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Boeing Plant 2
Seattle, WA

Target Media Cleanup Levels Technical Memorandum

Prepared For

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List of Abbreviations and Acronyms

Abbreviation/Acronym	Definition
ABW	Average body weight
API	Asian/Pacific Islander
BCF	Bioconcentration factor
bgs	Below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CMI	Corrective Measures Implementation
CMS	Corrective Measures Study
COC	Constituent of concern
CSL	Cleanup Screening Level
cPAH	Carcinogenic polycyclic aromatic hydrocarbon
DSOA	Duwamish Sediment Other Area
Ecology	Washington State Department of Ecology
FMCL	Final Media Cleanup Level
HHRA	Human Health Risk Assessment
IRMA	Industrial Risk Management Area
LDW	Lower Duwamish Waterway
LDW Site	Lower Duwamish Waterway Superfund Site
MLLW	Mean lower low water
MTCA	Washington State Model Toxics Control Act
PCB	Polychlorinated biphenyl
PCE	Tetrachloroethene
PMCL	Preliminary Target Media Cleanup Level
POC	Point of compliance
RBC	Risk-based concentraton
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RSL	Regional Screening Levels
SMS	Sediment Management Standards
SQS	Sediment Quality Standards
Shoreline RMA	Shoreline Risk Management Area
SRMA	Sediment Risk Management Area
SVOC	Semivolatile organic compound
SWB	Southwest Bank
TCE	Trichloroethene
TEE	Terrestrial Ecological Evaluation Exposure Analysis
TMCL	Target Media Cleanup Level
TPH	Total petroleum hydrocarbons
TSD	Treatment, storage, and disposal
USACE	U.S. Army Corp of Engineers
USEPA	U.S. Environmental Protection Agency
VOC	Volatile organic compound

Foreword

This Technical Memorandum is part of the Corrective Measures Study (CMS) for The Boeing Company (Boeing) Plant 2 facility (Plant 2) on the Lower Duwamish Waterway. This document and the CMS process are being performed under the Resource Conservation and Recovery Act (RCRA) Administrative Order on Consent (RCRA Order) issued by the U.S. Environmental Protection Agency (USEPA) to Boeing under the authority of Section 3008(h) of the RCRA of 1976, as amended, (42 United States Code [USC] 6928[h]). This RCRA Order (RCRA Docket Number 1092-01-22-3008[h]) became effective on January 18, 1994 and requires the performance of such interim measures as USEPA may require during the performance of a RCRA Facility Investigation/Corrective Measures Study (RFI/CMS) to assess the nature and extent of hazardous constituent contamination, and to analyze corrective action alternatives to address actual or potential threats to human health and the environment resulting from the release, or potential release, of hazardous constituents at, or from, Plant 2 located at 7755 East Marginal Way South, Seattle/Tukwila, Washington. The CMS Report is being produced as a multiple-volume document, with different volumes being prepared at different times to address different aspects and areas of Plant 2.

The Target Media Cleanup Levels (TMCLs) presented in this document will guide the corrective measures process by setting the "target" levels that corrective measures will be designed to use as cleanup goals and lead to development of Final Media Cleanup Levels (FMCLs). In the RCRA Order, the development of proposed TMCLs was intended to be performed as part of the RFI completed in 1998. However, cleanup levels were not proposed during the RFI process, but were to be established as part of the CMS process. The TMCLs proposed in this document will replace Preliminary Target Media Cleanup Levels (PMCLs) that were established in 1999 to provide goals for Interim Measures that were to be conducted prior to the availability of the TMCLs. In a similar manner, the TMCLs proposed in this document will replace the 2004 Screening Levels that were established at that time to update the 1999 PMCLs by incorporating a number of regulatory and toxicity value changes that followed the 1999 levels.

1.0 Introduction

1.1 GOALS AND OBJECTIVES

This Technical Memorandum documents the process used and assumptions made in developing Target Media Cleanup Levels (TMCLs) for The Boeing Company (Boeing) Plant 2 facility (Plant 2) as part of the Resource Conservation and Recovery Act (RCRA) Corrective Measures Study (CMS). The ability of a technology or alternative to meet TMCLs is one of the criteria used to screen and select corrective measures for Plant 2.

Throughout this document, an overall effort has been made to develop TMCLs that are consistent with the following documents or programs:

- RCRA Administrative Order on Consent (RCRA Order; RCRA Docket Number 1092-01-22-3008[h])
- CMS Work Plan, submitted September 1998 and approved by the U.S. Environmental Protection Agency (USEPA)
- RCRA Guidance and Policy
- Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Risk Assessment Guidance for Superfund (USEPA 1989)
- Framework for Selecting and Using Tribal Fish and Shellfish Consumption Rates for Risk-Based Decision Making at CERCLA and RCRA Cleanup Sites in Puget Sound and the Strait of Georgia (USEPA 2007)
- Washington State Model Toxics Control Act (MTCA) Regulations (Washington Administrative Code [WAC] 173-340)

A TMCL is a target concentration for a specific hazardous constituent in a particular medium combined with a point of compliance (POC) where this concentration should be met. This definition meets both the requirements of the RCRA Order and MTCA.

The development of TMCLs is a required component of the RCRA Order for Plant 2. Under the RCRA Order, a preference is made for promulgated criteria. If no promulgated criteria exist or if promulgated criteria address fewer than all potential exposure pathways for a specific constituent or medium, then human health or ecological risk-based criteria are to be developed. For a specific medium, more than one exposure pathway often exists; this results in multiple promulgated criteria and/or risk-based criteria for each constituent. For clarity, this Technical Memorandum will present proposed TMCLs with a clear identification of all constituent, medium, pathway, and POC combinations.

After technologies and specific alternatives have been identified, screened, and evaluated, specific corrective measures will be identified for Plant 2 and presented in the CMS. As part of the description of the corrective measure, Final Media Cleanup Levels (FMCLs) and POCs will be defined for each required action and summarized in the final volumes of the CMS. Much of the detail of their justification, use, and compliance will be presented in the specific volume for the CMS dealing with the specific corrective measure. For this reason, FMCLs may be location

dependent and vary from one area to another at Plant 2, due to differences in land use restrictions, physical settings, and selected corrective measures.

1.2 REGULATORY STATUS

1.2.1 Resource Conservation and Recovery Act (RCRA)

Plant 2 is a treatment, storage, and disposal (TSD) facility subject to RCRA regulation and permitting, which includes corrective action. Section 3008(h) authorizes the issuance of RCRA corrective action Orders. The 3008(h) Order issued to Boeing (RCRA Docket No 1092-01-22-3008[h], effective January 18, 1994) requires the performance of such interim measures as USEPA may require during the performance of a RCRA Facility Investigation/Corrective Measures Study (RFI/CMS) to assess the nature and extent of hazardous constituent contamination, and to analyze corrective action alternatives to address actual or potential threats to human health or the environment from the release or potential release at or from Plant 2.

USEPA has split the administration of Plant 2 into Uplands and Waterway portions. The Waterway portion, referred to as the Duwamish Sediment Other Area (DSOA), begins at the top of the bank (or the rear bulkhead wall under the buildings south of the 16th Avenue bridge), and includes a small area of Uplands referred to as the Southwest Bank (SWB). As such, the Uplands portion generally begins at the top of the bank and extends to the east to include the rest of the facility.

Groundwater discharging from the Uplands through the DSOA is considered part of the Uplands; however, the TMCL for groundwater includes an evaluation to protect the selected sediment remedy in the DSOA (refer to Section 6 for details).

Plant 2 is undergoing the CMS process. A series of data gap investigations was conducted in the Uplands to augment the RFI data set and provide additional data needed to complete the CMS evaluation report of alternatives and the selection of specific remedies in seven sub-areas of Plant 2.

Separately, a DSOA and Southwest Bank Interim Measure Alternatives Evaluation (AMEC and Floyd|Snider 2008) was approved by USEPA in 2011. A Statement of Basis (the RCRA decision document) describing the selected Corrective Measure is expected to be available for Public Comment in spring 2011. The Corrective Measure described in the Statement of Basis is consistent with this TMCL document.

1.2.2 Comprehensive Environmental Response Compensation and Liability Act (CERCLA)

An investigation and analysis of alternatives for the Lower Duwamish Waterway (LDW) Superfund Site is ongoing pursuant to a joint CERCLA/MTCA Administrative Remedial Investigation/Feasibility Study (RI/FS) Order on Consent issued on December 20, 2000, by USEPA and the Washington State Department of Ecology (Ecology) to Boeing, the City of Seattle, Port of Seattle and King County. A CERCLA RI/FS is generally equivalent to a RCRA

RFI/CMS. While the DSOA is geographically within the LDW Site, at Boeing's option, it continues to be addressed as part of the Plant 2 RCRA corrective action, pursuant to the pre-existing 1994 3008(h) Order. The DSOA has been characterized as a RCRA early action in the LDW RI/FS process, and DSOA planning has been coordinated with other LDW activities, particularly at the Jorgensen facility which borders Plant 2 to the south (the 1994 Plant 2 Order was amended to require coordination with the adjacent Jorgensen early action area, as was Jorgensen's CERCLA early action removal Order to require coordination with the adjacent Plant 2 DSOA); and to a much lesser degree with the Slip 4 CERCLA early action area removal, which borders Plant 2 to the north but is recessed from the waterway, and the Terminal 117 early action area removal, which is across the LDW from the southern portion of Plant 2.

1.2.3 Model Toxics Control Act (MTCA)

MTCA is the State of Washington's equivalent of the federal CERCLA statute and is implemented by Ecology. Ecology is participating in the Plant 2 RCRA process as a reviewer. USEPA and Ecology have generally agreed for their mutual convenience in a Memorandum of Understanding that USEPA will generally be the LDW Site lead agency for in-water portions of the Site and Ecology will generally be the lead agency for upland source control portions of the Site, and that the Agencies may alter these lead-support roles at any time for any portions of the Site.

Cleanup level requirements, including consideration of POCs and restoration time frame, specified in the MTCA regulations (WAC Chapter 173-340), have been included in the development of TMCLs at Plant 2.

2.0 Site Setting, History, and Current Land Use

2.1 PHYSICAL SETTING

2.1.1 Buildings and Physical Structures

Plant 2 is located on the east bank of the Duwamish Waterway in Seattle and Tukwila, Washington (refer to Figure 1). Historically, Plant 2 has specialized in manufacturing aluminum alloy, steel alloy, and titanium alloy parts for airplanes. Plant 2 was built on farmland in the late 1930s and became a significant manufacturing facility during World War II. In recent years, the activities at Plant 2 have shifted toward research, testing, and administration; although some manufacturing is still performed there.

As shown on Figure 2, Plant 2 is bounded on the east by East Marginal Way South, a four-lane arterial; on the south by Jorgensen Forge, an active steel and aluminum forge; on the north by Slip 4 and Emerald Services, Inc.; and on the west, by the Lower Duwamish Waterway. The Lower Duwamish Waterway is a federally maintained shipping channel of the Duwamish River; Slip 4 is an off-channel extension of the waterway. Plant 2 is served by both truck and rail, and is accessible from the waterway. Plant 2 is divided into northern and southern sections by a city arterial, 16th Avenue South, which services the 16th Avenue South Bridge over the Duwamish Waterway.

Plant 2 occupies approximately 107 acres of developed, topographically-flat land covered by buildings, paved yards, and parking areas. Most buildings are slab-on-grade with below-grade utilities.

2.1.2 Soils

The soils in the upper 100-feet beneath Plant 2 consist of four major geologic units. The first 3 to 9 feet of soil are comprised of a dark-gray to brown fill that is a loose to very dense, fine-to-medium sand and gray to grayish-brown gravel. Much of the fill appears to be alluvial in nature and probably reflects dredge spoils from modifications to the Duwamish River channel at the beginning of the 20th century; at some locations, debris exists within the fill. The fill is underlain by a discontinuous layer of brownish to greenish-gray to black silt and a soft organic silt layer that is up to approximately 2-feet thick where present.

Beneath the silt is the shallow portion of the upper aquifer that consists of poorly-graded, dark-gray, fine-to-medium sand with varying amounts of silt. This alluvial unit extends from approximately 10-feet below ground surface (bgs) to 40- to 50-feet bgs. Underlying this unit are the older Duwamish River alluvial deposits consisting of thick, coarsening-upward sequences of inter-bedded sand and silty sand. These alluvial deposits extend from approximately 40- to 50-feet bgs to 80-feet bgs.

At approximately 80-feet bgs, well and boring logs from Plant 2 describe a distinctive marine silt layer with shell fragments. The contact between the overlying silty sand and the marine silt is sharp and is readily noted in the field. The marine silt layer is underlain by a dense gray glacial till unit. These two low-permeability deposits form an aquitard that isolates the shallow aquifer (approximately upper 80 feet) from the deeper aquifers beneath the Lower Duwamish Valley.

2.1.3 Groundwater and Surface Water

Groundwater occurs in the alluvial aquifer generally starting at 9- to 12-feet bgs. The approximate groundwater flow direction is southwest towards the Duwamish Waterway. Groundwater from Plant 2 flows directly to the waterway without crossing other properties, except for limited migration across the southern property line onto the northern portion of the Jorgensen Forge facility. Even in that location, the dominant flow direction appears to be approximately parallel to the property line and towards the Duwamish Waterway (FSM 2004).

The Duwamish Waterway in the vicinity of Plant 2 is a tidally-controlled marine embayment with a freshwater lens of outgoing river water on top of the denser (more saline) marine waters. The sediments, while alluvial in nature, have salinities consistent with the marine waters from Elliott Bay. The saltwater layer extends into the Uplands as a saltwater wedge or prism. This wedge is approximately 18- to 23-feet bgs at the top of the bank (0- to minus 5-feet mean lower low water [MLLW]), and deepens as non-saline (and less dense) groundwater discharges from the Uplands over the top of this saltwater wedge. The effect of this saltwater wedge is to steepen the groundwater flow paths that curves upward near the waterway; most of the groundwater in the top 40 feet of the aquifer discharges in a fairly narrow band between minus 5- and plus 5-feet MLLW. Depending on the tidal stage, this discharge will occur into saline, brackish, or freshwater, with the most common situation being groundwater discharge into saline waters.

2.1.4 Plant 2 Corrective Measures Study Area

For the purposes of the CMS, Plant 2 has been divided into the following areas (as shown on Figure 2) for detailed investigation and analysis:

- The North Area
- The 2-10 Area
- The 2-31 Area
- The 2-40s Area
- The 2-60s Area
- The 2-66 Area
- The South Yard Area
- The Waterway Area (also called the DSOA/SWB)

This allows Boeing and the Agencies to focus on specific areas as the cleanup proceeds.

2.2 SURFACE WATER CONSIDERATIONS

2.2.1 Highest Beneficial Use of Groundwater

Risk-based cleanup standards for groundwater are dependent upon the existing and potential future uses of that groundwater. The National Contingency Plan states that "EPA expects to return usable ground waters to their beneficial uses" (40 Code of Federal Regulations [CFR] §300.430[a][1][iii][F]). Generally, the beneficial use of groundwater is either for drinking (i.e., potable) or for discharge to nearby surface waters. Potability is determined empirically using

criteria in WAC 173-340-720(2). While a majority of Plant 2 groundwater may not be potable due to factors in WAC 173-340-720(2), discrete areas of groundwater at Plant 2 may be potable.

In accordance with WAC 173-340-720(1)(i), more stringent cleanup levels may be required to protect sensitive subgroups. The DSOA encompasses American Indian usual and accustomed fishing areas pursuant to treaties of the United States. Northwest tribal populations claim to, and are well known to, consume locally harvested fish and shellfish at a higher rate than the general United States population. For this reason, the "Draft Framework for Selecting and Using Tribal Fish and Shellfish Consumption Rates for Risk-Based Decision Making at CERCLA and RCRA Cleanup Sites in Puget Sound and the Strait of Georgia" (Tribal Risk Framework) provides appropriate guidance for determining exposures used in calculating risk based TMCLs. Fish and shellfish consumption rates derived using this Framework provide more human health-protective cleanup levels than other promulgated or calculated groundwater levels.

Drinking water criteria, including State and Federal Maximum Contaminant Levels, USEPA Regional Screening Levels (RSLs) for tap water, and MTCA Method B/A for groundwater, have been included in this document for completeness, but are only used when insufficient information exists to calculate a criteria to protect fish consumption.

2.2.2 Beneficial Uses of Lower Duwamish Waterway Surface Water

The use designation of the Lower Duwamish Waterway is set forth in WAC 173-201A-602 (see Table 602, which was revised and implemented by Ecology in December 2006, and is pending approval by USEPA under the Clean Water Act). The Washington state-designated uses of the Duwamish River from its mouth to River Mile 11.0 are: salmonid rearing and migration, industrial/agricultural water supply, stock watering, wildlife habitat, secondary contact recreation, boating and sport fishing, commerce, and navigation. Importantly, the Lower Duwamish Waterway is not designated as a potential drinking-water source. Therefore, numerical surface water standards for human health are based on consumption of aquatic organisms (fish and shellfish), and do not include consumption of water.

While WAC 173-201A designates the Duwamish River as fresh surface water, the Duwamish Waterway in the vicinity of Plant 2 is actually a tidally-controlled marine embayment with a thin freshwater lens of outgoing river water on top of the denser (more saline) and more predominant marine waters. The sediments, while alluvial in nature, have salinities consistent with the marine waters from Elliott Bay. Accordingly, for the purposes of calculating Plant 2 TMCLs, the Lower Duwamish Waterway sediments in the vicinity of Plant 2 will be considered "marine," while surface waters will be considered both "freshwater" and "marine."

2.2.3 Designation of Marine vs. Freshwater Criteria

Several regulations and standards require a distinction be made between marine and freshwater. In estuaries, such as the Lower Duwamish Waterway, this distinction can be complex because of the presence of freshwater river discharge as a less-dense layer of water above the tidally influenced marine waters.

For discharge into the water column, both freshwater and marine standards have been considered, although the majority of the water column is saline. The salinity keeps the

groundwater from being potable and influences the biota present in the Lower Duwamish Waterway; however, some freshwater species use the waterway, especially in the upper sections of the water column.

2.3 LAND USE CONSIDERATIONS

2.3.1 Existing Facility Uses

Currently, Plant 2 is used primarily for research and testing, offices, motor pooling and vehicle maintenance, and warehousing of parts and equipment. Small-scale manufacturing operations are also ongoing in conjunction with research and testing functions. The North Area of Plant 2 has been redeveloped in recent years and now contains the Integrated Aircraft Systems Laboratory, associated parking, stormwater treatment bioswales, and a sliver of land that provides a public walking trail along Slip 4 and the Lower Duwamish Waterway. A portion of the South Yard Area has also been redeveloped in recent years and now is home to a wind-tunnel and other research facilities. In the 2-60s and 2-66 Areas, former Buildings 2-62, 2-63, 2-64, 2-65, and 2-66 have been removed, and the 2-40 series buildings are currently undergoing demolition to complete the redevelopment of these and other outdated and underused areas of Plant 2.

Except for the shoreline in the North Area along Slip 4, Plant 2 is a fenced, paved, and access-controlled property. The small portion of the North Area that is accessible to the public is separated from the rest of Plant 2 by a security fence.

2.3.2 Future Facility Uses

Boeing continues to plan for and conduct redevelopment of outdated and underused structures, particularly in areas south of 16th Avenue South. Future Uplands land use by Boeing at Plant 2 is anticipated to be industrial, which is consistent with local area land use controls. Deed restrictions and restrictive covenants will be implemented as needed to support corrective measures that rely on industrial exposure scenarios.

The Comprehensive Plans for the Cities of Seattle and Tukwila recognize the Duwamish Manufacturing/Industrial Center as key to continued industrial and manufacturing jobs in the region. Plant 2 is well within this area, and is zoned and targeted for continued industrial use (City of Seattle 2005; City of Tukwila 2005).

The City of Seattle and King County have slated the 16th Avenue South Bridge (the approach to which bisects Plant 2) for replacement because of its age and condition. Removal of the old bridge and construction of a new bridge adjacent to the north are scheduled to begin in spring 2011 and will be completed in 2013. Bridge demolition and reconstruction will shift the present bridge approach to the north and require an exchange of small areas of property between Boeing and King County. The future configuration of 16th Avenue South through Plant 2 will be documented in the CMS alternatives evaluation report.

Based on current uses and planned or anticipated projects, future activities at Plant 2 include the following:

- Operation of research facilities in the North and South Yard Areas

- Redevelopment of industrial facilities in the central portions of the Site
- Reconstruction of the 16th Avenue South Bridge and approach (by King County)
- Ongoing public access along Slip 4 in the North Area.
- Construction of shoreline habitat south of the 16th Avenue South Bridge and in the North Area
- Construction of updated stormwater management systems throughout Plant 2

At the end of these changes, approximately 95 percent of the current facility would remain a controlled-access, fenced, and paved industrial property. The other 5 percent would include unpaved, vegetated, and limited- or no-access habitat and stormwater control areas.

2.3.3 Waterway Uses

The Lower Duwamish Waterway is a straightened and dredged channel of the Duwamish River. Channel depth is maintained by the U.S. Army Corps of Engineers and the Port of Seattle. The river from bank-to-bank is generally owned by the Port of Seattle from approximately Harbor Island to the upper turning basin. The area is used for fish and shellfish habitat, salmon migration, boating and sport fishing, tribal fishing, shipping, navigation, and commerce. These uses are expected to continue in the future.

2.4 INTERIM MEASURES AND FACILITY UPGRADES

Beginning in 1986, Boeing has conducted, and continues to conduct, numerous interim measures and other actions to control or eliminate sources of contaminants to the environment. These actions include, for example, the installation of three sheetpile enclosures to contain solvent-contaminated soil and groundwater, updated management of electrical equipment and vaults, cleaning of legacy solids in stormwater drainage pipes, removal or control of polychlorinated biphenyl (PCB) containing caulks, removal of contaminated soils, removal of floating diesel from groundwater in one area, and actions to remedy contamination in groundwater in multiple locations. Some were performed as RCRA interim measures, some as pre-order activities, and some as part of facility upgrades in conjunction with the RCRA Order. Work is continuing today on such actions, including action as part of redevelopment activities.

The Uplands CMS volumes will describe the interim measures and other actions that have been conducted in each subarea to date, will clarify what contamination still remains at Plant 2, and will evaluate and propose required measures to eliminate remaining sources and pathways to be conducted during Corrective Measures Implementation (CMI).

3.0 TMCLs for Groundwater

3.1 GROUNDWATER USE

3.1.1 Highest Beneficial Use of Groundwater

Cleanup levels for groundwater are dependent upon the existing and potential future uses of that groundwater. The National Contingency Plan states that "EPA expects to return usable ground waters to their beneficial uses" (40 CFR §300.430[a][1][iii][F]). Generally, the beneficial use of groundwater is either for drinking (i.e., when potable) or for discharge to nearby surface waters. Potability is determined empirically using criteria in WAC 173-340-720(2). While a majority of Plant 2 groundwater may not be potable due to factors in WAC 173-340-720(2), discrete areas of groundwater at Plant 2 may be potable.

In any case, in accordance with WAC 173-340-720(1)(i), more stringent cleanup levels may be required to protect sensitive subgroups. The DSOA encompasses American Indian usual and accustomed fishing areas pursuant to treaties of the United States. Northwest tribal populations claim to, and are well known to, consume locally harvested fish and shellfish at a higher rate than the general United States population. For this reason, the "Draft Framework for Selecting and Using Tribal Fish and Shellfish Consumption Rates for Risk-Based Decision Making at CERCLA and RCRA Cleanup Sites in Puget Sound and the Strait of Georgia" (Tribal Risk Framework) provides appropriate guidance for determining exposures used in calculating risk based TMCLs. Fish and shellfish consumption rates derived using this Framework provide more human health-protective cleanup levels than other promulgated or calculated groundwater levels.

Drinking water criteria, including State and Federal Maximum Contaminant Levels, USEPA Regional Screening Levels (RSLs) for tap water, and MTCA Method B/A for groundwater, have been included in this document for completeness, but are only used when insufficient information exists to calculate a criteria to protect fish consumers.

3.1.2 Beneficial Uses of Lower Duwamish Waterway Surface Water

The following beneficial uses of the Duwamish River from its mouth to river mile 11.0 (inclusive of the Lower Duwamish Waterway) are set forth in WAC 173-201A-602 (Table 602, revised and implemented by Ecology, December 2006, and pending approval by USEPA under the Clean Water Act): salmonid rearing and migration, industrial/agricultural water supply, stock watering, wildlife habitat, secondary contact recreation, boating and sport fishing, commerce, and navigation. Importantly, the Lower Duwamish Waterway is not designated as a potential drinking-water source. Therefore, numerical surface water standards for human health are based on consumption of aquatic organisms (e.g., fish and shellfish), and do not include drinking water.

While WAC 173-201A designates the Duwamish River as fresh surface water, the Duwamish Waterway in the vicinity of Plant 2 is actually a tidally-controlled marine embayment with a thin freshwater lens of out-going river water on top of the denser (more saline) and more predominant marine waters. The sediments, while alluvial in nature, have salinities consistent with the marine waters from Elliott Bay. However, due to the presence of the freshwater lens of

water over this more dense saline water and for the purposes of calculating Plant 2 TMCLs, the Lower Duwamish Waterway surface water adjacent to Plant 2 will be considered both marine and freshwater.

3.1.3 Designation of Marine vs. Freshwater Criteria

For discharge into the water column, both freshwater and marine standards have been considered, although the majority of the water column is saline, except during extreme storm events. The salinity keeps the water from being potable and influences the biota present; however, some freshwater species use the waterway, especially in the upper sections of the water column.

