwise directed by the field geologist based on site conditions or specified in the work plan.

2. Samples are collected following Standard Penetration Test (SPT) procedures and using split-spoon type samplers.

3. Soil samples are logged by a qualified geologist using the USCS and/or ASTM D2488-90 guidelines. Monitoring well locations are measured to the nearest 0.01 ft by a licensed surveyor and plotted on the site map.

4. A decontaminated stainless steel spoon or trowel is used to place the soil directly into labeled sampling containers provided by the analytical laboratory.

5. Additional soil can be placed in a self-sealing bag for in-field headspace analysis.

SAMPLES FOR VOC ANALYSIS USING EPA METHOD 5035A

All soil samples for VOCs or TPH-Gas and BTEX analysis will be collected using EPA Method 5035A. This method involves field preservation using pre-weighed 40-milliliter (mL) vials that contain a pre-measured quantity of preservative. A prescribed mass of soil is collected using a hand-held coring device and is placed directly into the sample vial with as little disturbance as possible. Soil mass and preservative volume requirements are laboratory specific. Typically, 10 grams of soil are required and are placed into vials pre-preserved with 10-mL of methanol. The pre-preserved vials are weighed in the laboratory and the weights are recorded on the sample label. Specific field procedures are as follows:

1. Calibrate the field balance and reweigh the laboratory-supplied vials. The field balance should be sensitive to +/- 0.1 grams. If the difference between the laboratory tare weight and the field weight is > 0.2 grams, do not use the vial.

2. Prepare a methanol blank by leaving a blank methanol vial open during collection of a soil sample to check for atmospheric VOCs. When sample collection is complete, cap the vial and ship it to the lab for analysis along with the other samples. Prepare at least one methanol blank per sample cooler.

3. Collect the soil sample using a pre-calibrated syringe. Several syringe types are currently commercially available. Collect the sample from undisturbed soil on a freshly-exposed surface. If the soil type is such that the syringe will not penetrate, use a dedicated stainless steel spoon to collect the sample. Extrude (or place) the sample gently into the vial. Reweigh the vial; the target soil weight is 5 +\- 0.5 grams. The desired ratio of grams soil to mL methanol is 1:1 with a +\- 25 % tolerance. In all cases, the soil sample must be completely immersed in methanol. Collect as many vials as required by the laboratory (typically one to two).

4. Record sample information on the sample label applied by the laboratory. Do not place an additional label on the vial as this will alter the tare weight and affect the analytical results.

5. For each sample, collect a full two-ounce jar or 40 mL vial for moisture content analysis. Fill the container so no headspace is present.

SAMPLE LABELING AND HANDLING

Samples for chemical analysis are labeled at the time of collection. The labels should include project name, sample date and time, sample identification, requested analysis, and initials of the sampler. Document in the field logbook and on the field log form the project name and number, the sample date and time, weather conditions, personnel onsite, any problems or corrective actions, and any other information that will allow reconstruction of pertinent field activities. The labeled samples will be stored in an insulated cooler at 4 degrees (^{o}) centigrade (C). Record the project name and number, sample date and time, sample identification, sample matrix, sampler name, and desired analysis on the chain-of-custody form. The samples will be shipped or hand carried under chain-of-custody procedures to the analytical laboratory.

HEADSPACE ANALYSIS

During sampling operations, a field photoionization detector (PID) is used to detect the presence of analyte vapors from volatile organic compounds (VOCs) in the soil at the sampled interval.

For each interval, approximately 200 to 300 grams of soil are collected and placed in a self-sealing bag. After approximately 10 minutes, the Teflon™ tip of the PID is inserted through the seal and the highest concentration of VOCs will be recorded within the headspace of the bag. The PID is calibrated in accordance with the manufacturer's specifications.

DECONTAMINATION PROCEDURES

Decontaminate all equipment in direct contact with soil prior to commencing drilling activities, between drilling locations, and upon demobilization. Clean all equipment using the method described in Standard Operating Procedure (SOP): *Decontamination*.

HANDLING OF INVESTIGATION-DERIVED WASTE

Investigation-derived waste (IDW) generated during monitoring well installation activities can include: decontamination solutions, disposable equipment, drill cuttings and fluids, and groundwater monitoring well development and purge waters. Handle all IDW using the method described in SOP: *Handling of Investigation-Derived Waste*.