Several freshwater standards for metals are hardness dependent. Those standards have been calculated based on hardness data collected from the middle of the freshwater layer in the reach of the waterway that abuts Plant 2 (AMEC 2011); because hardness varies seasonally, the hardness that resulted in the lower freshwater standard was used to be most conservative.

3.2 PROTECTION OF SURFACE WATER

Surface water is not a contaminated medium at Plant 2. However, in order to establish groundwater TMCLs that are protective of surface water, it is necessary to define concentrations in surface water that are protective of human health and aquatic species, and then establish groundwater TMCLs that are protective of these calculated surface water concentrations.

3.2.1 Protection of Aquatic Species

Surface water concentrations that are protective of aquatic species can be found in three promulgated regulations:

- Ambient Water Quality Criteria established under Sections 303-304 of the Clean Water Act (33 U.S.C. 1313-14)
- National Toxics Rule at 40 CFR 131.36
- Washington State Surface Water Quality Standards at RCW 90-48 and WAC 173-201A, both chronic and acute, and marine and freshwater standards

3.2.2 Protection of Human Health

Surface water concentrations that are protective of human consumption of fish and shellfish can be found in three promulgated regulations:

- Ambient Water Quality Criteria established under Sections 303-304 of the Clean Water Act (33 U.S.C. 1313-14)
- National Toxics Rule at 40 CFR 131.36
- Model Toxics Control Act, WAC 173-340-730, surface water cleanup levels

These regulations contain provisions for developing modifications for sensitive populations. As discussed above, USEPA has determined that sensitive populations exist along the Lower Duwamish Waterway that require modification as discussed below.

Consideration of Tribal and Asian and Pacific Islanders' Seafood Consumption Rates

USEPA Region 10 published the document "Framework for Selecting and Using Tribal Fish and Shellfish Consumption Rates for Risk-Based Decision Making at CERCLA and RCRA Cleanup Sites in Puget Sound and the Strait of Georgia" (USEPA, 2007). It is based on fish and shellfish consumption studies of tribes, primarily the Tulalip Tribes and the Suquamish Tribe. For Plant 2, USEPA instructed Boeing to use the Tulalip Tribes' consumption rate, minus salmon and minus fish and shellfish harvested outside Puget Sound. USEPA made the following assumptions in providing this direction to Boeing:

1. The Tulalip Tribes' consumption rate is likely more appropriate for the Lower Duwamish Waterway area than is the Suquamish Tribe's rate, because the Lower Duwamish Waterway is unlikely—even under "clean" conditions—to have sufficient intertidal shellfish habitat to sustain the high rate of shellfish consumption that the Suquamish Tribe enjoys.
2. All fish and shellfish harvested from outside Puget Sound are assumed to not be contaminated by releases from Plant 2.
3. Salmon are assumed to be exposed to the chemicals present in their tissues when caught as adults in the Lower Duwamish Waterway from remote locations in Puget Sound or the open ocean.

There are many uncertainties associated with these assumptions, which are addressed in the Framework. The Framework specifically addresses the uncertainties associated with the third assumption above with this language:

> PCBs and other bio-accumulative and persistent chemicals found in contaminated sediments can be moved from their site of release via erosion, dredging, tidal currents, flood events, and vapor transport. Offsite transport is also possible when aquatic organisms become contaminated near a cleanup site and then migrate to distant locations, where they contribute to food chain effects that eventually affect fish, including adult salmon. However, adult salmon body burdens of bio-accumulative and persistent contaminants typically come from many sources and cannot currently be apportioned with confidence to specific locations. An assumption that contaminants present in harvested salmon are not associated with the site, even when the same chemicals have been released from the site, is likely to underestimate the site's contribution to risks from consuming such fish. The degree of underestimation is not known.
>
> If the full body burden of bioaccumulative and persistent contaminants released at a site and found in local salmon is attributed to a single source (*i.e.*, the site under evaluation), site contributions to risk are likely to be overestimated, since some portion of the body burden likely has been acquired elsewhere.
>
> Some site-related contaminants may bioconcentrate in adult salmon due to epithelial tissue or gill contact, depending in part upon the salmon residence time in the vicinity of the site-related contamination. Making an assumption that adult salmon do not reside in the vicinity of the site long enough for bioconcentration to occur could result in an erroneous exclusion of contaminants in salmon from the site-related risk assessment. An assumption that bioconcentration does occur could lead to an overestimation of risks if uptake does not occur.

The total fish and shellfish consumption rate for the Tulalip Tribes, based on a 95th percentile consumer-only consumption rate for benthic fish, pelagic fish, shellfish and salmon is 243 g/day. After adjusting for Puget Sound-harvested fish and shellfish only and assuming that the site-

related PCB contaminant body burden for salmon is zero, the effective consumption rate to be used for Plant 2 is 97.1 g/day. Pursuant to recommendations in the Framework, the tribal exposure duration is assumed to be 70 years (instead of the standard 30 years in a risk assessment) to account for a lifetime of eating fish and shellfish from a specific harvesting area. The average body weight of the adult participants in the study, 81.8 kg, is also used. The consumption rate for children was estimated to be 38.8 g/day, which is 40 percent of the adult rate, an option provided in the Framework.

Also accounted for are the seafood consumption rates of Asian and Pacific Islanders (A&PI) who harvest from the Lower Duwamish Waterway and Elliott Bay and may be exposed to chemical releases from Plant 2 in this manner. USEPA funded and participated in a study (Sechena et al., 1999) to estimate the amount and types of seafood consumed by the A&PI population in King County. The 95th percentile total seafood A&PI consumption rate is 305.7 g/day. The seafood harvested and consumed by A&PIs only from King County waters, was estimated and assumed to be the amount of seafood potentially affected by Plant 2 releases and hence associated with Plant 2 A&PI seafood consumption risks. This amount, for adults, is 57.1 g/day, extrapolated to a child rate of 23 g/day based on 40 percent of the adult rate. The average adult study participant body rate of 63 kg was used. As USEPA had no information regarding exposure duration based on consistency in harvesting from certain areas over a lifetime, the standard exposure duration of 30 years was used for this population. These exposure assumptions, including the adjusted seafood consumption rate, have been adopted by Ecology for use as appropriate for use with MTCA surface water cleanup equations for sites in the Lower Duwamish Waterway/Elliott Bay area.

3.3 GROUNDWATER TMCLS FOR PROTECTION OF SURFACE WATER AND POINT OF COMPLIANCE

Attachment A contains details on development of the groundwater TMCLs. Tables include the development of the constituent list (the list includes both a complete list of constituents detected at Plant 2 and other chemicals of interest to USEPA); a comprehensive list of toxicological factors and their source; a comprehensive list of partitioning factors and their source; equations for the calculation of risk-based levels with parameters for different exposure scenarios, including scenarios for Asian/Pacific Islander and Tribal populations; and tabulated comparison of risk-based levels and available standards and criteria used for the development of the TMCLs.

Table 1 contains USEPA's TMCLs for groundwater for the protection of surface water, including human and aquatic species. Table 1 also contains potential TMCLs based on consumption of drinking water; however, they are only appropriate for use at Plant 2 when it was not possible to develop a TMCL for the protection of surface water. For example, no surface water standard exists for petroleum hydrocarbons; therefore, the MTCA Method A values for total petroleum hydrocarbon (TPH) fractions in groundwater, which are based on a drinking water exposure, have been used as surrogate TMCLs for the protection of surface water.

Attachment B (Table B.2a through Table B.2e) contains the identification of groundwater Constituents of Concern for Boeing Plant 2 and the associated TMCLs that will be carried into the CMS consistent with Section 1.1.

The proposed POC at Plant 2 for groundwater for the protection of surface water is the Shoreline Monitoring Well Network. This existing network, which has been sampled routinely since 2001, will be modified as part of the CMS alternatives evaluation process at Plant 2. The Shoreline Monitoring Program is an ongoing program, and it is possible that future monitoring may result in the inclusion of additional of COCs should their concentrations exceed their TMCLs.

Several metals TMCLs are listed as "background." These metals occur naturally, and have associated background levels available to use as TMCLs that were previously approved by USEPA for use along the Lower Duwamish Waterway (USEPA May 2006).

4.0 TMCLs for Soil

4.1 DIRECT CONTACT EXPOSURES

4.1.1 Current and Future Land Use

The current land use at Plant 2 includes research and testing, offices, motor pooling and vehicle maintenance, and warehousing of parts and equipment. Some small-scale manufacturing operations are also ongoing in conjunction with research and testing functions. Except for the shoreline in the North Area, Plant 2 is a fenced, paved, and access-controlled property. Additional details on adjacent facilities and zoning is presented in Section 2.0.

Future Uplands land use at Plant 2 is expected to remain industrial, which is consistent with local area land use controls and deed restrictions. Boeing expects to establish restrictive covenants to ensure that land use remains industrial at the Site. Some small areas adjacent to the Duwamish Waterway will convert to habitat and stormwater management uses.

4.1.2 Risk Management Areas

To facilitate the discussion of TMCLs for soil and sediment, the Site has been divided into three risk management areas, as follows:

- The Industrial Risk Management Area (IRMA) is that section of the Plant 2 facility that is fenced, paved or covered by buildings, and access-controlled.
- The Sediment Risk Management Area (SRMA) is that section of the Lower Duwamish Waterway that is contained within the footprint of the DSOA, including the banks to the top of the bank, and the complete SWB Interim Measures footprint. This area is defined in detail in the *Duwamish Sediment Other Area and Southwest Bank Interim Measure Alternative Evaluation* (AMEC and Floyd|Snider 2008).
- The Shoreline Risk Management Area (Shoreline RMA) is generally located between the IRMA and SRMA. It contains areas that are neither industrial nor aquatic lands, including Uplands habitat areas, stormwater swales and vaults, major utility lines, and the Shoreline Monitoring Well Network.

4.1.3 Residential and Industrial Direct Contact Exposures

Direct Contact, Including Ingestion, Dermal, and Inhalation of Dust

USEPA has developed residential TMCLs for Plant 2. USEPA has stated that it intends to use the residential TMCLs as an "unrestricted land use baseline;" however, USEPA has also stated that Boeing may propose industrial FMCLs in this Technical Memorandum with the understanding that FMCLs will be determined in the subsequent CMS process. The following tables and discussion include both residential TMCLs and industrial TMCLs for soil.

TMCLs for soil were developed from the following two sources:

- USEPA Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites were used for both residential and industrial exposures. Industrial exposures have been modified to represent a 1 in 100,000 excess individual lifetime cancer risk to workers to comport with other risk management decisions in Region 10's RCRA corrective action program. Toxicological factors are those used by the USEPA RSL Program.
- MTCA standard Method C industrial and Method B residential exposures using generic default assumptions to calculate cleanup levels as per WAC 173-340-745 and WAC 173-340-740.

Trenching Exposures

In 2008, USEPA Region 10 requested that Boeing develop a trenching scenario as part of the development of soil and groundwater TMCLs (Floyd|Snider 2008). For soil, the trenching scenario was less restrictive than either the industrial or residential scenarios listed above; therefore, it did not control the selection of soil TMCLs and is not included in this TMCL document. All trenching at Boeing requires and will require a Health and Safety Plan that addresses all possible contaminants present in soils (and groundwater if applicable).

4.2 SOIL FOR THE PROTECTION OF GROUNDWATER

A pathway exists from the areas of contaminated vadose zone soils in the Uplands of Plant 2 into the groundwater. Once contaminated, this groundwater discharges through the sediments and into the surface water of the Lower Duwamish Waterway. The receptors in the Lower Duwamish Waterway include not only the sediments and benthic organisms residing in the sediments, but also the aquatic species and ultimately humans via ingestion of fish and shellfish.

Groundwater TMCLs were calculated in Section 3. In this section, MTCA's three-phase partitioning model (WAC 173-340-747) has been used to estimate soil concentrations that would be protective of groundwater directly beneath the soil contamination. No attempt has been made to attenuate contamination with groundwater migration or to account for the location of the groundwater POC (the shoreline) relative to the location of the soil contamination. Attenuation may be used in the site-specific discussions within the CMS to support the use of FMCLs.

For organic chemicals, the water-organic carbon (Koc) partitioning coefficients were found in the literature and guidance and are presented in Appendix A. Soil to water partitioning coefficients (Kd) were then calculated from the Koc using the soil fraction of organic carbon (Foc). At Boeing Plant 2 foc for the vadose zone soils was derived during the RFI and Data Gap Investigations as 0.02. This value was the average of 22 measurements taken across the site in areas with little or no organic contamination and is consistent with the nature of the vadose soils at the site.

4.3 OTHER EXPOSURES

Two additional exposure pathways have been considered at Plant 2: vapor intrusion into buildings and direct contact pathways for terrestrial ecological receptors.

Although vapor intrusion models have been developed in an attempt to determine soil and groundwater concentrations that are protective of indoor air, they have not been successful in partitioning concentrations between the media in situations where both soil and groundwater are contaminated. For this reason, it was determined that ambient air would be treated as a potentially contaminated medium at Plant 2 and that ambient air TMCLs would be developed for all volatile organic compounds (VOCs) detected at Plant 2 in any medium (plus other VOCs of interest to USEPA). Ambient air TMCLs are developed in Section 5. It is understood that should corrective action be needed at Plant 2 to reduce ambient air concentrations, including those in buildings, that the actions may deal with source concentrations in soil and/or groundwater. However, compliance will be demonstrated by measurement of ambient air as discussed in Section 5.

Direct contact between soil and terrestrial ecological receptors is currently blocked by paving, buildings, and the industrial nature of the facility. As requested by USEPA, specific "scoring" of the Site for ecological evaluation was made under MTCA using Table 749-1: Simplified Terrestrial Ecological Evaluation Exposure Analysis (TEE) under WAC 173-34007492(2)(a)(ii) was applied. Based on this evaluation, no site-specific is needed at this time. Because this pathway is currently blocked by pavement and buildings, and by Boeing management practices, ongoing industrial land use will depend on maintaining that control through deed restrictions and/or restrictive covenants and ongoing physical controls. Should land use change in the future, a more detailed ecological evaluation would be conducted at that time.

4.4 SOIL TMCLS AT PLANT 2 AND POINT OF COMPLIANCE

Attachment A contains details on development of the soil TMCLs. Tables include the development of the constituent list (the list includes both a complete list of constituents detected at Plant 2 and other chemicals of interest to USEPA); a comprehensive list of toxicological factors and their source; a comprehensive list of partitioning factors and their source; equations for the calculation of risk-based levels with parameters for different exposure scenarios; and tabulated comparison of risk-based levels and available standards and criteria used for the development of the TMCLs.

Table 2 contains the USEPA TMCLs for soil for residential exposure, industrial exposure, and protection of groundwater (based on the groundwater TMCL in Section 3).

Attachment B (Tables B.1a through B.1e) contains the identification of soil Constituents of Concern for Boeing Plant 2 and the list of soil TMCLs that will be carried into the CMS consistent with Section 1.1. The POC for soil is throughout the vadose zone (upper 11-feet bgs) over the entire Uplands site. In the Shoreline RMA, surface soil along the bank will also need to comply with sediment TMCLs (as described in Section 6.0) to protect the DSOA corrective measure from contamination caused by erosion and sloughing. If the Shoreline RMA is expanded in the future to include presently paved areas, soils in the then expanded Shoreline RMA will need to be made protective of terrestrial receptors at that time.

5.0 TMCLs for Ambient Air

As with the other media, a residential baseline TMCL has been established for ambient air. This exposure considers both the MTCA Method B Ambient Air cleanup levels (WAC 173-340-350) and USEPA RSL development. An industrial TMCL has also been defined based on the USEPA RSL assumptions for exposure and the Region 10 risk management decision to use a 1 in 100,000 cancer risk for workers.

Attachment A contains details on development of the ambient air TMCLs. Tables include the development of the constituent list (the list includes both a complete list of constituents detected at Plant 2 and other chemicals of interest to USEPA); a comprehensive list of toxicological factors and their source; and equations for the calculation of risk-based levels with parameters for different exposure scenarios.

Table 3 contains the USEPA ambient air TMCLs for both residential and industrial/worker exposures. This table does not consider background air concentrations, although many volatile organics are present in urban air in Seattle. Correction for background air concentrations may be considered at the time of sampling and when assessing indoor air concentrations, and are not needed for the present discussion.

Attachment B (Table B.4) contains the identification of ambient air COCs for Boeing Plant 2 and the list of ambient air TMCLs that will be carried into the Corrective Measures Study consistent with Section 1.1.

6.0 TMCLs for Sediments

6.1 SEDIMENT CONDITIONS

TMCLs for sediments in the Lower Duwamish Waterway are intended to protect benthic and pelagic aquatic species using the Lower Duwamish Waterway and humans who may consume seafood from the Lower Duwamish Waterway. The Sediment Quality Standards (SQS) of the Washington Sediment Management Standards (SMS) are numerical standards developed for the protection of benthic invertebrate organisms. These are the only organisms for which SMS numerical standards have been promulgated to date. WAC 173-204-570)(4) requires site-specific cleanup standards to be as close as practicable to the SQS, also called the "cleanup objective," but no higher than the Cleanup Screening Level (CSL), also called the "Minimum Cleanup Level." WAC 173-204-570(5) requires that all cleanup standards must ensure protection of human health and the environment. Human health SMS numerical criteria are reserved for site-specific determination. Due to bioaccumulation in the food chain some aquatic species above benthic invertebrates in the food chain could require more stringent protection than the SQS. Currently, these do not need to be specified or developed further because the calculated risk to human seafood consumers is consistently greater (refer to Windward 2007).

Risk-based concentrations (RBCs) of PCBs, as a driver COC for the protection of human seafood consumers, based on calculations using the Tribal Risk Framework consumption rate of 97.1 grams/day (i.e., approximately 3.5 ounces/day) are more stringent than background levels (refer to Windward 2007). MTCA requires that where RBCs are more stringent than background, cleanup standards for final remedies must achieve natural background levels, while interim actions may be designed to achieve anthropogenic background levels.

As such, the TMCLs for the sediments will be based on these standards and are contained in Table 4.

6.2 SEDIMENT TMCLS AT PLANT 2 AND POINT OF COMPLIANCE

The sediment TMCLs for Plant 2 apply to surface sediments in the intertidal and subtidal areas. These areas will consist of clean backfill placed during the proposed Corrective Measure. In areas where erosion or direct contact is possible, the sediment TMCLs will also be applied to the bank sediment. Monitoring of the new, clean sediment surface will be performed to assess the rate of recontamination, if any, that may migrate from outside the remedy area. Monitoring of groundwater also will be performed to assess the rate and potential for contamination present in the groundwater to affect the clean sediment backfill material.

Attachment B (Table B.3) contains the identification of sediment COCs for Boeing Plant 2 and the list of sediment TMCLs that are used in the 2011 DSOA/SW Bank Corrective Measures Report (AMEC and Floyd|Snider 2011) and Statement of Basis (USEPA 2011).

7.0 Summary

SCOPE OF TARGET MEDIA CLEANUP LEVEL TECHNICAL MEMORANDUM

This Technical Memorandum presents TMCLs for groundwater, soil, ambient air, and sediment, at Plant 2. TCMLs were developed for all constituents detected at Plant 2 (plus additional constituents of interest to USEPA) for which promulgated standards or established toxicity data are available.

In Attachment B, concentrations at Plant 2 were compared to TMCLs to identify the Constituents of Concern for the CMS.

The CMS will focus on identification of appropriate corrective measures in each area for the constituents needing TMCLs in that area. Because additional investigation work maybe performed at Plant 2 as part of the CMS, the list of constituents needing TMCLs for an area may be updated in the future as additional data are collected during the CMS process.

Once approved TMCLs are available for use, the CMS can proceed with evaluation of potential corrective measures. The TMCLs will also be used to evaluate the effectiveness of specific corrective measures and previously conducted interim measures.

The CMS discussion will address the issue of data representativeness when compared to TMCLs. For example, some of the older groundwater data at Plant 2 are 20 years old and no longer represent current conditions; more recent data have been collected for the entire Site, and these more current data will be the focus of the CMS evaluation process. Each section will discuss how historical and current data are used in identifying contamination and evaluating the appropriate corrective measure based on the pathways present within the given geographic area

FMCLs will be proposed as part of the CMS report. FMCLs may be developed for a constituent throughout an area or may be developed location-by-location based on some other factor. For example, Boeing may choose to use an industrial soil FCML of 10 mg/kg for PCBs in the IRMA beneath pavements and buildings rather than the soil to groundwater TMCL of 0.002 mg/kg. If so, the CMS will discuss the site-specific conditions and engineering controls that result in protection of human health and the environment. Site-specific conditions may include, but are not limited to, consideration of attenuation, degradation, and other related processes. Engineering and institutional controls may include, but are not limited to, pavement to reduce infiltration and block access, monitoring, and restricted access to industrial areas, and restrictive covenants.

8.0 References

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Windward. 2007. *Lower Duwamish Waterway Remedial Investigation Report. Appendix B: Baseline Human Health Risk Assessment, Final.* Prepared for the Lower Duwamish Waterway Group, USEPA, and Washington State Department of Ecology. 12 November.

Table 1
Groundwater Summary

CAS Number	Chemical[1]	Boeing Plant 2 Groundwater Background[2]	Protection of Drinking Water[3] – Drinking Water Standard/Criteria[4]					Protection of Aquatic Species – Freshwater Standards			Protection of Aquatic Species – Marine Standards			Protection of Human Health for Consumption of Fish and Shellfish in Marine Waters				EPA Proposed TMCL for Surface Water and Groundwater Discharging to Surface Water in the Lower Duwamish Waterway	
			Federal Primary Drinking Water Standards[5]	EPA RSL Tap Water Criteria[6]	State Primary Drinking Water Standards[7]	MTCA A Groundwater Cleanup Level[8]	MTCA B Groundwater Cleanup Level[9]	Federal National Toxics Rule[10]	Federal Ambient Water Quality Criteria[11,12]	Washington Surface Water Quality Standards[12,13]	Federal National Toxics Rule[10]	Federal Ambient Water Quality Criteria[11]	Washington Surface Water Quality Standards[12, 13]	Federal National Toxics Rule[10]	Federal Ambient Water Quality Criteria[11]	Lowest of Tribal and Asian/Pacific Islander Exposure Scenarios[14]	MTCA Method B Surface Water[15]		
			EPA MCLs		Washington MCLs			Chronic	Chronic	Chronic	Chronic	Chronic	Chronic	Organism Only			Fish/Shellfish		
			(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)			(µg/L)	(µg/L)	Exposure Pathway Basis of TMCL
Metals																			
7429-90-5	Aluminum	--	--	3.7E+04	--	--	1.6E+04	--	8.7E+01	--	--	--	--	--	--	--	--	8.7E+01	Freshwater Chronic AWQC to protect aquatic species.
7440-36-0	Antimony (metallic)	--	6.0E+00	1.5E+01	6.0E+00	--	6.4E+00	--	--	--	--	--	--	4.3E+03	6.4E+02	1.5E+02	1.0E+03	1.5E+02	EPA R10 Tribal Consumption of Seafood.
7440-38-2	Arsenic (inorganic)	8.0E+00	1.0E+01	4.5E-02	1.0E+01	--	5.8E-02	1.9E+02	1.5E+02	1.9E+02	3.6E+01	3.6E+01	3.6E+01	1.4E+01	1.4E-01	5.4E-03	3.8E-02	8.0E+00	Lower Duwamish Waterway Groundwater Background.
7440-39-3	Barium	--	2.0E+03	7.3E+03	2.0E+03	--	3.2E+03	--	--	--	--	--	--	--	--	1.2E+02	8.2E+02	1.2E+02	EPA R10 Tribal Consumption of Seafood.
7440-41-7	Beryllium	--	4.0E+00	7.3E+01	4.0E+00	--	3.2E+01	--	--	--	--	--	--	--	--	1.2E+01	8.4E+01	1.2E+01	EPA R10 Tribal Consumption of Seafood.
7440-43-9	Cadmium	--	5.0E+00	1.8E+01	5.0E+00	--	8.0E+00	1.9E+00	2.5E-01	1.9E+00	9.3E+00	8.8E+00	9.3E+00	--	--	4.3E-01	2.9E+00	2.5E-01	Freshwater Chronic AWQC to protect aquatic species.
18540-29-9	Chromium (VI)	--	--	4.3E-02	--	--	4.8E+01	1.0E+01	1.1E+01	1.0E+01	5.0E+01	5.0E+01	5.0E+01	--	--	5.8E-01	4.1E+00	5.8E-01	EPA R10 Tribal Consumption of Seafood.
7440-48-4	Cobalt	--	--	1.1E+01	--	--	4.8E+00	--	--	--	--	--	--	--	--	--	--	4.8E+00	Surrogate Value: MTCA B groundwater to protect drinking water.
7440-50-8	Copper	8.0E+00	1.3E+03	1.5E+03	--	--	6.4E+02	2.3E+01	2.9E+00	2.3E+01	2.4E+00	3.1E+00	3.1E+00	--	--	4.3E+02	2.9E+03	8.0E+00	Lower Duwamish Waterway Groundwater Background.
7439-89-6	Iron	--	--	2.6E+04	3.0E-01	--	1.1E+04	--	1.0E+03	--	--	--	--	--	--	--	--	1.0E+03	Freshwater Chronic AWQC to protect aquatic species.
7439-92-1	Lead	--	1.5E+01	--	--	--	--	6.1E+00	2.5E+00	6.1E+00	8.1E+00	8.1E+00	8.1E+00	--	--	--	--	2.5E+00	Freshwater Chronic AWQC to protect aquatic species.
7439-96-5	Manganese (non-diet)	2.0E+03	--	8.8E+02	5.0E+01	--	3.8E+02	--	--	--	--	--	--	--	1.0E+02	--	--	2.0E+03	Lower Duwamish Waterway Groundwater Background.
7439-97-6	Mercury (elemental)	--	2.0E+00	5.7E-01	2.0E+00	--	4.8E+00	1.2E-02	7.7E-01	1.2E-02	2.5E-02	9.4E-01	2.5E-02	1.5E-01	3.0E-01	--	--	1.2E-02	Freshwater Chronic NTR/WaWQS to protect aquatic species.
7487-94-7	Mercury (inorganic salts)[16]	--	--	--	--	--	4.8E+00	--	--	--	--	--	--	--	--	--	--	4.8E+00	Surrogate Value: MTCA B groundwater to protect drinking water.
22967-92-6	Mercury (methyl mercury)	--	--	3.7E+00	--	--	1.6E+00	--	7.7E-01	--	--	9.4E-01	--	--	3.0E-01	--	--	3.0E-01	EPA AWQC to protect human consumption of seafood.
7439-98-7	Molybdenum	--	--	1.8E+02	--	--	8.0E+01	--	--	--	--	--	--	--	--	--	--	8.0E+01	Surrogate Value: MTCA B groundwater to protect drinking water.
7440-02-0	Nickel	--	--	7.3E+02	1.0E+02	--	3.2E+02	3.2E+02	5.2E+01	3.2E+02	8.2E+00	8.2E+00	8.2E+00	4.6E+03	4.6E+03	9.9E+01	6.6E+02	8.2E+00	Marine Chronic AWQC to protect aquatic species.
7782-49-2	Selenium	--	5.0E+01	1.8E+02	5.0E+01	--	8.0E+01	5.0E+00	5.0E+00	5.0E+00	7.1E+01	7.1E+01	7.1E+01	--	4.2E+03	1.5E+01	1.0E+02	5.0E+00	Freshwater Chronic NTR/Washington WQS to protect aquatic species.
7440-22-4	Silver	--	--	1.8E+02	1.0E+02	--	8.0E+01	--	--	--	--	--	--	--	--	2.2E+01	1.5E+02	2.2E+01	EPA R10 Tribal Consumption of Seafood.
7440-31-5	Tin	--	--	2.2E+04	--	--	9.6E+03	--	--	--	--	--	--	--	--	--	--	9.6E+03	Surrogate Value: MTCA B groundwater to protect drinking water.
7440-62-2	Vanadium	--	--	1.8E+02	--	--	1.4E+02	--	--	--	--	--	--	--	--	--	--	1.4E+02	Surrogate Value: MTCA B groundwater to protect drinking water.
7440-66-6	Zinc (metallic)	--	--	1.1E+04	5.0E+03	--	4.8E+03	2.1E+02	1.2E+02	2.1E+02	--	8.1E+01	8.1E+01	--	2.6E+04	5.6E+01	3.8E+02	5.6E+01	EPA R10 Tribal Consumption of Seafood.
Other Inorganics																			
57-12-5	Cyanide (free)	--	2.0E+02	7.3E+02	--	--	3.2E+02	5.2E+00	5.2E+00	5.2E+00	1.0E+00	1.0E+00	1.0E+00	2.2E+05	1.6E+04	2.4E+03	1.6E+04	1.0E+00	Marine Chronic AWQC to protect aquatic species.
74-90-8	Cyanide (hydrogen)	--	--	1.6E+00	2.0E+02	--	9.6E+00	--	--	--	--	--	--	--	--	--	--	1.6E+00	Surrogate Value: EPA RSL Tap Water Criteria.

WA 6819
10A
Rec'd 5/26/11
Mike Wemigwans

The Boeing Company
P.O. Box 3707
Seattle, WA 98124-2207

May 26, 2011
9L-22-N410-WDE-087

HAND DELIVERED

Shawn Blocker
U.S. Environmental Protection Agency
1200 Sixth Avenue, Suite 900, AWT-121
Seattle, Washington 98101

Subject: *Target Media Cleanup Levels Technical Memorandum* Submittal
Boeing Plant 2, Seattle/Tukwila, Washington
EPA ID No. WAD 00925 6819
RCRA Docket No. 1092-01-22-3008(h)

Dear Mr. Blocker:

Please find enclosed four (4) copies (each with CD of the document attached) of the Target Media Cleanup Levels (TMCL) Technical Memorandum. The document consists of a text portion and numerous spreadsheet tables that are provided both in locked form to protect the content of individual cells and as pdfs to facilitate use and printing. A copy is being provided directly to Mr. Fujita of the Washington Department of Ecology.

This submittal is based on EPA's Approval with Modifications letter on this subject dated September 28 2010. Boeing values and appreciates the close working relationship that occurred since Boeing's receipt of that letter between Drs Marcia Bailey and Teri Floyd and others in our respective organizations. That work has allowed resolution of the many complex factors underlying this crucial document.

Completion of this document allows Boeing to proceed with the Corrective Measures Study (CMS) process for Plant 2. Consistent with work already completed in that regard, we anticipate completion of the CMS Alternatives Evaluation Reports for North and South Plant 2 to be ready for your review as drafts in August 2011.

Although we believe this submittal reflects all modifications requested by EPA in its September 2010 letter and subsequent discussions, Boeing requests your reply to confirm that this TMCL Technical Memorandum is indeed final at this time. Please don't hesitate to contact me if you have any questions.

Sincerely,

William D Ernst, 2911

Digitally signed by William D Ernst, 2911
DN: o=Boeing, ou=Secure Messaging, cn=William D Ernst, cn=2911, email=william.d.ernst@boeing.com
Date: 2011.05.26 12:00:24 -07'00'

Will Ernst
Plant 2 Project Coordinator
Environmental Remediation
M/C 1W-12; 425.891.7724; 206.544.7297 (fax); william.d.ernst@boeing.com

Enclosure

cc: Hideo Fujita –Department of Ecology (w/ CD copy)
Brad Helland – Department of Ecology (by email w/o enclosure)

Table 1
Groundwater Summary

CAS Number	Chemical[1]	Boeing Plant 2 Groundwater Background[2]	Protection of Drinking Water[3] – Drinking Water Standard/Criteria[4]: Federal Primary Drinking Water Standards[5] EPA MCLs (µg/L)	EPA RSL Tap Water Criteria[6] (µg/L)	State Primary Drinking Water Standards[7] Washington MCLs (µg/L)	MTCA A Groundwater Cleanup Level[8] (µg/L)	MTCA B Groundwater Cleanup Level[9] (µg/L)	Protection of Aquatic Species – Freshwater Standards: Federal National Toxics Rule[10] Chronic (µg/L)	Federal Ambient Water Quality Criteria[11,12] Chronic (µg/L)	Washington Surface Water Quality Standards[12,13] Chronic (µg/L)	Marine Standards: Federal National Toxics Rule[10] Chronic (µg/L)	Federal Ambient Water Quality Criteria[11] Chronic (µg/L)	Washington Surface Water Quality Standards[12, 13] Chronic (µg/L)	Protection of Human Health for Consumption of Fish and Shellfish in Marine Waters – Organism Only (µg/L): Federal National Toxics Rule[10]	Federal Ambient Water Quality Criteria[11]	Lowest of Tribal and Asian/Pacific Islander Exposure Scenarios[14]	MTCA Method B Surface Water[15] Fish/Shellfish (µg/L)	EPA Proposed TMCL for Surface Water and Groundwater Discharging to Surface Water in the Lower Duwamish Waterway (µg/L)	Exposure Pathway Basis of TMCL
Volatile Organic Compounds (VOCs)																			
67-64-1	Acetone	--	--	2.2E+04	--	--	7.2E+03	--	--	--	--	--	--	--	--	1.1E+05	7.4E+05	1.1E+05	EPA R10 Tribal Consumption of Seafood.
71-43-2	Benzene	--	5.00E+00	4.1E-01	5.00E+00	--	8.0E-01	--	--	--	--	--	--	7.1E+01	5.1E+01	2.0E+00	1.4E+01	2.0E+00	EPA R10 Tribal Consumption of Seafood.
78-93-3	2-Butanone (MEK)	--	--	7.1E+03	--	--	4.8E+03	--	--	--	--	--	--	--	--	7.3E+04	4.9E+05	7.3E+04	EPA R10 Tribal Consumption of Seafood.
75-15-0	Carbon Disulfide	--	--	1.0E+03	--	--	8.0E+02	--	--	--	--	--	--	--	--	3.9E+03	2.6E+04	3.9E+03	EPA R10 Tribal Consumption of Seafood.
56-23-5	Carbon Tetrachloride	--	5.00E+00	4.4E-01	5.00E+00	--	6.3E-01	--	--	--	--	--	--	4.4E+00	1.6E+00	4.6E-01	3.2E+00	4.6E-01	EPA R10 Tribal Consumption of Seafood.
108-90-7	Chlorobenzene	--	1.00E+02	9.1E+01	1.00E+02	--	1.6E+02	--	--	--	--	--	--	2.1E+04	1.6E+03	2.7E+02	1.8E+03	2.7E+02	EPA R10 Tribal Consumption of Seafood.
75-00-3	Chloroethane	--	--	2.1E+04	--	--	--	--	--	--	--	--	--	--	--	--	--	2.1E+04	Surrogate Value: EPA RSL Tap Water Criteria.
67-66-3	Chloroform	--	8.00E+01	1.9E-01	8.00E+01	--	1.4E+00	--	--	--	--	--	--	4.7E+02	4.7E+02	9.4E+00	6.6E+01	9.4E+00	EPA R10 Tribal Consumption of Seafood.
74-87-3	Chloromethane	--	--	1.9E+02	--	--	--	--	--	--	--	--	--	--	--	--	--	1.9E+02	Surrogate Value: EPA RSL Tap Water Criteria.
106-43-4	4-Chlorotoluene	--	--	2.6E+03	--	--	--	--	--	--	--	--	--	--	--	--	--	2.6E+03	Surrogate Value: EPA RSL Tap Water Criteria.
95-50-1	1,2-Dichlorobenzene	--	6.00E+02	3.7E+02	6.00E+02	--	7.2E+02	--	--	--	--	--	--	1.7E+04	1.3E+03	4.4E+02	2.9E+03	4.4E+02	EPA R10 Tribal Consumption of Seafood.
106-46-7	1,4-Dichlorobenzene	--	7.50E+01	4.3E-01	7.50E+01	--	8.1E+00	--	--	--	--	--	--	2.6E+03	1.9E+02	1.7E+00	1.2E+01	1.7E+00	EPA R10 Tribal Consumption of Seafood.
75-34-3	1,1-Dichloroethane	--	--	2.4E+00	--	--	7.7E+00	--	--	--	--	--	--	--	--	3.3E+01	2.3E+02	3.3E+01	EPA R10 Tribal Consumption of Seafood.
107-06-2	1,2-Dichloroethane	--	5.00E+00	1.5E-01	5.00E+00	--	4.8E-01	--	--	--	--	--	--	9.9E+01	3.7E+01	3.6E+00	2.5E+01	3.6E+00	EPA R10 Tribal Consumption of Seafood.
75-35-4	1,1-Dichloroethene	--	7.00E+00	3.4E+02	7.00E+00	--	4.0E+02	--	--	--	--	--	--	3.2E+00	7.1E+03	2.3E+03	1.6E+04	3.2E+00	NTR to protect human consumption of seafood.
156-59-2	*cis* -1,2-Dichloroethene	--	7.00E+01	7.3E+01	7.00E+01	--	1.6E+01	--	--	--	--	--	--	--	--	1.3E+02	9.0E+02	1.3E+02	EPA R10 Tribal Consumption of Seafood.
156-60-5	*trans* -1,2-Dichloroethene	--	1.00E+02	1.1E+02	1.00E+02	--	1.6E+02	--	--	--	--	--	--	--	1.0E+04	9.4E+02	6.3E+03	9.4E+02	EPA R10 Tribal Consumption of Seafood.
78-87-5	1,2-Dichloropropane	--	5.00E+00	3.9E-01	5.00E+00	--	1.2E+00	--	--	--	--	--	--	--	1.5E+01	3.7E+00	2.6E+01	3.7E+00	EPA R10 Tribal Consumption of Seafood.
100-41-4	Ethylbenzene	--	7.00E+02	1.5E+00	7.00E+02	--	4.0E+00	--	--	--	--	--	--	2.9E+04	2.1E+03	1.7E+00	1.2E+01	1.7E+00	EPA R10 Tribal Consumption of Seafood.
98-82-8	Isopropylbenzene(cumene)	--	--	6.8E+02	--	--	8.0E+02	--	--	--	--	--	--	--	--	2.7E+02	1.8E+03	2.7E+02	EPA R10 Tribal Consumption of Seafood.
591-78-6	2-Hexanone	--	--	4.7E+01	--	--	4.0E+01	--	--	--	--	--	--	--	--	3.2E+03	2.2E+04	3.2E+03	EPA R10 Tribal Consumption of Seafood.
75-09-2	Methylene Chloride	--	5.00E+00	4.8E+00	5.00E+00	--	5.8E+00	--	--	--	--	--	--	1.6E+03	5.9E+02	6.1E+01	4.3E+02	6.1E+01	EPA R10 Tribal Consumption of Seafood.
108-10-1	Methyl Isobutyl Ketone	--	--	2.0E+03	--	--	6.4E+02	--	--	--	--	--	--	--	--	1.9E+04	1.2E+05	1.9E+04	EPA R10 Tribal Consumption of Seafood.
91-20-3	Naphthalene	--	--	1.4E-01	--	--	1.6E+02	--	--	--	--	--	--	--	--	2.6E+01	1.7E+02	2.6E+01	EPA R10 Tribal Consumption of Seafood.
100-42-5	Styrene	--	1.00E+02	1.6E+03	1.00E+02	--	1.6E+03	--	--	--	--	--	--	--	--	7.7E+04	5.2E+05	7.7E+04	EPA R10 Tribal Consumption of Seafood.
79-34-5	1,1,2,2-Tetrachloroethane	--	--	6.7E-02	--	--	2.2E-01	--	--	--	--	--	--	1.1E+01	4.0E+00	3.3E-01	2.3E+00	3.3E-01	EPA R10 Tribal Consumption of Seafood.
127-18-4	Tetrachloroethene (PCE)	--	5.00E+00	1.1E-01	5.00E+00	--	8.1E-02	--	--	--	--	--	--	8.9E+00	3.3E+00	2.1E-02	1.4E-01	2.1E-02	EPA R10 Tribal Consumption of Seafood.
108-88-3	Toluene	--	1.00E+03	2.3E+03	1.00E+03	--	6.4E+02	--	--	--	--	--	--	2.0E+05	1.5E+04	1.3E+03	8.7E+03	1.3E+03	EPA R10 Tribal Consumption of Seafood.
71-55-6	1,1,1-Trichloroethane	--	2.00E+02	9.1E+03	2.00E+02	--	1.6E+04	--	--	--	--	--	--	--	--	4.6E+04	3.1E+05	4.6E+04	EPA R10 Tribal Consumption of Seafood.
79-00-5	1,1,2-Trichloroethane	--	5.00E+00	1.5E+02	5.00E+00	--	7.7E-01	--	--	--	--	--	--	4.2E+01	1.6E+01	2.3E+00	1.6E+01	2.3E+00	EPA R10 Tribal Consumption of Seafood.
79-01-6	Trichloroethene (TCE)	--	5.00E+00	2.0E+00	5.00E+00	--	3.4E-01	--	--	--	--	--	--	8.1E+01	3.0E+01	5.1E-01	3.6E+00	5.1E-01	EPA R10 Tribal Consumption of Seafood.
120-82-1	1,2,4-trichlorobenzene	--	7.00E+01	2.3E+00	7.00E+01	--	1.5E+00	--	--	--	--	--	--	--	7.0E+01	1.3E-01	9.3E-01	1.3E-01	EPA R10 Tribal Consumption of Seafood.
75-69-4	Trichlorofluoromethane	--	--	1.3E+03	--	--	2.4E+03	--	--	--	--	--	--	--	--	6.9E+03	4.6E+04	6.9E+03	EPA R10 Tribal Consumption of Seafood.
76-13-1	1,1,2-Trichlorotrifluoroethane	--	--	5.9E+04	--	--	2.4E+05	--	--	--	--	--	--	--	--	--	--	5.9E+04	Surrogate Value: EPA RSL Tap Water Criteria.
75-01-4	Vinyl chloride	--	2.0E+00	1.6E-02	2.00E+00	--	2.9E-02	--	--	--	--	--	--	5.3E+02	2.4E+00	--	--	2.4E+00	EPA AWQC to protect human consumption of seafood.
108-38-3	m-Xylene	--	--	1.2E+03	--	--	1.6E+03	--	--	--	--	--	--	--	--	1.3E+03	8.9E+03	1.3E+03	EPA R10 Tribal Consumption of Seafood.
95-47-6	o-Xylene	--	--	1.2E+03	--	--	1.6E+03	--	--	--	--	--	--	--	--	1.6E+03	1.1E+04	1.6E+03	EPA R10 Tribal Consumption of Seafood.
106-42-3	p-Xylene	--	--	1.2E+03	--	--	1.6E+03	--	--	--	--	--	--	--	--	1.6E+03	1.1E+04	1.6E+03	EPA R10 Tribal Consumption of Seafood.
10330-20-7	Xylenes (total)	--	1.0E+04	2.0E+02	1.00E+04	--	1.6E+03	--	--	--	--	--	--	--	--	1.5E+03	1.0E+04	1.5E+03	EPA R10 Tribal Consumption of Seafood.

Table 1
Groundwater Summary

CAS Number	Chemical[1]	Boeing Plant 2 Groundwater Background[2]	Protection of Drinking Water[3] – Drinking Water Standard/Criteria[4]: Federal Primary Drinking Water Standards[5] EPA MCLs (µg/L)	EPA RSL Tap Water Criteria[6] (µg/L)	State Primary Drinking Water Standards[7] Washington MCLs (µg/L)	MTCA A Groundwater Cleanup Level[8] (µg/L)	MTCA B Groundwater Cleanup Level[9] (µg/L)	Protection of Aquatic Species – Freshwater Standards: Federal National Toxics Rule[10] Chronic (µg/L)	Federal Ambient Water Quality Criteria[11,12] Chronic (µg/L)	Washington Surface Water Quality Standards[12,13] Chronic (µg/L)	Marine Standards: Federal National Toxics Rule[10] Chronic (µg/L)	Federal Ambient Water Quality Criteria[11] Chronic (µg/L)	Washington Surface Water Quality Standards[12, 13] Chronic (µg/L)	Protection of Human Health for Consumption of Fish and Shellfish in Marine Waters – Organism Only (µg/L): Federal National Toxics Rule[10]	Federal Ambient Water Quality Criteria[11]	Lowest of Tribal and Asian/Pacific Islander Exposure Scenarios[14]	MTCA Method B Surface Water[15] Fish/Shellfish (µg/L)	EPA Proposed TMCL for Surface Water and Groundwater Discharging to Surface Water in the Lower Duwamish Waterway (µg/L)	Exposure Pathway Basis of TMCL
Semivolatile Organic Compounds (SVOCs)																			
83-32-9	Acenaphthene	--	--	2.2E+03	--	--	9.6E+02	--	--	--	--	--	--	--	9.9E+02	1.2E+02	7.7E+02	1.2E+02	EPA R10 Tribal Consumption of Seafood.
208-96-8	Acenaphthylene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
120-12-7	Anthracene	--	--	1.1E+04	--	--	4.8E+03	--	--	--	--	--	--	1.1E+05	4.0E+04	2.0E+02	1.3E+03	2.0E+02	EPA R10 Tribal Consumption of Seafood.
191-24-2	Benzo(g,h,i)perylene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
117-81-7	Bis(2-ethylhexyl)phthalate	--	6.0E+00	4.8E+00	--	--	6.3E+00	--	--	--	--	--	--	5.9E+00	2.2E+00	1.2E+00	8.7E+00	1.2E+00	EPA R10 Tribal Consumption of Seafood.
85-68-7	Butylbenzyl phthalate	--	--	3.5E+01	--	--	4.6E+01	--	--	--	--	--	--	--	1.9E+03	4.1E-01	2.9E+00	4.1E-01	EPA R10 Tribal Consumption of Seafood.
59-50-7	4-chloro-3-methylphenol	--	--	3.7E+03	--	--	--	--	--	--	--	--	--	--	--	--	--	3.7E+03	Surrogate Value: EPA RSL Tap Water Criteria.
132-64-9	*Dibenzofuran*[17]	--	--	*3.7E+01*	--	--	*3.2E+01*	--	--	--	--	--	--	--	--	--	--	*3.2E+01*	*Surrogate Value: MTCA B groundwater to protect drinking water.*
84-74-2	Di-n-butylphthalate	--	--	3.7E+03	--	--	1.6E+03	--	--	--	--	--	--	1.2E+04	4.5E+03	4.7E+01	3.1E+02	4.7E+01	EPA R10 Tribal Consumption of Seafood.
84-66-2	Diethylphthalate	--	--	2.9E+04	--	--	1.3E+04	--	--	--	--	--	--	1.2E+05	4.4E+04	1.8E+04	1.2E+05	1.8E+04	EPA R10 Tribal Consumption of Seafood.
105-67-9	2,4-Dimethylphenol	--	--	7.3E+02	--	--	3.2E+02	--	--	--	--	--	--	--	8.5E+02	6.6E+02	4.4E+03	6.6E+02	EPA R10 Tribal Consumption of Seafood.
131-11-3	Dimethylphthalate	--	--	--	--	--	--	--	--	--	--	--	--	2.9E+06	1.1E+06	--	--	1.1E+06	Marine Chronic AWQC to protect human consumption of seafood.
117-84-0	Di-n-octyl phthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
206-44-0	Fluoranthene	--	--	1.5E+03	--	--	6.4E+02	--	--	--	--	--	--	3.7E+02	1.4E+02	1.1E+01	7.4E+01	1.1E+01	EPA R10 Tribal Consumption of Seafood.
86-73-7	Fluorene	--	--	1.5E+03	--	--	6.4E+02	--	--	--	--	--	--	1.4E+04	5.3E+03	4.5E+01	3.0E+02	4.5E+01	EPA R10 Tribal Consumption of Seafood.
7440-62-2	1-Methylnaphthalene	--	--	2.3E+00	--	--	--	--	--	--	--	--	--	--	--	--	--	2.3E+00	Surrogate Value: EPA RSL Tap Water Criteria.
91-57-6	2-Methylnaphthalene	--	--	1.5E+02	--	--	6.4E+01	--	--	--	--	--	--	--	--	--	--	6.4E+01	Surrogate Value: MTCA B groundwater to protect drinking water.
95-48-7	2-Methylphenol (o-cresol)	--	--	1.8E+03	--	--	8.0E+02	--	--	--	--	--	--	--	--	3.1E+03	2.0E+04	3.1E+03	EPA R10 Tribal Consumption of Seafood.
106-44-5	4-Methylphenol (p-cresol)	--	--	1.8E+02	--	--	8.0E+01	--	--	--	--	--	--	--	--	3.3E+02	2.2E+03	3.3E+02	EPA R10 Tribal Consumption of Seafood.
91-20-3	Naphthalene	--	--	1.4E-01	--	--	3.2E+02	--	--	--	--	--	--	--	--	1.1E+02	7.5E+02	2.6E+01	EPA R10 Tribal Consumption of Seafood.
85-01-8	Phenanthrene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
108-95-2	Phenol	--	--	1.1E+04	--	--	4.8E+03	--	--	--	--	--	--	4.6E+06	8.6E+05	4.1E+04	2.7E+05	4.1E+04	EPA R10 Tribal Consumption of Seafood.
129-00-0	Pyrene	--	--	1.1E+03	--	--	4.8E+02	--	--	--	--	--	--	1.1E+04	4.0E+03	9.8E+00	6.6E+01	9.8E+00	EPA R10 Tribal Consumption of Seafood.

Table 1
Groundwater Summary

CAS Number	Chemical[1]	Boeing Plant 2 Groundwater Background[2]	Protection of Drinking Water[3] – Drinking Water Standard/Criteria[4]: Federal Primary Drinking Water Standards[5] EPA MCLs (µg/L)	EPA RSL Tap Water Criteria[6] (µg/L)	State Primary Drinking Water Standards[7] Washington MCLs (µg/L)	MTCA A Groundwater Cleanup Level[8] (µg/L)	MTCA B Groundwater Cleanup Level[9] (µg/L)	Protection of Aquatic Species – Freshwater Standards: Federal National Toxics Rule[10] Chronic (µg/L)	Federal Ambient Water Quality Criteria[11,12] Chronic (µg/L)	Washington Surface Water Quality Standards[12,13] Chronic (µg/L)	Marine Standards: Federal National Toxics Rule[10] Chronic (µg/L)	Federal Ambient Water Quality Criteria[11] Chronic (µg/L)	Washington Surface Water Quality Standards[12, 13] Chronic (µg/L)	Protection of Human Health for Consumption of Fish and Shellfish in Marine Waters – Organism Only (µg/L): Federal National Toxics Rule[10]	Federal Ambient Water Quality Criteria[11]	Lowest of Tribal and Asian/Pacific Islander Exposure Scenarios[14]	MTCA Method B Surface Water[15] Fish/Shellfish (µg/L)	EPA Proposed TMCL for Surface Water and Groundwater Discharging to Surface Water in the Lower Duwamish Waterway (µg/L)	Exposure Pathway Basis of TMCL
Mutagenic Carcinogenic Polycyclic Aromatic Hydrocarbons (cPAHs)																			
56-55-3	Benzo(a) anthracene	--	--	2.9E-02		--		--	--	--	--	--	--	3.1E-02	1.8E-02	1.8E-03	2.9E-02	1.8E-03	EPA R10 Tribal Consumption of Seafood.
50-32-8	Benzo(a) pyrene	--	2.0E-01	2.9E-03		--		--	--	--	--	--	--	3.1E-02	1.8E-02	1.8E-04	2.9E-03	1.8E-04	EPA R10 Tribal Consumption of Seafood.
205-99-2	Benzo (b) fluoranthene	--	--	2.9E-02		--		--	--	--	--	--	--	3.1E-02	1.8E-02	1.8E-03	2.9E-02	1.8E-03	EPA R10 Tribal Consumption of Seafood.
207-08-9	Benzo(k) fluoranthene	--	--	2.9E-01		--		--	--	--	--	--	--	3.1E-02	1.8E-02	1.8E-03	2.9E-02	1.8E-03	EPA R10 Tribal Consumption of Seafood.
218-01-9	Chrysene	--	--	2.9E+00		--		--	--	--	--	--	--	3.1E-02	1.8E-02	1.8E-02	2.9E-01	1.8E-02	EPA R10 Tribal Consumption of Seafood.
53-70-3	Dibenz(a,h)anthracene	--	--	2.9E-03		--		--	--	--	--	--	--	3.1E-02	1.8E-02	1.8E-03	2.9E-02	1.8E-03	EPA R10 Tribal Consumption of Seafood.
193-39-5	Indeno(1,2,3-cd)pyrene	--	--	2.9E-02		--		--	--	--	--	--	--	3.1E-02	1.8E-02	1.8E-03	2.9E-02	1.8E-03	EPA R10 Tribal Consumption of Seafood.
--	Benzo(a)pyrene TEQ[18]	--	2.0E-01	2.9E-03	2.0E-01	--	1.2E-02	--	--	--	--	--	--	3.1E-02	1.8E-02	1.8E-04	2.9E-03	1.8E-04	EPA R10 Tribal Consumption of Seafood.
Polychlorinated Biphenyls (PCBs)																			
53469-21-9	Aroclor 1016/1242	--	--	3.4E-02	--	--	4.4E-02	--	--	--	--	--	--	--	--	2.3E-05	1.6E-04	2.3E-05	EPA R10 Tribal Consumption of Seafood.
12672-29-6	Aroclor 1248	--	--	3.4E-02	--	--	4.4E-02	--	--	--	--	--	--	--	--	2.3E-05	1.6E-04	2.3E-05	EPA R10 Tribal Consumption of Seafood.
11097-69-1	Aroclor 1254	--	--	3.4E-02	--	--	4.4E-02	--	--	--	3.0E-02	--	--	--	--	5.5E-06	3.9E-05	5.5E-06	EPA R10 Tribal Consumption of Seafood.
37324-23-2	Aroclor 1260	--	--	3.4E-02	--	--	4.4E-02	--	--	--	3.0E-02	--	--	--	--	2.3E-05	1.6E-04	2.3E-05	EPA R10 Tribal Consumption of Seafood.
1336-36-3	Total PCBs	--	--	3.4E-02	--	--	4.4E-02	--	1.4E-02	1.4E-02	--	3.0E-02	3.0E-02	1.7E-04	6.4E-05	2.3E-05	1.6E-04	2.3E-05	EPA R10 Tribal Consumption of Seafood.
Total Petroleum Hydrocarbons (TPH)																			
--	TPH - Gasoline (Benzene Present)	--	--	--	--	8.0E+02	--	--	--	--	--	--	--	--	--	--	--	1.0E+03	Surrogate Value: MTCA A Groundwater Cleanup Level.
--	TPH - Aged Gasoline and Mineral Spirits	--	--	--	--	1.0E+03	--	--	--	--	--	--	--	--	--	--	--	8.0E+02	Surrogate Value: MTCA A Groundwater Cleanup Level.
--	TPH - Diesel #2	--	--	--	--	5.0E+02	--	--	--	--	--	--	--	--	--	--	--	5.0E+02	Surrogate Value: MTCA A Groundwater Cleanup Level.
--	TPH - Heavy Oils	--	--	--	--	5.0E+02	--	--	--	--	--	--	--	--	--	--	--	5.0E+02	Surrogate Value: MTCA A Groundwater Cleanup Level.

Notes:

Washington state regulates carcinogenic polycyclic aromatic hydrocarbons as benzo(a)pyrene Toxic Equivalent Quantity (TEQ); therefore, no individual groundwater cleanup levels have been developed, and the cells are "grayed out." Refer to https://fortress.wa.gov/ecy/clarc/FocusSheets/tef.pdf.

1 Not all chemicals are constituents needing TMCLs at Boeing Plant 2.
2 Background concentration in groundwater as per EPA approval of the Technical Memorandum on background, May 2008.
3 Drinking water standards/criteria are not applicable to Boeing Plant 2 unless no other applicable standard exists for a constituent not needing a TMCL in groundwater.
4 The standards are potentially applicable to groundwater that may be used for drinking water supplies. Ecology determines the maximum beneficial use of groundwater, which may or may not include drinking.
5 National Primary Drinking Water Regulations, Maximum Contaminant Levels (MCLs); http://water.epa.gov/drink/contaminants/index.cfm.
6 EPA RSL, Residential Tapwaters; http://www.epa.gov/region9/superfund/prg/.
7 Washington Primary Drinking Water Standards WAC 246-290-130, Maximum Contaminant Levels (MCLs).
8 Surrogate values used for TPH based on drinking water consumption because the only TPH surface water criteria is based on visual sheen. These values presented in Table 720-1 in conjunction with regulations present in MTCA 173-340-720 (3)(b)(i).
9 Standard MTCA Method B uses WAC 173-340-740; equations 730-1 and 730-2 (Ecology 2007). Parameters and toxicity factors can be found in associated tables in this attachment.
10 National Toxics Rule (NTR), 40 CFR 131.36.
11 EPA Ambient Water Quality Criteria (AWQCs), Clean Water Action Section 304.
12 Washington Surface Water Quality Standards; WAC 173-201A, Surface Water Quality Criteria.
13 EPA and Ecology fish consumption scenarios are based on MTCA Method B Surface Water Equations (equations 730-1 and 730-2); however, they use different exposure assumptions. Details are given in associated tables in this attachment.
14 This column uses the approach described in Note 8, but selects the lower concentrations that are protective of special populations including Tribal and Asian/Pacific Islander; the lowest concentration is always associated with Tribal exposure.
15 This column is included for comparison only and is based on the default exposure scenario in MTCA 173-340-730.
16 Mercuric chloride used as a surrogate.
17 The provisional toxicity factors for this chemical are semi-quantative and should be used for screening purposes only.
18 Because cPAHs are considered mutagenic by EPA, EPA Tribal and Pacific Islander exposure scenarios include an early life correction.

Abbreviations:

BCF Bioconcentration factor
CAS Chemical abstract number
CLARC Cleanup Levels and Risk Calculation
Ecology Washington State Department of Ecology
EPA U.S. Environmental Protection Agency
MTCA Model Toxics Control Act
R10 Region 10
RSL Regional screening level

Table 2
Soil Summary

CAS Number	Chemical[1]	Puget Sound Background[2] (mg/kg)	Residential: EPA — EPA RSL Residential Includes Ingestion, Dermal, and Inhalation[3] (mg/kg)	Residential: Ecology — MTCA Method A Unrestricted Land Use Includes CLARC Toxicity Factors[4] (mg/kg)	Residential: Ecology — MTCA Method B Unrestricted Land Use Includes CLARC Toxicity Factors[5] (mg/kg)	Industrial: EPA Modified — EPA RSL Industrial Includes Ingestion, Dermal, and Inhalation[6] (mg/kg)	Industrial: Ecology — MTCA Method C Industrial Land Use Includes CLARC Toxicity Factors[5] (mg/kg)	Sediment Protection Ecology — SMS Sediment Quality Standards[7] (mg/kg dry weight)	Groundwater Protection Ecology — Soil Level to Protect Groundwater Using Three-phase Model[8] (mg/kg)	EPA Proposed Soil TMCL to Protect all Pathways (mg/kg)	Exposure Pathway Basis of TMCL
Metals											
7429-90-5	Aluminum	3.3E+04	7.7E+04	--	8.0E+04	5.0E+05	3.5E+06	--	--	7.7E+04	EPA RSL Residential Including Ingestion, Dermal, and Inhalation.
7440-36-0	Antimony (metallic)	--	3.1E+01	--	3.2E+01	2.0E+02	1.4E+03	--	7.8E+02	3.1E+01	EPA RSL Residential Including Ingestion, Dermal, and Inhalation.
7440-38-2	Arsenic (inorganic)	2.0E+01	3.9E-01	--	6.7E-01	8.7E+00	8.8E+01	5.7E+01	--	2.0E+01	Washington State Background.
7440-39-3	Barium	--	1.5E+04	--	1.6E+04	9.9E+04	7.0E+05	--	1.0E+02	1.0E+02	Soil to protect groundwater for Tribal seafood.
7440-41-7	Beryllium	6.1E-01	1.6E+02	--	1.6E+02	1.0E+03	7.0E+03	--	3.1E+02	1.6E+02	EPA RSL Residential Including Ingestion, Dermal, and Inhalation.
7440-43-9	Cadmium	7.7E-01	7.0E+01	--	8.0E+01	4.5E+02	3.5E+03	5.1E+00	4.0E+00	4.0E+00	Soil to protect groundwater for aquatic species.
18540-29-9	Chromium (VI)	--	1.2E+00	--	2.4E+02	2.8E+01	1.0E+04	--	--	1.2E+00	EPA RSL Residential Including Ingestion, Dermal, and Inhalation.
7440-48-4	Cobalt	--	2.3E+01	--	2.4E+01	1.5E+02	1.0E+03	--	1.2E+01	1.2E+01	Surrogate Value: soil to protect groundwater for drinking water use.
7440-50-8	Copper	3.6E+01	3.1E+03	--	3.2E+03	2.0E+04	1.4E+05	3.9E+02	8.0E+01	8.0E+01	Soil to protect groundwater background.
7439-89-6	Iron	5.9E+04	5.5E+04	--	5.6E+04	3.6E+05	2.4E+06	--	--	5.9E+04	Puget Sound Background.
7439-92-1	Lead[9]	2.4E+01	--	--	2.5E+02	--	1.0E+03	4.5E+02	7.9E+02	2.5E+02	MTCA A Residential.
7439-96-5	Manganese (non-diet)	1.2E+03	1.8E+03	--	1.9E+03	1.2E+04	8.4E+04	--	--	1.8E+03	EPA RSL Residential Including Ingestion, Dermal, and Inhalation.
7439-97-6	Mercury (elemental)	7.0E-02	5.6E+00	--	2.4E+01	2.8E+01	1.0E+03	4.1E-01	1.5E+00	1.5E+00	Soil to protect groundwater for aquatic species.
7487-94-7	Mercury (inorganic salts)[10]	--	2.3E+01	--	2.4E+01	1.5E+02	1.0E+03	--	--	2.3E+01	EPA RSL Residential Including Ingestion, Dermal, and Inhalation.
22967-92-6	Mercury (methyl mercury)	--	7.8E+00	--	8.0E+00	5.1E+01	3.5E+02	--	3.8E+00	3.8E+00	Soil to protect groundwater for Tribal seafood.
7439-98-7	Molybdenum	--	3.9E+02	--	4.0E+02	2.5E+03	1.7E+04	--	2.0E+01	2.0E+01	Surrogate Value: soil to protect groundwater for drinking water use.
7440-02-0	Nickel	4.8E+01	1.5E+03	--	1.6E+03	1.0E+04	7.0E+04	--	2.1E+02	2.1E+02	Soil to protect groundwater for aquatic species.
7782-49-2	Selenium	--	3.9E+02	--	4.0E+02	2.5E+03	1.7E+04	--	1.0E+00	1.0E+00	Soil to protect groundwater for aquatic species.
7440-22-4	Silver	--	3.9E+02	--	4.0E+02	2.5E+03	1.7E+04	6.1E+00	1.7E+02	1.7E+02	Soil to protect groundwater for Tribal seafood.
7440-31-5	Tin	--	4.7E+04	--	4.8E+04	3.1E+05	2.1E+06	--	1.5E+05	4.7E+04	EPA RSL Residential Including Ingestion, Dermal, and Inhalation.
1314-62-1	Vanadium (as vanadium pentoxide)	--	7.0E+02	--	7.2E+02	4.6E+03	3.1E+04	--	2.9E+03	7.0E+02	EPA RSL Residential Including Ingestion, Dermal, and Inhalation.
7440-66-6	Zinc (metallic)	8.5E+01	2.3E+04	--	2.4E+04	1.5E+05	1.0E+06	4.1E+02	1.4E+03	1.4E+03	Soil to protect groundwater for Tribal seafood.
Other Inorganics											
57-12-5	Cyanide (free)	--	1.6E+03	--	1.6E+03	1.0E+04	7.0E+04	--	2.0E+01	2.0E+01	Soil to protect groundwater for aquatic species.
74-90-8	Cyanide (hydrogen)	--	4.6E+00	--	4.8E+01	2.0E+01	2.1E+03	--	--	4.6E+00	EPA RSL Residential Including Ingestion, Dermal, and Inhalation.
Volatile Organic Constituents											
67-64-1	Acetone		6.1E+04	--	7.2E+04	3.7E+05	3.1E+06	--	5.1E+02	5.1E+02	Soil to protect groundwater for Tribal seafood.
71-43-2	Benzene		1.1E+00	--	1.8E+01	4.9E+01	2.4E+03	--	9.3E-02	9.3E-02	Soil to protect groundwater for Tribal seafood.
78-93-3	2-Butanone (MEK)		2.8E+04	--	4.8E+04	1.5E+05	2.1E+06	--	4.3E+02	4.3E+02	Soil to protect groundwater for Tribal seafood.
75-15-0	Carbon Disulfide		8.2E+02	--	8.0E+03	3.6E+03	3.5E+05	--	7.5E+01	7.5E+01	Soil to protect groundwater for Tribal seafood.
56-23-5	Carbon Tetrachloride		6.1E-01	--	1.4E+01	2.8E+01	1.9E+03	--	2.1E-02	2.1E-02	Soil to protect groundwater for Tribal seafood.
108-90-7	Chlorobenzene		2.9E+02	--	1.6E+03	1.3E+03	7.0E+04	--	2.6E+01	2.6E+01	Soil to protect groundwater for Tribal seafood.
75-00-3	Chloroethane		1.4E+04	--	--	6.1E+04	--	--	2.8E+02	2.8E+02	Surrogate Value: soil to protect groundwater for drinking water use.
67-66-3	Chloroform		3.0E-01	--	8.0E+02	1.5E+01	3.5E+04	--	2.0E-01	2.0E-01	Soil to protect groundwater for Tribal seafood.
74-87-3	Chloromethane		1.2E+02	--	--	5.0E+02	--	--	1.6E+00	1.6E+00	Surrogate Value: soil to protect groundwater for drinking water use.
106-43-4	4-Chlorotoluene		--	--	--	--	--	--	4.0E+02	4.0E+02	Surrogate Value: soil to protect groundwater for drinking water use.
95-50-1	1,2-Dichlorobenzene		1.9E+03	--	7.2E+03	8.9E+03	3.1E+05	--	6.8E+01	6.8E+01	Soil to protect groundwater for Tribal seafood.
106-46-7	1,4-Dichlorobenzene		2.4E+00	--	--	1.2E+02	--	--	3.5E-01	3.5E-01	Soil to protect groundwater for Tribal seafood.
75-34-3	1,1-Dichloroethane		3.3E+00	--	1.6E+04	1.6E+02	7.0E+05	--	7.1E-01	7.1E-01	Soil to protect groundwater for Tribal seafood.
107-06-2	1,2-Dichloroethane		4.3E-01	--	1.1E+01	2.0E+01	1.4E+03	--	7.0E-02	7.0E-02	Soil to protect groundwater for Tribal seafood.
75-35-4	1,1-Dichloroethene		2.4E+02	--	4.0E+03	1.0E+03	1.7E+05	--	8.1E-02	8.1E-02	Soil to protect groundwater for Tribal seafood.
156-59-2	*cis* -1,2-Dichloroethene		1.6E+02	--	1.6E+02	1.0E+03	7.0E+03	--	2.6E+00	2.6E+00	Soil to protect groundwater for Tribal seafood.
156-60-5	*trans* -1,2-Dichloroethene		1.6E+03	--	1.6E+03	1.0E+04	7.0E+04	--	1.9E+01	1.9E+01	Soil to protect groundwater for Tribal seafood.
78-87-5	1,2-Dichloropropane		8.9E-01	--	--	4.2E+01	--	--	9.2E-02	9.2E-02	Soil to protect groundwater for Tribal seafood.
100-41-4	Ethylbenzene		5.4E+00	--	8.0E+03	2.4E+02	3.5E+05	--	2.3E-01	2.3E-01	Soil to protect groundwater for Tribal seafood.
98-82-8	Isopropylbenzene(cumene)		2.1E+03	--	8.0E+03	9.5E+03	3.5E+05	--	7.8E+01	7.8E+01	Soil to protect groundwater for Tribal seafood.
591-78-6	2-Hexanone		2.1E+02	--	4.0E+02	1.1E+03	1.7E+04	--	3.2E+01	3.2E+01	Soil to protect groundwater for Tribal seafood.
75-09-2	Methylene Chloride		1.1E+01	--	1.3E+02	4.7E+02	1.8E+04	--	6.5E-01	6.5E-01	Soil to protect groundwater for Tribal seafood.
108-10-1	Methyl Isobutyl Ketone		5.3E+03	--	6.4E+03	3.2E+04	2.8E+05	--	1.7E+02	1.7E+02	Soil to protect groundwater for Tribal seafood.
91-20-3	Naphthalene		3.6E+00	--	1.6E+03	1.8E+02	7.0E+04	2.1E+00	1.6E+01	3.6E+00	EPA RSL Residential Including Ingestion, Dermal, and Inhalation.
100-42-5	Styrene		6.3E+03	--	1.6E+04	3.1E+04	7.0E+05	--	2.1E+04	6.3E+03	EPA RSL Residential Including Ingestion, Dermal, and Inhalation.
79-34-5	1,1,2,2-Tetrachloroethane		5.6E-01	--	5.0E+00	2.3E+01	6.6E+02	--	1.3E-02	1.3E-02	Soil to protect groundwater for Tribal seafood.
127-18-4	Tetrachloroethene (PCE)		5.6E-01	--	8.0E+02	1.8E+01	3.5E+04	--	1.6E-03	1.6E-03	Soil to protect groundwater for Tribal seafood.
108-88-3	Toluene		5.0E+03	--	6.4E+03	2.9E+04	2.8E+05	--	1.0E+02	1.0E+02	Soil to protect groundwater for Tribal seafood.
71-55-6	1,1,1-Trichloroethane		8.7E+03	--	1.6E+05	3.7E+04	7.0E+06	--	1.9E+03	1.9E+03	Soil to protect groundwater for Tribal seafood.
79-00-5	1,1,2-Trichloroethane		1.1E+00	--	1.8E+01	4.8E+01	2.3E+03	--	7.3E-02	7.3E-02	Soil to protect groundwater for Tribal seafood.
79-01-6	Trichloroethene (TCE)		2.7E-01	--	1.1E+01	1.3E+01	1.0E+03	--	1.8E-02	1.8E-02	Soil to protect groundwater for Tribal seafood.
120-82-1	1,2,4-trichlorobenzene		2.2E+01	--	3.4E+01	4.9E+02	4.5E+03	--	8.0E-02	8.0E-02	Soil to protect groundwater for Tribal seafood.
75-69-4	Trichlorofluoromethane		7.8E+02	--	2.4E+04	3.3E+03	1.0E+06	--	2.0E+02	2.0E+02	Soil to protect groundwater for Tribal seafood.
76-13-1	1,1,2-Trichlorotrifluoroethane		4.3E+02	--	2.4E+06	1.8E+03	1.0E+08	--	7.1E+03	4.3E+02	EPA RSL Residential Including Ingestion, Dermal, and Inhalation.
75-01-4	Vinyl chloride[11]		8.1E-05	--	6.7E-01	4.1E-03	8.8E+01	--	3.4E-02	8.1E-05	EPA RSL Residential Including Ingestion, Dermal, and Inhalation.
108-38-3	m-Xylene		3.4E+03	--	1.6E+04	1.5E+04	7.0E+05	--	1.6E+02	1.6E+02	Soil to protect groundwater for Tribal seafood.
95-47-6	o-Xylene		3.8E+03	--	1.6E+04	1.8E+04	7.0E+05	--	2.0E+02	2.0E+02	Soil to protect groundwater for Tribal seafood.
106-42-3	p-Xylene		3.4E+03	--	1.6E+04	1.6E+04	7.0E+05	--	2.3E+02	2.3E+02	Soil to protect groundwater for Tribal seafood.
10330-20-7	Xylenes (total)		6.3E+02	--	1.6E+04	2.7E+03	7.0E+05	--	2.0E+02	2.0E+02	Soil to protect groundwater for Tribal seafood.

Table 2
Soil Summary

Semivolatile Organic Compounds (SVOCs)											
83-32-9	Acenaphthene	--	3.4E+03	--	4.8E+03	2.1E+04	2.1E+05	5.0E-01	2.3E+02	2.3E+02	Soil to protect groundwater for Tribal seafood.
208-96-8	Acenaphthylene	--	--	--	--	--	--	1.3E+00	--	--	SMS SQS may be appropriate for bank soils.
120-12-7	Anthracene	--	1.7E+04	--	2.4E+04	1.1E+05	1.1E+06	9.6E-01	1.6E+03	1.6E+03	Soil to protect groundwater for Tribal seafood.
191-24-2	Benzo(g,h,i)perylene	--	--	--	--	--	--	--	--	--	--
117-81-7	Bis(2-ethylhexyl)phthalate	--	3.5E+01	--	7.1E+01	7.7E+02	9.4E+03	1.3E+00	5.7E+01	3.5E+01	EPA RSL Residential Including Ingestion, Dermal, and Inhalation.
85-68-7	Butylbenzyl phthalate	--	2.6E+02	--	5.3E+02	5.7E+03	6.9E+04	6.3E-02	1.7E+00	1.7E+00	Soil to protect groundwater for Tribal seafood.
59-50-7	4-chloro-3-methylphenol	--	6.1E+03	--	8.0E+03	3.8E+04	3.5E+05	--	7.4E+02	7.4E+02	Surrogate Value: soil to protect groundwater for drinking water use
132-64-9	*Dibenzofuran [12]*	--	--	--	*1.6E+02*	--	*7.0E+03*	*5.4E-01*	*1.2E+02*	*1.2E+02*	*Semi-quantitative: soil to protect groundwater for drinking water use.*
84-74-2	Di-n-butylphthalate	--	6.1E+03	--	8.0E+03	3.8E+04	3.5E+05	1.4E+00	2.6E+01	2.6E+01	Soil to protect groundwater for Tribal seafood.
84-66-2	Diethylphthalate	--	4.9E+04	--	6.4E+04	3.1E+05	2.8E+06	2.0E-01	7.6E+02	7.6E+02	Soil to protect groundwater for Tribal seafood.
105-67-9	2,4-Dimethylphenol	--	1.2E+03	--	1.6E+03	7.7E+03	7.0E+04	2.9E-02	9.5E+01	9.5E+01	Soil to protect groundwater for Tribal seafood.
131-11-3	Dimethylphthalate	--	--	--	--	--	--	7.1E-02	--	--	SMS SQS may be appropriate for bank soils.
117-84-0	Di-n-octyl phthalate	--	--	--	--	--	--	6.2E+00	--	--	SMS SQS may be appropriate for bank soils.
206-44-0	Fluoranthene	--	2.3E+03	--	3.2E+03	1.4E+04	1.4E+05	1.7E+00	2.3E+02	2.3E+02	Soil to protect groundwater for Tribal seafood.
86-73-7	Fluorene	--	2.3E+03	--	3.2E+03	1.4E+04	1.4E+05	5.4E-01	1.5E+02	1.5E+02	Soil to protect groundwater for Tribal seafood.
7440-62-2	1-Methylnaphthalene	--	1.6E+01	--	3.4E+01	3.5E+02	4.5E+03	1.6E+01	--	1.6E+01	EPA RSL Residential Including Ingestion, Dermal, and Inhalation.
91-57-6	2-Methylnaphthalene	--	2.3E+02	--	3.2E+02	1.4E+03	1.4E+04	6.7E-01	--	2.3E+02	EPA RSL Residential Including Ingestion, Dermal, and Inhalation.
95-48-7	2-Methylphenol (o-cresol)	--	3.0E+03	--	4.0E+03	1.9E+04	1.8E+05	6.3E-02	2.5E+02	2.5E+02	Soil to protect groundwater for Tribal seafood.
106-44-5	4-Methylphenol (p-cresol)	--	3.0E+02	--	4.0E+02	1.9E+03	1.8E+04	6.7E-01	4.1E+01	4.1E+01	Soil to protect groundwater for Tribal seafood.
91-20-3	Naphthalene	--	3.6E+00	--	1.6E+03	1.8E+02	7.0E+04	2.1E+00	1.6E+01	3.6E+00	EPA RSL Residential Including Ingestion, Dermal, and Inhalation.
85-01-8	Phenanthrene	--	--	--	--	--	--	1.5E+00	--	--	SMS SQS may be appropriate for bank soils.
108-95-2	Phenol	--	1.8E+04	--	2.4E+04	1.2E+05	1.1E+06	4.2E-01	1.9E+03	1.9E+03	Soil to protect groundwater for Tribal seafood.
129-00-0	Pyrene	--	1.7E+03	--	2.4E+03	1.1E+04	1.1E+05	2.6E+00	2.4E+02	2.4E+02	Soil to protect groundwater for Tribal seafood.
Mutagenic Carcinogenic Polycyclic Aromatic Hydrocarbons (cPAHs)											
56-55-3	Benzo(a) anthracene	--						1.1E+02			
50-32-8	Benzo(a) pyrene	--						9.9E+01			
205-99-2	Benzo (b) fluoranthene	--						2.3E+02			
207-08-9	Benzo(k) fluoranthene	--						2.3E+02			
218-01-9	Chrysene	--						1.1E+02			
53-70-3	Dibenz(a,h)anthracene	--						1.2E+01			
193-39-5	Indeno(1,2,3-cd)pyrene	--						3.4E+01			
--	Benzo(a)pyrene TEQ[13]	--	1.5E-02	--	1.4E-01	1.4E+00	1.8E+01	--	5.7E-02	1.5E-02	EPA RSL Residential with Early Life Correction.
Polychlorinated Biphenyls (PCBs)											
53469-21-9	Aroclor 1016/1242	--	2.2E-01	--	5.0E-01	4.9E+00	6.6E+01	--	7.2E-04	7.2E-04	Soil to protect groundwater for Tribal seafood.
12672-29-6	Aroclor 1248	--	2.2E-01	--	5.0E-01	4.9E+00	6.6E+01	--	--	2.2E-01	EPA RSL Residential Including Ingestion, Dermal, and Inhalation.
11097-69-1	Aroclor 1254	--	2.2E-01	--	5.0E-01	4.9E+00	6.6E+01	--	2.9E-04	2.9E-04	Soil to protect groundwater for Tribal seafood.
37324-23-2	Aroclor 1260	--	2.2E-01	--	5.0E-01	4.9E+00	6.6E+01	--	5.4E-03	5.4E-03	Soil to protect groundwater for Tribal seafood.
1336-36-3	Total PCBs	--	2.2E-01	--	5.0E-01	4.9E+00	6.6E+01	1.3E-01	1.8E-03	1.8E-03	Soil to protect groundwater for Tribal seafood.
Total Petroleum Hydrocarbons (TPH)											
--	TPH - Gasoline (Benzene Present)	--	--	3.0E+01	--	--	--	--	--	3.0E+01	Surrogate Value: MTCA A Soil Cleanup Level.
--	TPH - Aged Gasoline and Mineral Spirits	--	--	1.0E+02	--	--	--	--	--	1.0E+02	Surrogate Value: MTCA A Soil Cleanup Level.
--	TPH - Diesel #2	--	--	2.0E+03	--	--	--	--	--	2.0E+03	Surrogate Value: MTCA A Soil Cleanup Level.
--	TPH - Heavy Oils	--	--	2.0E+03	--	--	--	--	--	2.0E+03	Surrogate Value: MTCA A Soil Cleanup Level.

Notes:

Washington state regulates carcinogenic polycyclic aromatic hydrocarbons using the benzo(a)pyrene Toxic Equivalent; therefore, no individual soil cleanup levels have been developed, and the cells are "grayed out." Refer to https://fortress.wa.gov/ecy/clarc/FocusSheets/tef.pdf.

1 Not all chemicals are constituents needing TMCLs at Boeing Plant 2.
2 Table 7, Puget Sound Soil Background Values from Ecology State-wide Natural Background for Metals in Soil, October 1994; except for Arsenic where MTCA established 20 mg/kg as background (WAC 173-340-900 Table 740-1, Footnote b).
3 EPA RSL calculations using EPA toxicity factors and exposure parameters as presented in associated tables in this attachment.
4 Surrogate value used for TPH based on protection of groundwater as drinking water. This value is presented in MTCA's Table 740-1 in conjunction with regulations present in MTCA 173-340-740 (2)(b)(i).
5 MTCA Method B uses WAC 173-340-740, equations 740-1 and 740-2; MTCA Method C uses WAC-173-340-745, equations 745-1 and 745-2 (Ecology 2007); specific parameters are presented in associated tables in this attachment; CLARC toxicity values updated (refer to Toxicity Factor Table).
6 EPA RSL calculations using EPA toxicity factors and exposure parameters as presented in associated tables in this attachment; excess individual lifetime cancer risk was adjusted to 1 in 100,000 and ingestion rate was increased to 200 mg/day by EPA Region 10 (R10) risk management decision.
7 Sediment Management Standards Sediment Quality Standards Chemical Criteria (WAC-173-204-320[a]); expressed as their equivalent dry weight values.
8 Soil to Groundwater cleanup values are based on the MTCA fixed parameter three-phase partitioning model (WAC 173-340-747, equation 747-1), using partitioning factors presented in associated tables in this attachment.
9 Lead risk levels were calculated using the biokinetic model rather than standard risk equations; the values included on this spreadsheet are MTCA Method A values for residential and industrial exposures using the biokinetic model.
10 Mercuric chloride was used as a surrogate.
11 Ecology has established the following "rule" for dealing with the mutagenic effects of vinyl chloride; refer to for details: https://fortress.wa.gov/ecy/clarc/FocusSheets/VinylChloride.pdf. EPA R10 has accepted this approach for this site.
12 The provisional toxicity factors for this chemical are semi-quantative and should be used for screening purposes only.
13 Because these cPAHs are considered mutagenic by EPA, EPA RSL calculations included an early life correction.

Abbreviations:

CAS Chemical abstract number
CLARC Cleanup Levels and Risk Calculation
Ecology Washington State Department of Ecology
EPA U.S. Environmental Protection Agency
MTCA Model Toxics Control Act
RSL Regional screening level
SMS Sediment Management Standards

Table 3
Ambient Air Summary

CAS Number	Chemical	Proposed Ambient Air TMCLs			
		Residential		Worker[1, 2]	
		TMCL ($\mu g/m^3$)	Source ($\mu g/m^3$)	TMCL ($\mu g/m^3$)	Source ($\mu g/m^3$)
67-64-1	Acetone	3.2E+04	EPA RSL	1.4E+05	Modified EPA RSL
71-43-2	Benzene	3.1E-01	EPA RSL	1.6E+01	Modified EPA RSL
78-93-3	2-Butanone (MEK)	5.2E+03	EPA RSL	2.2E+04	Modified EPA RSL
75-15-0	Carbon Disulfide	7.3E+02	EPA RSL	3.1E+03	Modified EPA RSL
56-23-5	Carbon Tetrachloride	4.1E-01	EPA RSL	2.0E+01	Modified EPA RSL
108-90-7	Chlorobenzene	5.2E+01	EPA RSL	2.2E+02	Modified EPA RSL
75-00-3	Chloroethane	1.0E+04	EPA RSL	4.4E+04	Modified EPA RSL
67-66-3	Chloroform	1.1E-01	EPA RSL	5.3E+00	Modified EPA RSL
74-87-3	Chloromethane	9.4E+01	EPA RSL	3.9E+02	Modified EPA RSL
106-43-4	4-Chlorotoluene	--	--	--	--
95-50-1	1,2-Dichlorobenzene	2.1E+02	EPA RSL	8.8E+02	Modified EPA RSL
106-46-7	1,4-Dichlorobenzene	2.2E-01	EPA RSL	1.1E+01	Modified EPA RSL
75-34-3	1,1-Dichloroethane	1.5E+00	EPA RSL	7.7E+01	Modified EPA RSL
107-06-2	1,2-Dichloroethane	9.4E-02	EPA RSL	4.7E+00	Modified EPA RSL
75-35-4	1,1-Dichloroethene	2.1E+02	EPA RSL	8.8E+02	Modified EPA RSL
156-59-2	*cis* -1,2-Dichloroethene[3]	--	--	--	--
156-60-5	*trans* -1,2-Dichloroethene[3]	--	--	--	--
78-87-5	1,2-Dichloropropane	2.4E-01	EPA RSL	1.2E+01	Modified EPA RSL
100-41-4	Ethylbenzene	9.7E-01	EPA RSL	4.9E+01	Modified EPA RSL
98-82-8	Isopropylbenzene(cumene)	4.2E+02	EPA RSL	1.8E+03	Modified EPA RSL
591-78-6	2-Hexanone	3.1E+01	EPA RSL	1.3E+02	Modified EPA RSL
75-09-2	Methylene Chloride	5.2E+00	EPA RSL	2.6E+02	Modified EPA RSL
108-10-1	Methyl Isobutyl Ketone	3.1E+03	EPA RSL	1.3E+04	Modified EPA RSL
91-20-3	Naphthalene	7.2E-02	EPA RSL	3.6E+00	Modified EPA RSL
100-42-5	Styrene	1.0E+03	EPA RSL	4.4E+03	Modified EPA RSL
79-34-5	1,1,2,2-Tetrachloroethane	4.2E-02	EPA RSL	2.1E+00	Modified EPA RSL
127-18-4	Tetrachloroethene (PCE)	4.1E-01	EPA RSL	2.1E+01	Modified EPA RSL
108-88-3	Toluene	5.2E+03	EPA RSL	2.2E+04	Modified EPA RSL
71-55-6	1,1,1-Trichloroethane	5.2E+03	EPA RSL	2.2E+04	Modified EPA RSL
79-00-5	1,1,2-Trichloroethane	1.5E-01	EPA RSL	7.7E+00	Modified EPA RSL
79-01-6	Trichloroethene (TCE)	1.2E-01	EPA RSL	6.1E+00	Modified EPA RSL
120-82-1	1,2,4-trichlorobenzene[3]	--	--	--	--
75-69-4	Trichlorofluoromethane	7.3E+02	EPA RSL	3.1E+03	Modified EPA RSL
76-13-1	1,1,2-Trichlorotrifluoroethane	3.1E+02	EPA RSL	1.3E+03	Modified EPA RSL
75-01-4	Vinyl chloride[4]	2.8E-01	EPA RSL	1.4E+01	Modified EPA RSL
108-38-3	m-Xylene	7.3E+02	EPA RSL	3.1E+03	Modified EPA RSL
95-47-6	o-Xylene	7.3E+02	EPA RSL	3.1E+03	Modified EPA RSL
106-42-3	p-Xylene	7.3E+02	EPA RSL	3.1E+03	Modified EPA RSL
10330-20-7	Xylenes (total)	1.0E+02	EPA RSL	4.4E+02	Modified EPA RSL

Notes:

1 EPA Region (R10) has made a risk management decision to use a 1 in 100,000 excess individual lifetime cancer risk for workers at Boeing Plant 2. Calculations are based on the EPA RSL equations modified for a total risk of 1.0E-5.

2 Ecology's worker exposure have been modified from full time (365 days/year x 24 hours/day) to the work week allowed under industrial soils (10 hours/day x 7 days/week x 50 weeks/year).

3 No inhalation toxicity factors are available.

4 Ecology has established the following "rule" for dealing with the mutagenic effects of vinyl chloride; refer to for details: https://fortress.wa.gov/ecy/clarc/FocusSheets/VinylChloride.pdf. EPA R10 has accepted this approach for this site.

Abbreviations:

CAS Chemical abstract number
Ecology Washington State Department of Ecology
EPA U.S. Environmental Protection Agency
RSL Regional screening level

Table 4
Identification of Sediment Constituents of Concern[1]

CAS Number	Chemical	Number of Results[1]	SMS SQS (dry weight equivalents)	Units	SMS SQS (organic carbon-normalized)	Units
Metals						
7440-38-2	Arsenic	98	5.7E+01	mg/kg dw	--	
7440-43-9	Cadmium	135	5.1E+00	mg/kg dw	--	
7440-47-3	Chromium	136	2.6E+02	mg/kg dw	--	
7440-50-8	Copper	136	3.9E+02	mg/kg dw	--	
7439-92-1	Lead	135	4.5E+02	mg/kg dw	--	
7439-97-6	Mercury	134	4.1E-01	mg/kg dw	--	
7440-22-4	Silver	135	6.1E+00	mg/kg dw	--	
7440-66-6	Zinc	135	4.1E+02	mg/kg dw	--	
Semivolatile Organic Compounds						
Polycyclic Aromatic Hydrocarbons						
	Total LPAH [2]	75	5.2E+03	µg/kg dw	3.7E+02	mg/kg OC
91-20-3	Naphthalene	75	2.1E+03	µg/kg dw	9.9E+01	mg/kg OC
208-96-8	Acenaphthylene	75	1.3E+03	µg/kg dw	6.6E+01	mg/kg OC
83-32-9	Acenaphthene	75	5.0E+02	µg/kg dw	1.6E+01	mg/kg OC
86-73-7	Fluorene	75	5.4E+02	µg/kg dw	2.3E+01	mg/kg OC
85-01-8	Phenanthrene	75	1.5E+03	µg/kg dw	1.0E+02	mg/kg OC
120-12-7	Anthracene	75	9.6E+02	µg/kg dw	2.2E+02	mg/kg OC
91-57-6	2-Methylnaphthalene	75	6.7E+02	µg/kg dw	3.8E+01	mg/kg OC
	Total HPAH [3]	75	1.2E+04	µg/kg dw	9.6E+02	mg/kg OC
206-44-0	Fluoranthene	75	1.7E+03	µg/kg dw	1.6E+02	mg/kg OC
129-00-0	Pyrene	75	2.6E+03	µg/kg dw	1.0E+03	mg/kg OC
56-55-3	Benzo(a)anthracene	75	1.3E+03	µg/kg dw	1.1E+02	mg/kg OC
218-01-9	Chrysene	75	1.4E+03	µg/kg dw	1.1E+02	mg/kg OC
	Total benzofluoranthenes [4]	75	3.2E+03	µg/kg dw	2.3E+02	mg/kg OC
205-99-2	*Benzo(b)fluoranthene* [5]	75	no criterion		no criterion	
207-08-9	*Benzo(k)fluoranthene* [5]	75	no criterion		no criterion	
50-32-8	Benzo(a)pyrene	75	1.6E+03	µg/kg dw	9.9E+01	mg/kg OC
193-39-5	Indeno(1,2,3-cd)pyrene	75	6.0E+02	µg/kg dw	3.4E+01	mg/kg OC
53-70-3	Dibenz(a,h)anthracene	75	2.3E+02	µg/kg dw	1.2E+01	mg/kg OC
191-24-2	Benzo(g,h,i)perylene	75	6.7E+02	µg/kg dw	3.1E+01	mg/kg OC
Chlorinated Benzenes						
95-50-1	1,2-Dichlorobenzene	75	3.5E+01	µg/kg dw	2.3E+00	mg/kg OC
106-46-7	1,4-Dichlorobenzene	75	1.1E+02	µg/kg dw	3.1E+00	mg/kg OC
120-82-1	1,2,4-Trichlorobenzene	75	3.1E+01	µg/kg dw	8.1E-01	mg/kg OC
118-74-1	Hexachlorobenzene	75	2.2E+01	µg/kg dw	3.8E-01	mg/kg OC
Phthalate Esters						
131-11-3	Dimethylphthalate	80	7.1E+01	µg/kg dw	5.3E+01	mg/kg OC
84-66-2	Diethylphthalate	80	2.0E+02	µg/kg dw	6.1E+01	mg/kg OC
84-74-2	Di-n-butylphthalate	80	1.4E+03	µg/kg dw	2.2E+02	mg/kg OC
85-68-7	Butylbenzylphthalate	80	6.3E+01	µg/kg dw	4.9E+00	mg/kg OC
117-81-7	bis(2-Ethylhexyl)phthalate	80	1.3E+03	µg/kg dw	4.7E+01	mg/kg OC
117-84-0	Di-n-octylphthalate	80	6.2E+03	µg/kg dw	5.8E+01	mg/kg OC
Miscellaneous						
132-64-9	Dibenzofuran	75	5.4E+02	µg/kg dw	1.5E+01	mg/kg OC
87-68-3	Hexachlorobutadiene	75	1.1E+01	µg/kg dw	3.9E+00	mg/kg OC
86-30-6	N-Nitrosodiphenylamine	75	2.8E+01	µg/kg dw	1.1E+01	mg/kg OC
Polychlorinated Biphenyls						
11141-16-5	Aroclor 1232	284	no criterion	µg/kg dw	no criterion	
53469-21-9	Aroclor 1016/1242 [6]	469	no criterion	µg/kg dw	no criterion	
12672-29-6	Aroclor 1248	469	no criterion	µg/kg dw	no criterion	
11097-69-1	Aroclor 1254	469	no criterion	µg/kg dw	no criterion	
11096-82-5	Aroclor 1260	469	no criterion	µg/kg dw	no criterion	
1336-36-3	Total PCBs (as Aroclors)	476	1.3E+02	µg/kg dw	1.2E+01	mg/kg OC
Ionizable Organic Compounds						
108-95-2	Phenol	75	4.2E+02	µg/kg dw	--	
95-48-7	2-Methylphenol	75	6.3E+01	µg/kg dw	--	
106-44-5	4-Methylphenol	71	6.7E+02	µg/kg dw	--	
105-67-9	2,4-Dimethylphenol	75	2.9E+01	µg/kg dw	--	
87-86-5	Pentachlorophenol	75	3.6E+02	µg/kg dw	--	
100-51-6	Benzyl alcohol	75	5.7E+01	µg/kg dw	--	
65-85-0	Benzoic acid	75	6.5E+02	µg/kg dw	--	

Notes:

Blank cells are intentional

This table from the Target Media Cleanup Levels Technical Memorandum, Revised Agency Review Draft, December 2008.

1 Data selection notes:
Only locations flagged in the database as being within the Duwamish Sediment Other Area (DSOA) Location group have been included.

Only samples designated as "field sample" or "field duplicate" have been included.
Only samples with an "approved" flag (in regards to dilutions and other QC measures) have been included.
Only samples with a media of "Sediment, #" have been included.
Cores and grabs of any depth have been included.

2 The total LPAH criterion represents the sum of the following low molecular weight polynuclear aromatic compounds: naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene. 2-Methylnaphthalene is not included in the LPAH definition. The LPAH criterion is not the sum of criteria values for the individual LPAH compounds listed.

3 The total HPAH criterion represents the sum of the following high molecular weight polynuclear aromatic compounds: fluoranthene, pyrene, benz(a)anthracene, chrysene, total benzofluoranthenes, benzo(a)pyrene, indeno(1,2,3)pyrene, dibenz(a,h)anthracene, and benzo(g,h,i)perylene. The HPAH criterion is not the sum of criteria values for the individual HPAH compounds listed.

4 The total benzofluoranthenes criteria are compared to the sums of the concentrations of the b, j, and k isomers of benzofluoranthene.

5 There are no criteria for benzo(b)fluoranthene or benzo(k)fluoranthene.

6 For PCBs:
All Aroclor 1016, 1016/1242, and 1242 results have been summed together and reported under the heading "Aroclor 1016/1242" with the CAS for Aroclor 1242.

7 SMS regulates PCBs as "total PCB" only.

Abbreviations:

COC Constituent of concern
DW Dry weight
HPAH High molecular weight polycyclic aromatic hydrocarbon
LPAH Low molecular weight polycyclic aromatic hydrocarbon
ND Not detected
OC Organic carbon
PCB Polychlorinated biphenyl
SMS Sediment Management Standards
SQS Sediment Quality Standards

Boeing Plant 2
Seattle, WA

Target Media Cleanup Levels Technical Memorandum

Attachment A
Risk-based Calculations

FINAL

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Table A.1a
Soil Standards, Criteria, and Risk-based Calculations

CAS Number	Chemical[1]	Puget Sound Background[2] (mg/kg)	Residential: EPA — EPA RSL Residential Includes Ingestion, Dermal, and Inhalation[3]	Residential: Ecology — MTCA Method B Unrestricted Land Use Includes CLARC Toxicity Factors[4] (mg/kg)	Industrial: EPA — EPA RSL Industrial Includes Ingestion, Dermal, and Inhalation[5]	Industrial: Ecology — MTCA Method C Industrial Land Use Includes CLARC Toxicity Factors[4] (mg/kg)	Sediment Protection: Ecology — SMS Sediment Quality Standards[6] (mg/kg dry weight)	Groundwater Protection: Ecology — Soil Level to Protect Groundwater Using Three-phase Model[7] (mg/kg)	EPA Proposed Soil TMCL to Protect all Pathways (mg/kg)	Exposure Pathway Basis of TMCL
Metals										
7429-90-5	Aluminum	3.3E+04	7.7E+04	8.0E+04	5.0E+05	3.5E+06	--	--	7.7E+04	EPA RSL Residential Including Ingestion, Dermal, and Inhalation.
7440-36-0	Antimony (metallic)	--	3.1E+01	3.2E+01	2.0E+02	1.4E+03	--	7.8E+02	3.1E+01	EPA RSL Residential Including Ingestion, Dermal, and Inhalation.
7440-38-2	Arsenic (inorganic)	2.0E+01	3.9E-01	6.7E-01	8.7E+00	8.8E+01	5.7E+01	--	2.0E+01	Washington State Background.
7440-39-3	Barium	--	1.5E+04	1.6E+04	9.9E+04	7.0E+05	--	1.0E+02	1.0E+02	Soil to protect groundwater for Tribal seafood.
7440-41-7	Beryllium	6.1E-01	1.6E+02	1.6E+02	1.0E+03	7.0E+03	--	3.1E+02	1.6E+02	EPA RSL Residential Including Ingestion, Dermal, and Inhalation.
7440-43-9	Cadmium	7.7E-01	7.0E+01	8.0E+01	4.5E+02	3.5E+03	5.1E+00	4.0E+00	4.0E+00	Soil to protect groundwater for aquatic species.
18540-29-9	Chromium (VI)	--	1.2E+00	2.4E+02	2.8E+01	1.0E+04	--	--	1.2E+00	EPA RSL Residential Including Ingestion, Dermal, and Inhalation.
7440-48-4	Cobalt	--	2.3E+01	2.4E+01	1.5E+02	1.0E+03	--	1.2E+01	1.2E+01	Surrogate Value: soil to protect groundwater for drinking water use.
7440-50-8	Copper	3.6E+01	3.1E+03	3.2E+03	2.0E+04	1.4E+05	3.9E+02	8.0E+01	8.0E+01	Soil to protect groundwater background.
7439-89-6	Iron	5.9E+04	5.5E+04	5.6E+04	3.6E+05	2.4E+06	--	--	5.9E+04	Puget Sound Background.
7439-92-1	Lead[8]	2.4E+01	4.0E+02	2.5E+02	8.0E+02	1.0E+03	4.5E+02	7.9E+02	2.5E+02	MTCA A Residential.
7439-96-5	Manganese (non-diet)	1.2E+03	1.8E+03	1.9E+03	1.2E+04	8.4E+04	--	--	1.8E+03	EPA RSL Residential Including Ingestion, Dermal, and Inhalation.
7439-97-6	Mercury (elemental)	7.0E-02	5.6E+00	2.4E+01	2.8E+01	1.0E+03	4.1E-01	1.5E+00	1.5E+00	Soil to protect groundwater for aquatic species.
7487-94-7	Mercury (inorganic salts)[9]	--	2.3E+01	2.4E+01	1.5E+02	1.0E+03	--	--	2.3E+01	EPA RSL Residential Including Ingestion, Dermal, and Inhalation.
22967-92-6	Mercury (methyl mercury)	--	7.8E+00	8.0E+00	5.1E+01	3.5E+02	--	3.8E+00	3.8E+00	Soil to protect groundwater for Tribal seafood.
7439-98-7	Molybdenum	--	3.9E+02	4.0E+02	2.6E+03	1.7E+04	--	2.0E+01	2.0E+01	Surrogate Value: soil to protect groundwater for drinking water use.
7440-02-0	Nickel	4.8E+01	1.5E+03	1.6E+03	1.0E+04	7.0E+04	--	2.1E+02	2.1E+02	Soil to protect groundwater for aquatic species.
7782-49-2	Selenium	--	3.9E+02	4.0E+02	2.6E+03	1.7E+04	--	1.0E+00	1.0E+00	Soil to protect groundwater for aquatic species.
7440-22-4	Silver	--	3.9E+02	4.0E+02	2.6E+03	1.7E+04	6.1E+00	1.7E+02	1.7E+02	Soil to protect groundwater for Tribal seafood.
7440-31-5	Tin	--	4.7E+04	4.8E+04	3.1E+05	2.1E+06	--	1.5E+05	4.7E+04	EPA RSL Residential Including Ingestion, Dermal, and Inhalation.
1314-62-1	Vanadium (as vanadium pentoxide)	--	7.0E+02	7.2E+02	4.6E+03	3.1E+04	--	2.9E+03	7.0E+02	EPA RSL Residential Including Ingestion, Dermal, and Inhalation.
7440-66-6	Zinc (metallic)	8.5E+01	2.3E+04	2.4E+04	1.5E+05	1.0E+06	4.1E+02	1.4E+03	1.4E+03	Soil to protect groundwater for Tribal seafood.
Other Inorganics										
57-12-5	Cyanide (free)	--	1.6E+03	1.6E+03	1.0E+04	7.0E+04	--	2.0E+01	2.0E+01	Soil to protect groundwater for aquatic species.
74-90-8	Cyanide (hydrogen)	--	4.6E+00	4.8E+01	2.0E+01	2.1E+03	--	--	4.6E+00	EPA RSL Residential Including Ingestion, Dermal, and Inhalation.

Notes:

1 Not all chemicals are constituents needing TMCLs at Boeing Plant 2.
2 Table 7, Puget Sound Soil Background Values from Ecology State-wide Natural Background for Metals in Soil, October 1994; except for Arsenic where MTCA established 20 mg/kg as background (WAC 173-340-900 Table 740-1, Footnote b).
3 EPA RSL calculations using EPA toxicity factors and exposure parameters as presented in associated tables in this attachment.
4 MTCA Method B uses WAC 173-340-740, equations 740-1 and 740-2; MTCA Method C uses WAC-173-340-745, equations 745-1 and 745-2 (Ecology 2007); specific parameters are presented in associated tables in this attachment; CLARC toxicity values updated (refer to toxicity factor table).
5 EPA RSL calculations using EPA toxicity factors and exposure parameters as presented in associated tables in this attachment. EPA RSL Worker scenario has been modified to a 1 in 100,000 excess individual lifetime cancer risk and a soil ingestion rate of 200 mg/kg-day by an EPA Region 10 risk management decision.
6 Sediment Management Standards Sediment Quality Standards Chemical Criteria (WAC-173-204-320[a]); expressed as their equivalent dry weight values.
7 Soil to Groundwater cleanup values are based on the MTCA fixed parameter three-phase partitioning model (WAC 173-340-747, equation 747-1), using partitioning factors presented in associated tables in this attachment.
8 Lead risk levels were calculated using the Integrated Exposure Uptake Biokinetic (IEUBK) model rather than standard risk equations; the MTCA values included on this spreadsheet are MTCA Method A values for residential and industrial exposures.
9 Mercuric chloride was used as a surrogate.

Abbreviations:

CAS Chemical abstract number
CLARC Cleanup Levels and Risk Calculation
Ecology Washington State Department of Ecology
EPA U.S. Environmental Protection Agency
MTCA Model Toxics Control Act
RSL Regional screening levels
SMS Sediment Management Standards

Table A.1b
Groundwater Standards, Criteria, and Risk-based Calculations

CAS Number	Chemical[1]	Boeing Plant 2 Groundwater Background[2]	Protection of Drinking Water[3] – Drinking Water Standard/Criteria[4]				Protection of Aquatic Species – Freshwater Standards			Protection of Aquatic Species – Marine Standards			Protection of Human Health for Consumption of Fish and Shellfish in Marine Waters				EPA Proposed TMCL for Surface Water and Groundwater Discharging to Surface Water in the Lower Duwamish Waterway	
			Federal Primary Drinking Water Standards[5] (µg/L)	EPA RSL Tap Water Criteria[6] (µg/L)	State Primary Drinking Water Standards[7] (µg/L)	MTCA B Groundwater Cleanup Level[8] (µg/L)	Federal National Toxics Rule[9] Chronic (µg/L)	Federal Ambient Water Quality Criteria[10,11] Chronic (µg/L)	Washington Surface Water Quality Standards[11,12] Chronic (µg/L)	Federal National Toxics Rule[9] Chronic (µg/L)	Federal Ambient Water Quality Criteria[10] Chronic (µg/L)	Washington Surface Water Quality Standards[11, 12] Chronic (µg/L)	Federal National Toxics Rule[9] Organism (Fish/Shellfish) Only (µg/L)	Federal Ambient Water Quality Criteria[10] Organism (Fish/Shellfish) Only (µg/L)	Lowest of Tribal and Asian/Pacific Islander Exposure Scenarios[12, 13] Organism (Fish/Shellfish) Only (µg/L)	MTCA Method B Surface Water[12, 14] Fish/Shellfish (µg/L)	(µg/L)	Exposure Pathway Basis of TMCL
Metals																		
7429-90-5	Aluminum	--	--	3.7E+04	--	1.6E+04	--	8.7E+01	--	--	--	--	--	--	--	--	8.7E+01	Freshwater Chronic AWQC to protect aquatic species.
7440-36-0	Antimony (metallic)	--	6.0E+00	1.5E+01	6.0E+00	6.4E+00	--	--	--	--	--	--	4.3E+03	6.4E+02	1.5E+02	1.0E+03	1.5E+02	EPA R10 Tribal Consumption of Seafood.
7440-38-2	Arsenic (inorganic)	8.0E+00	1.0E+01	4.5E-02	1.0E+01	5.8E-02	1.9E+02	1.5E+02	1.9E+02	3.6E+01	3.6E+01	3.6E+01	1.4E+01	1.4E-01	5.4E-03	3.8E-02	8.0E+00	Lower Duwamish Waterway Groundwater Background.
7440-39-3	Barium	--	2.0E+03	7.3E+03	2.0E+03	3.2E+03	--	--	--	--	--	--	--	--	1.2E+02	8.2E+02	1.2E+02	EPA R10 Tribal Consumption of Seafood.
7440-41-7	Beryllium	--	4.0E+00	7.3E+01	4.0E+00	3.2E+01	--	--	--	--	--	--	--	--	1.2E+01	8.4E+01	1.2E+01	EPA R10 Tribal Consumption of Seafood.
7440-43-9	Cadmium[15]	--	5.0E+00	1.8E+01	5.0E+00	8.0E+00	1.9E+00	2.5E-01	1.9E+00	9.3E+00	8.8E+00	9.3E+00	--	--	4.3E-01	2.9E+00	2.5E-01	Freshwater Chronic AWQC to protect aquatic species.
18540-29-9	Chromium (VI)	--	--	4.3E-02	--	4.8E+01	1.0E+01	1.1E+01	1.0E+01	5.0E+01	5.0E+01	5.0E+01	--	--	5.8E-01	4.1E+00	5.8E-01	EPA R10 Tribal Consumption of Seafood.
7440-48-4	Cobalt	--	--	1.1E+01	--	4.8E+00	--	--	--	--	--	--	--	--	--	--	4.8E+00	Surrogate Value: MTCA B groundwater to protect drinking water.
7440-50-8	Copper[15]	8.0E+00	1.3E+03	1.5E+03	--	6.4E+02	2.3E+01	2.9E+00	2.3E+01	2.4E+00	3.1E+00	3.1E+00	--	--	4.3E+02	2.9E+03	8.0E+00	Lower Duwamish Waterway Groundwater Background.
7439-89-6	Iron	--	--	2.6E+04	3.0E-01	1.1E+04	--	1.0E+03	--	--	--	--	--	--	--	--	1.0E+03	Freshwater Chronic AWQC to protect aquatic species.
7439-92-1	Lead[15]	--	1.5E+01	--	--	--	6.1E+00	2.5E+00	6.1E+00	8.1E+00	8.1E+00	8.1E+00	--	--	--	--	2.5E+00	Freshwater Chronic AWQC to protect aquatic species.
7439-96-5	Manganese (non-diet)	2.0E+03	--	8.8E+02	5.0E+01	3.8E+02	--	--	--	--	--	--	--	1.0E+02	--	--	2.0E+03	Lower Duwamish Waterway Groundwater Background.
7439-97-6	Mercury (elemental)	--	2.0E+00	5.7E-01	2.0E+00	4.8E+00	1.2E-02	7.7E-01	1.2E-02	2.5E-02	9.4E-01	2.5E-02	1.5E-01	3.0E-01	--	--	1.2E-02	Freshwater Chronic NTR/WSWQS to protect aquatic species.
7487-94-7	Mercury (inorganic salts)[16]	--	--	--	--	4.8E+00	--	--	--	--	--	--	--	--	--	--	4.8E+00	Surrogate Value: MTCA B groundwater to protect drinking water.
22967-92-6	Mercury (methyl mercury)	--	--	3.7E+00	--	1.6E+00	--	7.7E-01	--	--	9.4E-01	--	--	3.0E-01	--	--	3.0E-01	EPA AWQC to protect human consumption of seafood.
7439-98-7	Molybdenum	--	--	1.8E+02	--	8.0E+01	--	--	--	--	--	--	--	--	--	--	8.0E+01	Surrogate Value: MTCA B groundwater to protect drinking water.
7440-02-0	Nickel[15]	--	--	7.3E+02	1.0E+02	3.2E+02	3.2E+02	5.2E+01	3.2E+02	8.2E+00	8.2E+00	8.2E+00	4.6E+03	4.6E+03	9.9E+01	6.6E+02	8.2E+00	Marine Chronic AWQC to protect aquatic species.
7782-49-2	Selenium	--	5.0E+01	1.8E+02	5.0E+01	8.0E+01	5.0E+00	5.0E+00	5.0E+00	7.1E+01	7.1E+01	7.1E+01	--	4.2E+03	1.5E+01	1.0E+02	5.0E+00	Freshwater Chronic NTR/WSWQS to protect aquatic species.
7440-22-4	Silver	--	--	1.8E+02	1.0E+02	8.0E+01	--	--	--	--	--	--	--	--	2.2E+01	1.5E+02	2.2E+01	EPA R10 Tribal Consumption of Seafood.
7440-31-5	Tin	--	--	2.2E+04	--	9.6E+03	--	--	--	--	--	--	--	--	--	--	9.6E+03	Surrogate Value: MTCA B groundwater to protect drinking water.
7440-62-2	Vanadium	--	--	1.8E+02	--	1.4E+02	--	--	--	--	--	--	--	--	--	--	1.4E+02	Surrogate Value: MTCA B groundwater to protect drinking water.
7440-66-6	Zinc (metallic)[15]	--	--	1.1E+04	5.0E+03	4.8E+03	2.1E+02	1.2E+02	2.1E+02	--	8.1E+01	8.1E+01	--	2.6E+04	5.6E+01	3.8E+02	5.6E+01	EPA R10 Tribal Consumption of Seafood.
Other Inorganics																		
57-12-5	Cyanide (free)	--	2.0E+02	7.3E+02	--	3.2E+02	5.2E+00	5.2E+00	5.2E+00	1.0E+00	1.0E+00	1.0E+00	2.2E+05	1.6E+04	2.4E+03	1.6E+04	1.0E+00	Marine Chronic AWQC to protect aquatic species.
74-90-8	Cyanide (hydrogen)	--	--	1.6E+00	2.0E+02	9.6E+00	--	--	--	--	--	--	--	--	--	--	1.6E+00	Surrogate Value: EPA RSL Tap Water Criteria.

Notes:

1 Not all chemicals are constituents needing TMCLs at Boeing Plant 2.
2 Background concentration in groundwater as per EPA approval of the Technical Memorandum on background, May 2008.
3 Drinking water standards/criteria are not applicable to Boeing Plant 2 unless no other applicable standard exists for a constituent needing a TMCL in groundwater.
4 The standards are potentially applicable to groundwater that may be used for drinking water supplies. Ecology determines the maximum beneficial use of groundwater, which may or may not include drinking.
5 National Primary Drinking Water Regulations, Maximum Contaminant Levels (MCLs); http://water.epa.gov/drink/contaminants/index.cfm.
6 EPA RSL, Residential Tapwaters; http://www.epa.gov/region9/superfund/prg/.
7 Washington Primary Drinking Water Standards WAC 246-290-130, Maximum Contaminant Levels (MCLs).
8 Standard MTCA Method B uses WAC 173-340-740; equations 730-1 and 730-2 (Ecology 2007). Parameters and toxicity factors can be found in associated tables in this attachment.
9 National Toxics Rule (NTR), 40 CFR 131.36.
10 EPA Ambient Water Quality Criteria (AWQCs), Clean Water Action Section 304.
11 Washington Surface Water Quality Standards; WAC 173-201A, Surface Water Quality Criteria.
12 EPA and Ecology fish consumption scenarios are based on MTCA Method B Surface Water Equations (equations 730-1 and 730-2); however, they use different exposure assumptions. Details are given in associated tables in this attachment.
13 This column uses the approach described in Note 8, but selects the lower concentrations that are protective of special populations including Tribal and Asian/Pacific Islander; the lowest concentration is always associated with Tribal exposure.
14 This column is included for comparison only and is based on the default exposure scenario in MTCA 173-340-730.
15 For these chemicals, freshwater standards for protection of aquatic species are water hardness dependent. The standards have been adjusted from the default values in the guidance to a site-specific average value at Boeing Plant 2 of 229 mg/L (obtained from AMEC Geomatrix, Water Quality Technical Memorandum, 2011) using equations available in the NTR, AWQCs, and WAC 173-201A, respectively. Copper is treated differently in the AWQCs (http://water.epa.gov/scitech/swguidance/standards/criteria/aqlife/pollutants/copper/index.cfm). The copper criteria is calculated using a Biotic Ligand Model with the following parameters: temperature = 17.75°C, pH = 6.73, dissolved organic carbon (DOC) = 0.5 mg/L, humic acids (HA) = 10%, calcium = 62.5 mg/L, magnesium = 163 mg/L, sodium = 1,460 mg/L, potassium = 53.4 mg/L, sulfate = 363 mg/L, chloride = 2,510 mg/L, alkalinity = 55.2 mg/L, and sulfide = 0.0003 mg/L. Of the parameters, DOC, HA, and sulfide are model defaults, while the other parameters are site specific and obtained from: (1) AMEC Geomatrix, DSOA Additional Characterization Water Sample Collection, 2008 and (2) Floyd|Snider, Jorgenson Forge Outfall Site Source Control Action Completion Report, 2011.
16 Mercuric chloride used as a surrogate.

Abbreviations:

BCF Bioconcentration factor
CAS Chemical abstract number
DOC Dissolved organic carbon
CLARC Cleanup Levels and Risk Calculation
Ecology Washington State Department of Ecology
EPA U.S. Environmental Protection Agency
HA Humic acids
MTCA Model Toxics Control Act
NTR National Toxics Rule
R10 Region 10
RSL Regional screening level
WSWQS Washington Surface Water Quality Standards

Table A.1c
Soil Calculations

		Direct Contact Exposures																								Protection of Groundwater	
		Ecology Default Calculations				EPA RSL Calculations with Site-specific Factors								EPA RSL Calculations with Site-specific Factors								Proposed TMCLs				MTCA 3-Phase Model for Unsaturated Soils	
		Residential		Industrial		Residential Exposure								Worker Exposure								Direct Contact Exposure					
		MTCA Method B with CLARC Values		MTCA Method C with CLARC Values		Cancer Risk with EPA RSL Calculations, Parameters, and Toxicity Factors				Non-Cancer Risk with EPA RSL Calculations, Parameters, and Toxicity Factors				Cancer Risk with EPA RSL Calculations, Parameters, and Toxicity Factors; Modified to 10-5 Cancer Risk and Ingestion Rate of 200 mg/day				Non-Cancer Risk with EPA RSL Calculations, Parameters, and Toxicity Factors				Residential		Industrial		Groundwater Target to be Protected[1]	Three-phase Partitioning Between Soil, Soil Vapor, and Groundwater Using MTCA Equation[2,3]
CAS Number	Chemical	Cancer (mg/kg)	Non-Cancer (mg/kg)	Cancer (mg/kg)	Non-Cancer (mg/kg)	Ingestion (mg/kg)	Dermal (mg/kg)	Inhalation (mg/kg)	TOTAL (mg/kg)	Ingestion (mg/kg)	Dermal (mg/kg)	Inhalation (mg/kg)	TOTAL (mg/kg)	Ingestion (mg/kg)	Dermal (mg/kg)	Inhalation (mg/kg)	TOTAL (mg/kg)	Ingestion (mg/kg)	Dermal (mg/kg)	Inhalation (mg/kg)	TOTAL (mg/kg)	Cancer (mg/kg)	Non-Cancer (mg/kg)	Cancer (mg/kg)	Non-Cancer (mg/kg)	(mg/kg)	(mg/kg)
Metals																											
7429-90-5	Aluminum	--	7.98E+04	--	3.5E+06	--	--	--	--	7.8E+04	--	7.1E+06	7.7E+04	--	--	--	--	5.1E+05	--	3.0E+07	5.0E+05	--	7.7E+04	--	5.0E+05	8.7E+01	--
7440-36-0	Antimony (metallic)	--	3.19E+01	--	1.4E+03	--	--	--	--	3.1E+01	--	--	3.1E+01	--	--	--	--	2.0E+02	--	--	2.0E+02	--	3.1E+01	--	2.0E+02	1.5E+02	7.8E+02
7440-38-2	Arsenic (inorganic)	6.7E-01	2.39E+01	8.8E+01	1.0E+03	4.3E-01	4.5E+00	7.7E+02	3.9E-01	2.3E+01	2.8E+02	2.1E+04	2.2E+01	9.5E+00	9.6E+01	3.9E+04	8.7E+00	1.5E+02	1.5E+03	8.9E+04	1.4E+02	3.9E-01	2.2E+01	8.7E+00	1.4E+02	8.0E+00	--
7440-39-3	Barium	--	1.60E+04	--	7.0E+05	--	--	--	--	1.6E+04	--	7.1E+05	1.5E+04	--	--	--	--	1.0E+05	--	3.0E+06	9.9E+04	--	1.5E+04	--	9.9E+04	1.2E+02	1.0E+02
7440-41-7	Beryllium	--	1.60E+02	--	7.0E+03	--	--	1.4E+03	1.4E+03	1.6E+02	--	2.8E+04	1.6E+02	--	--	6.9E+04	6.9E+04	1.0E+03	--	1.2E+05	1.0E+03	1.4E+03	1.6E+02	6.9E+04	1.0E+03	1.2E+01	3.1E+02
7440-43-9	Cadmium	--	7.98E+01	--	3.5E+03	--	--	1.8E+03	1.8E+03	7.8E+01	7.0E+02	1.4E+04	7.0E+01	--	--	9.3E+04	9.3E+04	5.1E+02	3.9E+03	6.0E+04	4.5E+02	1.8E+03	7.0E+01	9.3E+04	4.5E+02	2.5E-01	4.0E+00
18540-29-9	Chromium(VI)	--	2.39E+02	--	1.0E+04	1.3E+00	--	3.9E+01	1.2E+00	2.3E+02	--	1.4E+05	2.3E+02	2.9E+01	--	2.0E+03	2.8E+01	1.5E+03	--	6.0E+05	1.5E+03	1.2E+00	2.3E+02	2.8E+01	1.5E+03	5.8E-01	--
7440-48-4	Cobalt	--	2.39E+01	--	1.0E+03	--	--	3.7E+02	3.7E+02	2.3E+01	--	8.5E+03	2.3E+01	--	--	1.9E+04	1.9E+04	1.5E+02	--	3.6E+04	1.5E+02	3.7E+02	2.3E+01	1.9E+04	1.5E+02	4.8E+00	1.2E+01
7440-50-8	Copper	--	3.19E+03	--	1.4E+05	--	--	--	--	3.1E+03	--	--	3.1E+03	--	--	--	--	2.0E+04	--	--	2.0E+04	--	3.1E+03	--	2.0E+04	8.0E+00	8.0E+01
7439-89-6	Iron	--	5.58E+04	--	2.4E+06	--	--	--	--	5.5E+04	--	--	5.5E+04	--	--	--	--	3.6E+05	--	--	3.6E+05	--	5.5E+04	--	3.6E+05	1.0E+03	--
7439-92-1	Lead	--	2.50E+02	--	1.0E+03	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.5E+02	--	1.0E+03	2.5E+00	7.9E+02
7439-96-5	Manganese (non-diet)	--	1.91E+03	--	8.4E+04	--	--	--	--	1.9E+03	--	7.1E+04	1.8E+03	--	--	--	--	1.2E+04	--	3.0E+05	1.2E+04	--	1.8E+03	--	1.2E+04	2.0E+03	--
7439-97-6	Mercury (elemental)	--	2.39E+01	--	1.0E+03	--	--	--	--	1.3E+01	--	1.0E+01	5.6E+00	--	--	--	--	8.2E+01	--	4.2E+01	2.8E+01	--	5.6E+00	--	2.8E+01	1.2E-02	1.5E+00
7487-94-7	Mercury (inorganic salts)	--	2.39E+01	--	1.0E+03	--	--	--	--	2.3E+01	--	--	2.3E+01	--	--	--	--	1.5E+02	--	--	1.5E+02	--	2.3E+01	--	1.5E+02	4.8E+00	--
22967-92-6	Mercury (methyl mercury)	--	7.98E+00	--	3.5E+02	--	--	--	--	7.8E+00	--	--	7.8E+00	--	--	--	--	5.1E+01	--	--	5.1E+01	--	7.8E+00	--	5.1E+01	3.0E-01	3.8E+00
7439-98-7	Molybdenum	--	3.99E+02	--	1.7E+04	--	--	--	--	3.9E+02	--	--	3.9E+02	--	--	--	--	2.6E+03	--	--	2.6E+03	--	3.9E+02	--	2.6E+03	8.0E+01	2.0E+01
7440-02-0	Nickel	--	1.60E+03	--	7.0E+04	--	--	1.3E+04	1.3E+04	1.6E+03	--	1.3E+05	1.5E+03	--	--	6.4E+05	6.4E+05	1.0E+04	--	5.4E+05	1.0E+04	1.3E+04	1.5E+03	6.4E+05	1.0E+04	8.2E+00	2.1E+02
7782-49-2	Selenium	--	3.99E+02	--	1.7E+04	--	--	--	--	3.9E+02	--	2.8E+07	3.9E+02	--	--	--	--	2.6E+03	--	1.2E+08	2.6E+03	--	3.9E+02	--	2.6E+03	5.0E+00	1.0E+00
7440-22-4	Silver	--	3.99E+02	--	1.7E+04	--	--	--	--	3.9E+02	--	--	3.9E+02	--	--	--	--	2.6E+03	--	--	2.6E+03	--	3.9E+02	--	2.6E+03	2.2E+01	1.7E+02
7440-31-5	Tin	--	4.79E+04	--	2.1E+06	--	--	--	--	4.7E+04	--	--	4.7E+04	--	--	--	--	3.1E+05	--	--	3.1E+05	--	4.7E+04	--	3.1E+05	9.6E+03	1.5E+05
1314-62-1	Vanadium (as vanadium pentoxide)	--	7.18E+02	--	3.1E+04	--	--	--	--	7.0E+02	--	--	7.0E+02	--	--	--	--	4.6E+03	--	--	4.6E+03	--	7.0E+02	--	4.6E+03	1.4E+02	2.9E+03
7440-66-6	Zinc (metallic)	--	2.39E+04	--	1.0E+06	--	--	--	--	2.3E+04	--	--	2.3E+04	--	--	--	--	1.5E+05	--	--	1.5E+05	--	2.3E+04	--	1.5E+05	5.6E+01	1.4E+03
Other Inorganics																											
57-12-5	Cyanide (free)	--	1.60E+03	--	7.0E+04	--	--	--	--	1.6E+03	--	--	1.6E+03	--	--	--	--	1.0E+04	--	--	1.0E+04	--	1.6E+03	--	1.0E+04	1.0E+00	2.0E+01
74-90-8	Cyanide (hydrogen)	--	4.79E+01	--	2.1E+03	--	--	--	--	4.7E+01	--	5.1E+00	4.6E+00	--	--	--	--	3.1E+02	--	2.1E+01	2.0E+01	--	4.6E+00	--	2.0E+01	1.6E+00	--

Notes:

1 Refer to Table A.1b,Groundwater Standards, Criteria, and Risk-based Calculations, of this attachment.
2 WAC 173-340-747, equations 747-1 and 747-2.
3 When Henry's constant is not available for use in the 3-phase partitioning equation (i.e., when "--" is displayed in place of a value), a value of 0 is used as a surrogate (see Table A1.g for Henry's constants).

Abbreviations:

CAS Chemical abstract number
CLARC Cleanup Levels and Risk Calculation
Ecology Washington State Department of Ecology
EPA U.S. Environmental Protection Agency
MTCA Model Toxics Control Act
RSL Regional screening level

Table A.1d
Soil Equations and Parameters

Ecology — **Soil Cleanup Levels from Non-cancer Effects for Ingestion Only**

Equation 740-1 Non-cancer

Soil Cleanup Level (mg/kg) = **EPA $SSL_{SOIL\text{-}NC\text{-}ING}$ =**

$$\frac{(RfD_o \times ABW \times UCF \times HQ \times AT)}{(SIR \times AB1 \times EF \times ED)}$$

Terminology in MTCA:

RfD_o = Reference dose (mg/kg-day), as specified in WAC 173-340-708(7)
ABW = Average body weight (kg) over the exposure duration
UCF = 1,000,000 mg/kg
SIR = Soil ingestion rate (mg/kg)
AB1 = Gastrointestinal absorption fraction
HQ = Hazard quotient (unitless)
AT = Averaging time (years)
ED = Exposure duration (years)
EF = Exposure frequency (fraction of time)

Terminology in EPA RSL Equation:

=	BW	Body weight (kg)
=	same	
=	IRS	Ingestion rate soil (mg/day)
=	not used	
=	THQ	Target hazard quotient (unitless)
=	AT	Averaging time (days)
=	ED	Exposure duration (years)
=	EF	Exposure frequency (days/year)

Exposure Scenarios	RfD_o (mg/kg-day)	ABW (kg)	HQ (unitless)	AT (years)	SIR (mg/day)	AB1 (unitless)	EF (unitless)	ED (years)	Assumptions for Unitless EF Term: Total Days (days)	hours/day (unitless)	days/week (unitless)	weeks/year (unitless)
MTCA Method B Residential Child	<table>	16	1	6	200	1	1.00	6	365	24	7	52
MTCA Method C Worker	<table>	70	1	20	50	1	0.40	20	350	10	7	50
EPA RSL Residental Child	<table>	15	1	6	200	1	0.96	6	350			
EPA RSL Residental Adult	<table>	70	1	25	100	1	0.96	25	350			
Modified EPA RSL Worker[1,2]	<table>	70	1	25	200	1	0.68	25	250			

EPA RSL — **Soil Screening Levels from Non-cancer Effects**

Soil Screening Level (mg/kg) =

$$\frac{1}{\frac{1}{SSL_{SOIL\text{-}NC\text{-}ING}} + \frac{1}{SSL_{SOIL\text{-}NC\text{-}DER}} + \frac{1}{SSL_{SOIL\text{-}NC\text{-}INH}}}$$

< ---------- Ingestion of Soil Term ----------> < ------ Dermal Contact with Soil Term -------> < ---------- Inhalation of Dust ----------->

$SSL_{SOIL\text{-}NC\text{-}ING}$ = **Use the MTCA equation above for ingestion.**

$$SSL_{SOIL\text{-}NC\text{-}DER} = \frac{THQ \times BW \times AT \times RfD_d \times UCF1}{EF \times ED \times SA \times AF \times ABS_d} = \frac{RfD_d}{ABS_d} \times \frac{THQ \times BW \times AT \times UCF1}{EF \times ED \times SA \times AF}$$

$$SSL_{SOIL\text{-}NC\text{-}INH} = \frac{THQ \times AT}{(1/RfC_i) \times EF \times ED \times ET \times UCF2 \times [(1/PEF) + (1/VF)]} = \frac{RfC_i}{[1/VF + 1/PEF]} \times \frac{THQ \times AT}{EF \times ED \times ET \times UCF2}$$

THQ = Target hazard quotient (or HQ for hazard quotient), unitless
BW = Body weight (kg)
AT = Averaging time (total number of days in the averaging time: 6 years for children; 25 years for workers)
RfD_d = Dermal reference dose (mg/kg-day) = RfD_o * GI-abs
GI-abs = GI absorption factor correction
UCF1 = 1,000,000 mg/kg
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
ET = Exposure time (hours/day)
SA = Surface area exposed (cm^2/day)
AF = Adherence factor (mg/cm^2)
ABS_d = Skin absorption factor (unitless)
RfC_i = Reference concentration, inhalation (mg/m^3; chemical specific)
PEF = Particulate emission factor used for dusts (m^3/kg; 1.4 E+9 from EPA RSL User Manual)
VF = Volatilization factor used for volatile organic compounds (m^3/kg; chemical specific)
UCF2 = 1/24 day/hour

Source: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

Exposure Scenarios	THQ (unitless)	BW (kg)	AT (days)	RfD_d (mg/kg-day)	ED (years)	EF (days/year)	ET (hours/day)	IRS (mg/day)	SA (cm^2/day)	AF (mg/cm^2)	ABS_d (unitless)	RfC_i (mg/m^3)	VF (m^3/kg)	PEF (m^3/kg)	1/VF + 1/PEF (m^3/kg)
EPA RSL Residential (Child)	1	15	2,190	<table>	6	350	24	200	2,800	0.2	<table>	<table>	<table>	1.36E+09	<table>
Modified EPA RSL Worker[1,2]	1	70	9,125	<table>	25	250	8	200	3,300	0.2	<table>	<table>	<table>	1.36E+09	<table>

Ecology — **Soil Cleanup Levels from Cancer Risk for Ingestion Only**

Equation 740-2 Cancer

Soil cleanup level (mg/kg) =

$$\frac{(RISK \times ABW \times AT \times UCF)}{(CPF_o \times SIR \times AB1 \times ED \times EF)}$$

RISK = Acceptable excess individual lifetime cancer risk (unitless)
ABW = Average body weight (kg) over the exposure duration
AT = Averaging time (years)
UCF = 1,000,000 mg/kg
CPF_o = Carcinogenic potency factor (kg-day/mg)
SIR = Soil ingestion rate (mg/day)
AB1 = Gastrointestinal absorbtion fraction (unitless)
ED = Exposure duration (years)
EF = Exposure frequency (unitless)

Exposure Scenarios	RISK (unitless)	ABW (kg)	AT (years)	CPF_o (kg-day/mg)	SIR (mg/day)	AB1 (unitless)	ED (years)	EF (unitless)	Assumptions for EF Term: hours/day (unitless)	days/week (unitless)	weeks/year (unitless)
DEFAULT MTCA Method B	1.00E-06	16	75	<table>	200	1	6	1.00	24	7	52
DEFAULT MTCA Method C	1.00E-05	70	75	<table>	50	1	20	0.40	24	7	52

Table A.1d
Soil Equations and Parameters

EPA RSL — **Soil Screening Levels from Cancer Risk for Residents (childhood corrected) and Workers**

< ---------- Ingestion of Soil Term ----------> < ------ Dermal Contact with Soil Term -------> < ---------- Inhalation of Dust ---------->

$$\text{Soil Screening Level (mg/kg)} = \frac{1}{\frac{1}{SSL_{SOIL\text{-}CA\text{-}ING}} + \frac{1}{SSL_{SOIL\text{-}CA\text{-}DER}} + \frac{1}{SSL_{SOIL\text{-}CA\text{-}INH}}}$$

$$SSL_{SOIL\text{-}CA\text{-}ING} = \frac{TR \times AT}{CSF_o \times EF \times IFS \times UCF1} \quad \text{where} \quad IFS = \frac{ED_c \times IRS_c}{BW_c} + \frac{ED_a \times IRS_a}{BW_a}$$

$$SSL_{SOIL\text{-}CA\text{-}DER} = \frac{TR \times AT}{CSF_d \times EF \times DFS \times ABS_d \times UCF1} \quad \text{where} \quad DFS = \frac{ED_c \times SA_c \times AF_c}{BW_c} + \frac{ED_a \times SA_a \times AF_a}{BW_a} \quad \text{and where} \quad CSF_d = CSF_o * \text{GI-Abs}$$

$$SSL_{SOIL\text{-}NC\text{-}INH} = \frac{TR \times AT}{IUR \times UCF2 \times EF \times ED \times ET \times UCF3 \times [(1/PEF) + (1/VF)]} = \frac{1}{IUR*[1/VF + 1/PEF]} \times \frac{TR \times AT}{UCF2 \times EF \times ED \times ET \times UCF3}$$

TR = Target excess individual lifetime cancer risk (unitless)
AT = Averaging time in days = 365 day/year * Lifetime (years)
CSF_o = Oral cancer slope factor (kg-day/mg)
EF = Exposure frequency (days/year)
IFS = Resident soil ingestion rate; age-adjusted (mg-year/kg-day)
UCF1 = 1.0E-6 kg/mg
ED_c = Exposure duration, child (years)
IRS_c = Resident soil ingestion rate, child; age-adjusted (mg-year/kg-day)
BW_c = Body weight, child (kg)
ED_a = Exposure duration, adult (years)
IRS_a = Resident soil ingestion rate, adult; age-adjusted (mg-year/kg-day)
BW_a = Body weight, adult (kg)
CSF_d = Cancer slope factor, dermal = CSF_o*GI-abs
GI-abs = GI absorption factor correction
DFS = Resident soil dermal contact factor; age-adjusted (mg-year/kg-day)
ABS_d = Skin absorption factor (unitless, chemical specific)
SA_c = Surface area, child (cm^2/day)
AF_c = Adherence factor, child (mg/cm^2)
SA_a = Surface area, adult (cm^2/day)
AF_a = Adherence factor, adult (mg/cm^2)
IUR = Inhalation unit rate (m^3/µg)
UCF2 = 1000 (µg/mg)
UCF3 = 1/24 (day/hour)
ED = Exposure duration (years)
ET = Exposure time (hours/day)
PEF = Particulate emission factor used for dusts (m^3/kg)
VF = Volatilization factor used for volatile organic compounds (m^3/kg)

Source: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

Exposure Scenarios	TR (unitless)	AT (days)	LT (years)	CSF_o (kg-day/mg)	EF (days/year)	ET (hours/day)	IFS (mg-year/kg-day)	IRS (mg-year/kg-day)	ED (years)	BW (kg)	DFS (mg-year/kg-day)	SA (cm^2/day)	AF (mg/cm^2)	ABS (unitless)	IUR (m^3/µg)	PEF (m^3/kg)	VF (m^3/kg)	1/VF + 1/PEF (m^3/kg)
EPA RSL Resident	1.00E-06	25,550	70	<table>	350	24	114		30		361			<table>	<table>	1.36E+09	<table>	<table>
contribution during childhood							80	200	6	15	224	2,800	0.2					
contribution during adult years							34	100	24	70	137	5,700	0.07					
Modified EPA RSL Worker[1,2]	1.00E-05	25,550	70	<table>	250	8	71	200	25	70	236	3,300	0.2	<table>	<table>	1.36E+09	<table>	<table>

Ecology — **Three-phase Partitioning Between Soil, Soil Vapor, and Groundwater Using MTCA Equation**

Equation 747-1 — **Soil Concentration (mg/kg)**

$$C_s = C_w \times UCF \times DF \times \left(K_d + \frac{(\theta_w + \theta a H_{cc})}{\rho_b}\right) = C_w \times UCF \times DF \times K_d + \frac{C_w \times UCF \times DF \times \theta_w}{\rho_b} + \frac{C_w \times UCF \times DF \times \theta_a \times H_{cc}}{\rho_b} = C_w * (C1*K_d + C2 + C3*H_{cc})$$

where $C1 = UCF \times DF$

$C2 = \frac{UCF \times DF \times \theta_w}{\rho_b}$

$C3 = \frac{UCF \times DF \times \theta_a}{\rho_b}$

C_w = Ground water cleanup level established under WAC 173-340-720 (µg/L)
UCF = 1/1,000 (mg/µg)
DF = Dilution factor (dimensionless)
K_d = Distribution coefficient (L/kg)
θ_w = Water-filled soil porosity (ml water/ml soil)
θ_a = Air-filled soil porosity (ml air/ml soil)
H_{cc} = Henry's law constant (dimensionless)
ρ_b = Dry soil bulk density (kg/L)

Exposure Scenarios	C_w (µg/L)	DF (unitless)	K_d (L/kg)	θ_w (ml water/ ml soil)	θ_a (ml air/ ml soil)	H_{cc} (unitless)	ρ_b (kg/L)	C1 (mg/µg)	C2 (L-ml water/ ml soil)	C3 (L-ml air/ ml soil)
Soil Concentration for Saturated Soil	<table>	20	<table>	0.3	0.13	<table>	1.5	0.02	0.004	0.002

Notes:

[ ] Indicates no value is required in calculations for the associated exposure scenario indicated.
<table> Indicates a chemical-specific factor is available in the associated tables of this attachment.
1 EPA RSL Worker scenario has been modified to a 1 in 100,000 excess individual lifetime cancer risk and a soil ingestion rate of 200 mg/kg-day by an EPA Region 10 risk management decision.
2 Exposure frequency taken to be 250 days/year. This value was selected based on Region 9 EPA RSL tables last updated November 2010, which uses parameters associated with an indoor worker to calculate risk.

Abbreviations:

EPA U.S. Environmental Protection Agency
MTCA Model Toxics Control Act
RSL Regional screening level
SSL Soil Screening Level

Subscripts:

CA Cancer
DER Dermal
ING Ingestion
INH Inhalation
NC Non-cancer

Table A.1e
Groundwater Calculations

		Surface Water to Fish Consumption Pathway														Drinking Water Pathways			
						Ecology MTCA Calculations						Proposed Water to Fish Consumption TMCLs				EPA		Ecology	
		Tribal Consumption Child Includes EPA BCFs and Toxicity Factors[1]		Tribal Consumption Adult Includes EPA BCFs and Toxicity Factors[1]		Default (Recreational) Includes EPA BCFs and Toxicity Factors[2]		Asian/Pacific Islander Consumption Child Includes EPA BCFs and Toxicity Factors[3]		Asian/Pacific Islander Consumption Adult Includes EPA BCFs and Toxicity Factors[3]		MTCA Default Consumption Rate Modified to Use EPA Toxicity and Partitioning Coefficients		Tribal and/or Asian/Pacific Islander Modified to Use EPA Toxicity and Partitioning Coefficients		EPA RSL Tap Water[4]		MTCA Method B Groundwater to Protect Drinking Water Use[5]	
CAS Number	Chemical	Cancer (µg/L)	Non-cancer (µg/L)	Cancer (µg/L)	Non-cancer (µg/L)	Cancer (µg/L)	Non-cancer (µg/L)	Cancer (µg/L)	Non-cancer (µg/L)	Cancer (µg/L)	Non-cancer (µg/L)	TMCL (µg/L)	Source (µg/L)	TMCL (µg/L)	Source (µg/L)	Cancer (µg/L)	Non-cancer (µg/L)	Cancer (µg/L)	Non-cancer (µg/L)
Metals																			
7429-90-5	Aluminum	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3.7E+04	--	1.6E+04
7440-36-0	Antimony (metallic)	--	1.5E+02	--	3.4E+02	--	1.0E+03	--	2.6E+02	--	4.4E+02	1.0E+03	MTCA B	1.5E+02	Tribal Child	--	1.5E+01	--	6.4E+00
7440-38-2	Arsenic (inorganic)	2.6E-02	1.0E+00	5.4E-03	2.2E+00	3.8E-02	6.8E+00	4.4E-02	1.7E+00	1.9E-02	2.9E+00	3.8E-02	MTCA B	5.4E-03	Tribal Adult	4.5E-02	1.1E+01	5.8E-02	4.8E+00
7440-39-3	Barium	--	1.2E+02	--	2.7E+02	--	8.2E+02	--	2.1E+02	--	3.5E+02	8.2E+02	MTCA B	1.2E+02	Tribal Child	--	7.3E+03	--	3.2E+03
7440-41-7	Beryllium	--	1.2E+01	--	2.7E+01	--	8.4E+01	--	2.1E+01	--	3.6E+01	8.4E+01	MTCA B	1.2E+01	Tribal Child	--	7.3E+01	--	3.2E+01
7440-43-9	Cadmium	--	4.3E-01	--	9.3E-01	--	2.9E+00	--	7.2E-01	--	1.2E+00	2.9E+00	MTCA B	4.3E-01	Tribal Child	--	1.8E+01	--	8.0E+00
18540-29-9	Chromium (VI)	2.8E+00	3.6E+02	5.8E-01	7.9E+02	4.1E+00	2.4E+03	4.8E+00	6.1E+02	2.0E+00	1.0E+03	4.1E+00	MTCA B	5.8E-01	Tribal Adult	4.3E-02	1.1E+02	--	4.8E+01
7440-48-4	Cobalt	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.1E+01	--	4.8E+00
7440-50-8	Copper	--	4.3E+02	--	9.4E+02	--	2.9E+03	--	7.2E+02	--	1.2E+03	2.9E+03	MTCA B	4.3E+02	Tribal Child	--	1.5E+03	--	6.4E+02
7439-89-6	Iron	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.6E+04	--	1.1E+04
7439-92-1	Lead	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
7439-96-5	Manganese (non-diet)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	8.8E+02	--	3.8E+02
7439-97-6	Mercury (elemental)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5.7E-01	--	4.8E+00
7487-94-7	Mercury (inorganic salts)[6]	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	4.8E+00
22967-92-6	Mercury (methyl mercury)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3.7E+00	--	1.6E+00
7439-98-7	Molybdenum	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.8E+02	--	8.0E+01
7440-02-0	Nickel	--	9.9E+01	--	2.2E+02	--	6.6E+02	--	1.7E+02	--	2.8E+02	6.6E+02	MTCA B	9.9E+01	Tribal Child	--	7.3E+02	--	3.2E+02
7782-49-2	Selenium	--	1.5E+01	--	3.3E+01	--	1.0E+02	--	2.5E+01	--	4.3E+01	1.0E+02	MTCA B	1.5E+01	Tribal Child	--	1.8E+02	--	8.0E+01
7440-22-4	Silver	--	2.2E+01	--	4.8E+01	--	1.5E+02	--	3.7E+01	--	6.3E+01	1.5E+02	MTCA B	2.2E+01	Tribal Child	--	1.8E+02	--	8.0E+01
7440-31-5	Tin	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.2E+04	--	9.6E+03
7440-62-2	Vanadium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.8E+02	--	1.4E+02
7440-66-6	Zinc (metallic)	--	5.6E+01	--	1.2E+02	--	3.8E+02	--	9.5E+01	--	1.6E+02	3.8E+02	MTCA B	5.6E+01	Tribal Child	--	1.1E+04	--	4.8E+03
Other Inorganics																			
57-12-5	Cyanide (free)	--	2.4E+03	--	5.3E+03	--	1.6E+04	--	4.1E+03	--	7.0E+03	1.6E+04	MTCA B	2.4E+03	Tribal Child	--	7.3E+02	--	3.2E+02
74-90-8	Cyanide (hydrogen)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.6E+00	--	9.6E+00

Notes:

1 MTCA Method B Equations 730-1 and 730-2 modified to apply Tribal fish ingestion rates, body weights, and exposure duration (Ecology 2007). Refer to associated tables in this attachment for toxicity factors, bioconcentration factors, and exposure parameters.

2 MTCA Method B Equations 730-1 and 730-2 using default exposure assumptions. Refer to associated tables in this attachment for toxicity factors, bioconcentration factors, and exposure parameters.

3 MTCA Method B Equations 730-1 and 730-2 modified to apply Asian/Pacific Islander fish ingestion rates, body weights, and exposure duration (Ecology 2007). Refer to associated tables in this attachment for toxicity factors, bioconcentration factors, and exposure parameters.

4 EPA RSL, Residential Tapwaters; http://www.epa.gov/region9/superfund/prg/.

5 MTCA Method B Equations 720-1 and 720-2; groundwater cleanup levels to protect drinking water use.

6 Mercuric chloride used as a surrogate.

Abbreviations:

BCF Bioconcentration factor
CAS Chemical abstract number
Ecology Washington State Department of Ecology
EPA U.S. Environmental Protection Agency
MTCA Model Toxics Control Act
RSL Regional screening level

Table A.1f
Groundwater Equations and Parameters

Surface Water to Fish Consumption by Humans: Non-cancer Effects

$$\text{Surface Water Cleanup or Screening Level } (\mu g/L) = \frac{(RfD_o \times ABW \times UCF1 \times UCF2 \times HQ \times AT)}{(BCF \times FCR \times FDF \times ED)}$$

RfD_o = Oral reference dose (mg/kg-day)
ABW = Average body weight (kg)
UCF1 = 1,000 g/mg
UCF2 = 1,000 g/L
HQ = Hazard quotient (unitless)
AT = Averaging time (years)
BCF = Bioconcentration factor (L/kg)
FCR = Fish consumption rate (g/day)
FDF = Fish diet fraction (unitless)
ED = Exposure duration (years)

Exposure Scenarios	RfD_o (mg/kg-day)	ABW (kg)	HQ (unitless)	AT (years)	BCF (L/kg)	FCR (g/day)	FDF (unitless)	ED (years)
MTCA Default[1]	<table>	70	1	30	<table>	54	0.50	30
MTCA Asian/Pacific Islander Child[2,3]	<table>	15	1	6	<table>	23	1.00	6
MTCA Asian/Pacific Islander Adult[2,3]	<table>	63	1	24	<table>	57	1.00	24
EPA Tribal Child[3,4]	<table>	15	1	6	<table>	39	1.00	6
EPA Tribal Adult[3,4]	<table>	81.8	1	64	<table>	97	1.00	64

Surface Water to Fish Consumption by Humans: Cancer

$$\text{Surface Water Cleanup or Screening Level } (\mu g/L) = \frac{(RISK \times ABW \times UCF1 \times UCF2 \times AT)}{(CPF_o \times BCF \times FCR \times FDF \times ED)}$$

Risk = Acceptable excess individual lifetime cancer risk (unitless)
ABW = Average body weight (kg)
UCF1 = 1,000 µg/mg
UCF2 = 1,000 g/L
AT = Averaging time (years)
CPF_o = Cancer potency factor (kg-day/mg)
BCF = Bioconcentration factor (L/kg)
FCR = Fish consumption rate (g/day)
FDF = Fish diet fraction (unitless)
ED = Exposure duration (years)

Exposure Scenarios	Risk (unitless)	ABW (kg)	AT (years)	CPF_o (kg-day/mg)	BCF (L/kg)	FCR (g/day)	FDF (unitless)	ED (years)
MTCA Default[1]	1.00E-06	70	75	<table>	<table>	54	0.50	30
MTCA Asian/Pacific Islander Child[2,3]	1.00E-06	15	70	<table>	<table>	23	1.00	6
MTCA Asian/Pacific Islander Adult[2,3]	1.00E-06	63	70	<table>	<table>	57	1.00	24
EPA Tribal Child[3,4]	1.00E-06	15	70	<table>	<table>	39	1.00	6
EPA Tribal Adult[3,4]	1.00E-06	81.8	70	<table>	<table>	97	1.00	64

Groundwater (as Drinking Water) Cleanup Levels: Non-cancer Effects

$$\text{Groundwater Cleanup or Screening Level } (\mu g/L) = \frac{(RfD_o \times ABW \times UCF \times HQ \times AT)}{(DWIR \times INH \times DWF \times ED)}$$

RfD_o = Oral reference dose (mg/kg-day)
ABW = Average body weight (kg)
UCF = 1,000 µg/mg
HQ = Hazard quotient (unitless)
AT = Averaging time (years)
DWIR = Drinking water ingestion rate (L/day)
INH = Inhalation correction factor (unitless)
DWF = Drinking water fraction (unitless)
ED = Exposure duration (years)

Exposure Scenarios	RfD_o (mg/kg-day)	ABW (kg)	HQ (unitless)	AT (years)	DWIR (L/day)	INH (unitless)	DWF (unitless)	ED (years)
MTCA Default[1]	<table>	16	1	6	1	1	1.00	6

Groundwater (as Drinking Water) Cleanup Levels: Cancer

$$\text{Groundwater Cleanup or Screening Level } (\mu g/L) = \frac{(RISK \times ABW \times UCF \times AT)}{(CPF_o \times DWIR \times INH \times DWF \times ED)}$$

Risk = Acceptable excess individual lifetime cancer risk level (unitless)
ABW = Average body weight (kg)
UCF = 1,000 µg/mg
AT = Averaging time (years)
CPF_o = Cancer potency factor (kg-day/mg)
DWIR = Drinking water ingestion rate (L/day)
INH = Inhalation correction factor (unitless)
DWF = Drinking water fraction (unitless)
ED = Exposure duration (years)

Exposure Scenarios	Risk (unitless)	ABW (kg)	AT (years)	CPF_o (kg-day/mg)	DWIR (L/day)	INH (unitless)	DWF (unitless)	ED (years)
MTCA Default[1]	1.00E-06	70	75	<table>	2	1	1.00	30

Notes:

<table> Indicates a chemical-specific factor is available in the associated tables of this attachment.
1 All parameters derived from Model Toxics Control Act (MTCA) WAC 173-340-730, equations 730-1 and 730-2.
2 Fish consumption rates derived from Washington State Department of Ecology (Ecology) 2009: MTCA Regulation Update Summary, Fish Consumption Rates for High Exposure Populations.
3 Fish consumption rates include both finfish and shellfish, and exclude salmon.
4 All parameters derived from U.S Environmental Protection Agenecy (EPA) Region 10, 2007: Framework for Selecting and Using Tribal Fish and Shellfish Consumption Rates for Risk-based Decision Making.

Table A.1g
Cross-Media Factors

		Other Chemical Factors					Bioconcentration Factors							
		EPA R10					EPA R10		Ecology MTCA/CLARC		Others		Selected for Use	
CAS Number	Chemical	GI Absorption Conversion Factor (unitless)	Dermal Absorption Fraction (unitless)	Volatilization Factor (m^3/kg)	Source For Preceeding Factors	(1/VF + 1/PEF) (kg/m^3)	Water to Fish BCF[1] (L/kg)	Source	Water to Fish BCF[2] (L/kg)	Source	Water to Fish BCF (L/kg)	Source	Water to Fish BCF (L/kg)	Source
Metals														
7429-90-5	Aluminum	1.0E+00	--	--	EPA RSL 2010	7.4E-10	--	--	--	--	--	--	--	--
7440-36-0	Antimony (metallic)	1.5E-01	--	--	EPA RSL 2010	7.4E-10	1.0E+00	ATSDR 1992	1.0E+00	AWQC Gold Book	4.0E+01	HHRAP	1.0E+00	ATSDR 1992
7440-38-2	Arsenic (inorganic)[3]	1.0E+00	3.0E-02	--	EPA RSL 2010	7.4E-10	1.1E+02	HHRAP	4.4E+01	AWQC Gold Book	--	--	1.1E+02	HHRAP
7440-39-3	Barium	7.0E-02	--	--	EPA RSL 2010	7.4E-10	6.3E+02	HHRAP	--		--	--	6.3E+02	HHRAP
7440-41-7	Beryllium	7.0E-03	--	--	EPA RSL 2010	7.4E-10	6.2E+01	HHRAP	1.9E+01	AWQC Gold Book	--	--	6.2E+01	HHRAP
7440-43-9	Cadmium	2.5E-02	1.0E-03	--	EPA RSL 2010	7.4E-10	9.1E+02	HHRAP	6.4E+01	AWQC Gold Book	--	--	9.1E+02	HHRAP
18540-29-9	Chromium(VI)[3]	2.5E-03	--	--	EPA RSL 2010	7.4E-10	3.2E+00	HHRAP	1.6E+01	AWQC Gold Book	--	--	3.2E+00	HHRAP
7440-48-4	Cobalt	1.0E+00	--	--	EPA RSL 2010	7.4E-10	--	--	--	--	--	--	--	--
7440-50-8	Copper	1.0E+00	--	--	EPA RSL 2010	7.4E-10	3.6E+01	HHRAP	3.6E+01	AWQC Gold Book	--	--	3.6E+01	HHRAP
7439-89-6	Iron	1.0E+00	--	--	EPA RSL 2010	7.4E-10	--	--	--	--	--	--	--	--
7439-92-1	Lead	1.0E+00	--	--	EPA RSL 2010	7.4E-10	9.00E-02	HHRAP	--	--	--	--	9.00E-02	HHRAP
7439-96-5	Manganese (non-diet)[3]	4.0E-02	--	--	EPA RSL 2010	7.4E-10	--	--	--	--	--	--	--	--
7439-97-6	Mercury (elemental)[5]	1.0E+00	--	3.2E+04	EPA RSL 2010	3.1E-05	--	--	--	--	--	--	--	--
7487-94-7	Mercury (inorganic salts)	7.0E-02	--	--	EPA RSL 2010	7.4E-10	--	--	--	--	--	--	--	--
22967-92-6	Mercury (methyl mercury)	1.0E+00	--	--	EPA RSL 2010	7.4E-10	--	--	--	--	--	--	--	--
7439-98-7	Molybdenum	1.0E+00	--	--	EPA RSL 2010	7.4E-10	--	--	--	--	--	--	--	--
7440-02-0	Nickel	4.0E-02	--	--	EPA RSL 2010	7.4E-10	7.8E+01	HHRAP	4.7E+01	AWQC Gold Book	--	--	7.8E+01	HHRAP
7782-49-2	Selenium	1.0E+00	--	--	EPA RSL 2010	7.4E-10	1.3E+02	HHRAP	4.8E+00	AWQC Gold Book	--	--	1.3E+02	HHRAP
7440-22-4	Silver	4.0E-02	--	--	EPA RSL 2010	7.4E-10	8.8E+01	HHRAP	5.0E-01	AWQC Gold Book	--	--	8.8E+01	HHRAP
7440-31-5	Tin	1.0E+00	--	--	EPA RSL 2010	7.4E-10	--	--	--	--	--	--	--	--
7440-62-2	Vanadium	2.6E-02	--	--	EPA RSL 2010	7.4E-10	--	--	--	--	--	--	--	--
7440-66-6	Zinc (metallic)	1.0E+00	--	--	EPA RSL 2010	7.4E-10	2.1E+03	HHRAP	4.7E+01	AWQC Gold Book	--	--	2.1E+03	HHRAP
Other Inorganics														
57-12-5	Cyanide (free)	1.0E+00	--	5.0E+04	EPA RSL 2010	2.0E-05	3.2E+00	HHRAP	1.0E+00	AWQC Gold Book	--	--	3.2E+00	HHRAP
74-90-8	Cyanide (hydrogen)	1.0E+00	--	6.1E+03	EPA RSL 2010	1.6E-04	--	--	--	--	--	--	--	--

Table A.1g
Cross-Media Factors

CAS Number	Chemical	Soil to Water Partitioning								Air to Water Partitioning	
		EPA R10		Ecology MTCA/CLARC		Others		Selected for Use[4]		Selected for Use	
		Distribution Coefficient (K_d)[3] (L/kg)	Source	Distribution Coefficient (K_d)[3] (L/kg)	Source	Distribution Coefficient (K_d)[3] (L/kg)	Source	Distribution Coefficient (K_d)[3] (L/kg)	Source	Henry's Constant Law (H_{cc})[5] (unitless)	Source
Metals											
7429-90-5	Aluminum	--	--	--	--	--	--	--	--	--	EPA RSL 2010
7440-36-0	Antimony (metallic)	4.5E+01	EPA SSL 2002	4.5E+01	EPA SSL 2002	2.5E+02	EPA RD 2005	2.5E+02	EPA RD 2005	--	EPA RSL 2010
7440-38-2	Arsenic (inorganic)[3]	--	--	--	--	2.5E+03	EPA RD 2005	--	--	--	EPA RSL 2010
7440-39-3	Barium	4.1E+01	EPA SSL 2002	4.1E+01	EPA SSL 2002	--	--	4.1E+01	EPA SSL 2002	--	EPA RSL 2010
7440-41-7	Beryllium	7.9E+02	EPA SSL 2002	7.9E+02	EPA SSL 2002	1.3E+03	EPA RD 2005	1.3E+03	EPA RD 2005	--	EPA RSL 2010
7440-43-9	Cadmium	6.7E+00	WAC 173-340-900	6.7E+00	WAC 173-340-900	7.9E+02	EPA RD 2005	7.9E+02	EPA RD 2005	--	EPA RSL 2010
18540-29-9	Chromium(VI)[3]	--	--	--	--	1.3E+01	EPA RD 2005	--	--	--	EPA RSL 2010
7440-48-4	Cobalt	--	--	--	--	1.3E+02	EPA RD 2005	1.3E+02	EPA RD 2005	--	EPA RSL 2010
7440-50-8	Copper	2.2E+01	WAC 173-340-900	2.2E+01	EPA SSL 2002	5.0E+02	EPA RD 2005	5.0E+02	EPA RD 2005	--	EPA RSL 2010
7439-89-6	Iron	--	--	--	--	--	--	--	--	--	EPA RSL 2010
7439-92-1	Lead	1.0E+04	WAC 173-340-900	1.0E+04	WAC 173-340-900	1.6E+04	EPA RD 2005	1.6E+04	EPA RD 2005	--	EPA RSL 2010
7439-96-5	Manganese (non-diet)[3]	--	--	--	--	--	--	--	--	--	EPA RSL 2010
7439-97-6	Mercury (elemental)[5]	5.2E+01	WAC 173-340-900	5.2E+01	WAC 173-340-900	6.3E+03	EPA RD 2005	6.3E+03	EPA RD 2005	4.70E-01	EPA SSL 2002
7487-94-7	Mercury (inorganic salts)	--	--	--	--	--	--	--	--	--	EPA RSL 2010
22967-92-6	Mercury (methyl mercury)	--	--	--	--	6.3E+02	EPA RD 2005	6.3E+02	EPA RD 2005	--	EPA RSL 2010
7439-98-7	Molybdenum	--	--	--	--	1.3E+01	EPA RD 2005	1.3E+01	EPA RD 2005	--	EPA RSL 2010
7440-02-0	Nickel	6.5E+01	WAC 173-340-900	6.5E+01	WAC 173-340-900	1.3E+03	EPA RD 2005	1.3E+03	EPA RD 2005	--	EPA RSL 2010
7782-49-2	Selenium	5.0E+00	WAC 173-340-900	5.0E+00	WAC 173-340-900	1.0E+01	EPA RD 2005	1.0E+01	EPA RD 2005	--	EPA RSL 2010
7440-22-4	Silver	8.3E+00	EPA SSL 2002	8.3E+00	EPA SSL 2002	4.0E+02	EPA RD 2005	4.0E+02	EPA RD 2005	--	EPA RSL 2010
7440-31-5	Tin	--	--	--	--	7.9E+02	EPA RD 2005	7.9E+02	EPA RD 2005	--	EPA RSL 2010
7440-62-2	Vanadium	1.0E+03	EPA SSL 2002	1.0E+03	EPA SSL 2002	--	--	1.0E+03	EPA SSL 2002	--	EPA RSL 2010
7440-66-6	Zinc (metallic)	6.2E+01	WAC 173-340-900	6.2E+01	WAC 173-340-900	1.3E+03	EPA RD 2005	1.3E+03	EPA RD 2005	--	EPA RSL 2010
Other Inorganics											
57-12-5	Cyanide (free)	9.9E+00	EPA SSL 2002	--	EPA SSL 2002	1.0E+03	EPA RD 2005	1.0E+03	EPA RD 2005	--	EPA RSL 2010
74-90-8	Cyanide (hydrogen)	9.9E+00	EPA SSL 2002	--	EPA SSL 2002	--	--	--	--	--	EPA RSL 2010

Notes:

1 BCFs derived from Meylan, et al., 1999 (in EPA Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities [HHRAP] Guidance, 2005, EPA520-R-05-006)

2 BCFs derived from CLARC database, originally sourced from EPA Quality Criteria for Water (AWQC Gold Book 1986), EPA 440/5-86-001

3 Arsenic, chromium, manganese, and iron have K_d that are very dependent on the oxidation state of the metal, and they have oxidation states that vary under normal soil and groundwater conditions (refer to Stumm and Morgan, Aquatic Chemistry 1996). For this reason the following assumptions have been made:

For arsenic: no K_d has been selected for use because the varying redox conditions are present in groundwater at Plant 2 resulting in poor agreement between predicted and measured concentrations.

For chromium(VI): Cr(VI) is not stable under normal soil conditions and no K_d has been used for Cr(VI) partitioning between media; Cr(III) is stable and its K_d could be used, but it is not a constituents of concern due to its low toxicity.

For iron: no K_d has been selected for use because the varying redox conditions are present in groundwater at Plant 2 resulting in poor agreement between predicted and measured concentrations.

For manganese: no K_d has been selected for use because the varying redox conditions are present in groundwater at Plant 2 resulting in poor agreement between predicted and measured concentrations.

4 The distribution coefficients present in EPA RD 2005 were selected because this source contained the most comprehensive and critical review of partitioning coefficients among the sources available

5 Of the metals, only elemental mercury is sufficiently volatile to have either a volatilization factor or a Henry's Law Constant, which are given below

Volalitzation Factor (m^3/kg): EPA 3.20E+04, EPA SSL 2002; MTCA not used.

Henry's Law Constant (H_{cc}): EPA 4.70E-01, EPA SSL 2002; MTCA 4.70E-01, WAC 173-340.

For all other metals, Henry's Law Constant is taken to be equivalent to 0 in all equations which require use of Henry's Law Constant.

Abbreviations:

ATSDR Agency for Toxic Substances and Disease Registry
ATSDR 1992 ATSDR Toxicological Profile for Antimony and Compounds, September 2992; available online at http://www.atsdr.cdc.gov/ToxProfiles/tp23.pdf
AWQC Ambient Water Quality Criteria
BCF Bioconcentration factor
CAS Chemical abstract number
CLARC Cleanup Levels and Risk Calculation
EPA U.S. Environmental Protection Agency
EPA RD 2005 Partition Coefficients for Metals in Surace Water, Soil, and Waste, Office of Research and Development, EPA/600/R-05/074, July 2005
EPA RSL 2010 Regional Screening Levels, November 2010; https://www.epa.gov/region9/superfund/prg/.
EPA SSL 2002 Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, OSWER 9355.4-24, December 2002
GI Gastrointestinal
MTCA Model Toxics Control Act
PEF Particulate emission factor
R10 Region 10

Table A.1h
Chemical-specific Toxicity Factors for Inorganics

		EPA R10[1]												Ecology[2]											
		Oral/Ingestion Toxicity Factors				Dermal Toxicity Factors[3]				Inhalation Toxicity Factors				Oral/Ingestion Toxicity Factors				Dermal Toxicity Factors[4]				Inhalation Toxicity Factors			
CAS Number	Chemical	Cancer Slope Factor (CSF_o) (kg-day/mg)	Source	Reference Dose (RfD_o) (mg/kg-day)	Source	Cancer Slope Factor (CSF_d) (kg-day/mg)	Source	Reference Dose (RfD_d) (mg/kg-day)	Source	Inhalation Unit Risk (IUR) (µg/m^3)	Source	Reference Concentration (RfC_i) (mg/m^3)	Source	Cancer Potency Factor (CPF_o) (kg-day/mg)	Source	Reference Dose (RfD_o) (mg/kg-day)	Source	Cancer Potency Factor (CPF_d) (kg-day/mg)	Source	Reference Dose (RfD_d) (mg/kg-day)	Source	Cancer Potency Factor (CPF_i) (kg-day/mg)	Source	Reference Dose (RfD_d) (mg/kg-day)	Source
Metals																									
7429-90-5	Aluminum	--	--	1.0E+00	PPRTV	--	--	1.0E+00	RfD_o*GI-abs	--	--	5.0E-03	PPRTV	--	--	1.0E+00	PPRTV	--	--	2.0E-01	RfD_o*GI-abs	--	--	--	--
7440-36-0	Antimony (metallic)	--	--	4.0E-04	IRIS	--	--	6.0E-05	RfD_o*GI-abs	--	--	--	--	--	--	4.0E-04	IRIS	--	--	8.0E-05	RfD_o*GI-abs	--	--	--	--
7440-38-2	Arsenic (inorganic)	1.5E+00	IRIS	3.0E-04	IRIS	1.5E+00	CSF_o/GI-abs	3.0E-04	RfD_o*GI-abs	4.3E-03	IRIS	1.5E-05	Cal/EPA	1.5E+00	IRIS	3.0E-04	IRIS	7.5E+00	CSF_o/GI-abs	6.0E-05	RfD_o*GI-abs	1.5E+01	IRIS	1.5E+01	HEAST
7440-39-3	Barium	--	--	2.0E-01	IRIS	--	--	1.4E-02	RfD_o*GI-abs	--	--	5.0E-04	HEAST	--	--	2.0E-01	IRIS	--	--	4.0E-02	RfD_o*GI-abs	--	--	2.0E-01	HEAST
7440-41-7	Beryllium	--	--	2.0E-03	IRIS	--	--	1.4E-05	RfD_o*GI-abs	2.4E-03	IRIS	2.0E-05	IRIS	--	--	2.0E-03	IRIS	--	--	4.0E-04	RfD_o*GI-abs	8.4E+00	IRIS	5.7E-06	IRIS
7440-43-9	Cadmium (in water)	--	--	1.0E-03	IRIS	--	--	2.5E-05	RfD_o*GI-abs	1.8E-03	IRIS	--	--	--	--	5.0E-04	IRIS	--	--	1.0E-04	RfD_o*GI-abs	6.3E+00	IRIS	--	--
7440-43-9a	Cadmium (in soil)	--	--	1.0E-03	IRIS	--	--	2.5E-05	RfD_o*GI-abs	1.8E-03	IRIS	1.0E-05	ATSDR	--	--	1.0E-03	IRIS	--	--	2.0E-04	RfD_o*GI-abs	6.3E+00	IRIS	--	--
7440-47-3	Chromium (total)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
18540-29-9	Chromium(VI)	5.0E-01	NJDEP	3.0E-03	IRIS	2.0E+02	CSF_o/GI-abs	7.5E-06	RfD_o*GI-abs	8.4E-02	IRIS	1.0E-04	IRIS	--	--	3.0E-03	IRIS	--	--	6.0E-04	RfD_o*GI-abs	--	--	2.3E-06	IRIS
7440-48-4	Cobalt	--	--	3.0E-04	PPRTV	--	--	3.0E-04	RfD_o*GI-abs	9.0E-03	PPRTV	6.0E-06	PPRTV	--	--	3.0E-04	PPRTV	--	--	6.0E-05	RfD_o*GI-abs	--	--	--	--
7440-50-8	Copper	--	--	4.0E-02	HEAST	--	--	4.0E-02	RfD_o*GI-abs	--	--	--	--	--	--	4.0E-02	Unknown[5]	--	--	8.0E-03	RfD_o*GI-abs	--	--	--	--
7439-89-6	Iron	--	--	7.0E-01	PPRTV	--	--	7.0E-01	RfD_o*GI-abs	--	--	--	--	--	--	7.0E-01	PPRTV	--	--	1.4E-01	RfD_o*GI-abs	--	--	--	--
7439-92-1	Lead	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
7439-96-5	Manganese (non-diet)	--	--	2.4E-02	IRIS	--	--	9.6E-04	RfD_o*GI-abs	--	--	5.0E-05	IRIS	--	--	2.4E-02	IRIS	--	--	4.8E-03	RfD_o*GI-abs	--	--	1.4E-05	IRIS
7439-97-6	Mercury (elemental)	--	--	1.6E-04	Cal/EPA	--	--	1.6E-04	RfD_o*GI-abs	--	--	3.0E-04	IRIS	--	--	3.0E-04	HEAST	--	--	6.0E-05	RfD_o*GI-abs	--	--	8.6E-05	IRIS
7487-94-7	Mercury (inorganic salts)	--	--	3.0E-04	IRIS	--	--	2.1E-05	RfD_o*GI-abs	--	--	--	--	--	--	3.0E-04	IRIS	--	--	6.0E-05	RfD_o*GI-abs	--	--	--	--
22967-92-6	Mercury (methyl mercury)	--	--	1.0E-04	IRIS	--	--	1.0E-04	RfD_o*GI-abs	--	--	--	--	--	--	1.0E-04	IRIS	--	--	2.0E-05	RfD_o*GI-abs	--	--	--	--
7439-98-7	Molybdenum	--	--	5.0E-03	IRIS	--	--	5.0E-03	RfD_o*GI-abs	--	--	--	--	--	--	5.0E-03	IRIS	--	--	1.0E-03	RfD_o*GI-abs	--	--	--	--
7440-02-0	Nickel	--	--	2.0E-02	IRIS	--	--	8.0E-04	RfD_o*GI-abs	2.6E-04	Cal/EPA	9.0E-05	ATSDR	--	--	2.0E-02	IRIS	--	--	4.0E-03	RfD_o*GI-abs	--	--	--	--
7782-49-2	Selenium	--	--	5.0E-03	IRIS	--	--	5.0E-03	RfD_o*GI-abs	--	--	2.0E-02	Cal/EPA	--	--	5.0E-03	IRIS	--	--	1.0E-03	RfD_o*GI-abs	--	--	--	--
7440-22-4	Silver	--	--	5.0E-03	IRIS	--	--	2.0E-04	RfD_o*GI-abs	--	--	--	--	--	--	5.0E-03	IRIS	--	--	1.0E-03	RfD_o*GI-abs	--	--	--	--
7440-31-5	Tin	--	--	6.0E-01	HEAST	--	--	6.0E-01	RfD_o*GI-abs	--	--	--	--	--	--	6.0E-01	HEAST	--	--	1.2E-01	RfD_o*GI-abs	--	--	--	--
7440-62-2	Vanadium	--	--	9.0E-03	IRIS	--	--	2.3E-04	RfD_o*GI-abs	--	--	--	--	--	--	9.0E-03	IRIS	--	--	1.8E-03	RfD_o*GI-abs	--	--	--	--
7440-66-6	Zinc (metallic)	--	--	3.0E-01	IRIS	--	--	3.0E-01	RfD_o*GI-abs	--	--	--	--	--	--	3.0E-01	IRIS	--	--	6.0E-02	RfD_o*GI-abs	--	--	--	--
Other Inorganics																									
57-12-5	Cyanide (free)	--	--	2.0E-02	IRIS	--	--	2.0E-02	RfD_o*GI-abs	--	--	--	--	--	--	2.0E-02	IRIS	--	--	4.0E-03	RfD_o*GI-abs	--	--	--	--
74-90-8	Cyanide (hydrogen)	--	--	6.0E-04	IRIS	--	--	6.0E-04	RfD_o*GI-abs	--	--	8.0E-04	IRIS	--	--	6.0E-04	IRIS	--	--	1.2E-04	RfD_o*GI-abs	--	--	--	--

Notes:

1 Toxicity factors are from the November 2010 EPA RSL Tables unless otherwise noted.

2 Toxicity factors from Ecology were taken from CLARC on January 30, 2011; then updated to include all IRIS changes. PPRTV were also incorporated where it was clear what value would be used. Values from ATSDR, Cal/EPA, and NJEPA were not used.

3 EPA dermal toxicity factors are calculated based on the oral toxicity factors as follows: $CSF_d = CSF_o$/GI-abs; $RfD_d = RfD_o$ x GI-abs. GI-abs is the gastrointestinal absorption conversion factor, which is equal to 1.0 except where otherwise specified in EPA RSL 2010.

4 MTCA dermal toxicity factors are calculated based on the oral toxicity factors as follows: $CSF_d = CSF_o$/GI-abs; $RfD_d = RfD_o$ x GI-abs. GI-abs is the gastrointestinal absorption conversion factor, which is equal to 0.2 for inorganic compounds (see equations 740-4 and 740-5).

5 Reported in CLARC as "Unknown citation"; no value reported in IRIS.

Abbreviations:

ATSDR Agency for Toxic Substances and Disease Registry.
Cal/EPA California Environmental Protection Agency.
CSF and CPF The terms "cancer slope factor" and "cancer potency factor" are interchangeable.
Ecology Washington State Department of Ecology.
HEAST Health Effects Assessment Summary Tables.
IRIS Integrated Risk Information System.
MTCA Model Toxics Control Act.
NJDEP New Jersey Department of Environmental Protection.
PPRTV Provisional Peer Reviewed Toxicity Value.
R10 Region 10.
Rfd and RfC The terms "Reference factor Dose" and "Reference factor Concentration" are not interchangeable. The former is expressed as a dose (mg/kg-day) while the later is a concentrations (mg/unit volume of media).
VOC Volatile organic compound.

Table A.2a
Ambient Air Risk-based Calculations

CAS Number	Chemical	Proposed Ambient Air TMCLs			
		Residential		Worker[1, 2]	
		TMCL ($\mu g/m^3$)	Source ($\mu g/m^3$)	TMCL ($\mu g/m^3$)	Source ($\mu g/m^3$)
67-64-1	Acetone	3.2E+04	EPA RSL	1.4E+05	Modified EPA RSL
71-43-2	Benzene	3.1E-01	EPA RSL	1.6E+01	Modified EPA RSL
78-93-3	2-Butanone (MEK)	5.2E+03	EPA RSL	2.2E+04	Modified EPA RSL
75-15-0	Carbon Disulfide	7.3E+02	EPA RSL	3.1E+03	Modified EPA RSL
56-23-5	Carbon Tetrachloride	4.1E-01	EPA RSL	2.0E+01	Modified EPA RSL
108-90-7	Chlorobenzene	5.2E+01	EPA RSL	2.2E+02	Modified EPA RSL
75-00-3	Chloroethane	1.0E+04	EPA RSL	4.4E+04	Modified EPA RSL
67-66-3	Chloroform	1.1E-01	EPA RSL	5.3E+00	Modified EPA RSL
74-87-3	Chloromethane	9.4E+01	EPA RSL	3.9E+02	Modified EPA RSL
106-43-4	4-Chlorotoluene	--	--	--	--
95-50-1	1,2-Dichlorobenzene	2.1E+02	EPA RSL	8.8E+02	Modified EPA RSL
106-46-7	1,4-Dichlorobenzene	2.2E-01	EPA RSL	1.1E+01	Modified EPA RSL
75-34-3	1,1-Dichloroethane	1.5E+00	EPA RSL	7.7E+01	Modified EPA RSL
107-06-2	1,2-Dichloroethane	9.4E-02	EPA RSL	4.7E+00	Modified EPA RSL
75-35-4	1,1-Dichloroethene	2.1E+02	EPA RSL	8.8E+02	Modified EPA RSL
156-59-2	*cis* -1,2-Dichloroethene[3]	--	--	--	--
156-60-5	*trans* -1,2-Dichloroethene[3]	--	--	--	--
78-87-5	1,2-Dichloropropane	2.4E-01	EPA RSL	1.2E+01	Modified EPA RSL
100-41-4	Ethylbenzene	9.7E-01	EPA RSL	4.9E+01	Modified EPA RSL
98-82-8	Isopropylbenzene(cumene)	4.2E+02	EPA RSL	1.8E+03	Modified EPA RSL
591-78-6	2-Hexanone	3.1E+01	EPA RSL	1.3E+02	Modified EPA RSL
75-09-2	Methylene Chloride	5.2E+00	EPA RSL	2.6E+02	Modified EPA RSL
108-10-1	Methyl Isobutyl Ketone	3.1E+03	EPA RSL	1.3E+04	Modified EPA RSL
91-20-3	Naphthalene	7.2E-02	EPA RSL	3.6E+00	Modified EPA RSL
100-42-5	Styrene	1.0E+03	EPA RSL	4.4E+03	Modified EPA RSL
79-34-5	1,1,2,2-Tetrachloroethane	4.2E-02	EPA RSL	2.1E+00	Modified EPA RSL
127-18-4	Tetrachloroethene (PCE)	4.1E-01	EPA RSL	2.1E+01	Modified EPA RSL
108-88-3	Toluene	5.2E+03	EPA RSL	2.2E+04	Modified EPA RSL
71-55-6	1,1,1-Trichloroethane	5.2E+03	EPA RSL	2.2E+04	Modified EPA RSL
79-00-5	1,1,2-Trichloroethane	1.5E-01	EPA RSL	7.7E+00	Modified EPA RSL
79-01-6	Trichloroethene (TCE)	1.2E-01	EPA RSL	6.1E+00	Modified EPA RSL
120-82-1	1,2,4-trichlorobenzene[3]	--	--	--	--
75-69-4	Trichlorofluoromethane	7.3E+02	EPA RSL	3.1E+03	Modified EPA RSL
76-13-1	1,1,2-Trichlorotrifluoroethane	3.1E+02	EPA RSL	1.3E+03	Modified EPA RSL
75-01-4	Vinyl chloride[4]	2.8E-01	EPA RSL	1.4E+01	Modified EPA RSL
108-38-3	m-Xylene	7.3E+02	EPA RSL	3.1E+03	Modified EPA RSL
95-47-6	o-Xylene	7.3E+02	EPA RSL	3.1E+03	Modified EPA RSL
106-42-3	p-Xylene	7.3E+02	EPA RSL	3.1E+03	Modified EPA RSL
10330-20-7	Xylenes (total)	1.0E+02	EPA RSL	4.4E+02	Modified EPA RSL

Notes:

1 EPA Region 10 (R10) has made a risk management decision to use a 1 in 100,000 excess indiviual lifetime risk for cancer for workers at Boeing Plant 2. Calculations are based on the EPA RSL equations modified for a total risk of 1.0E-5.

2 Ecology worker exposure was modified from full time (365 days/year x 24 hours/day) to the work week allowed under industrial soil exposure (10 hours/day x 7 days/week x 50 weeks/year).

3 No inhalation toxicity factors are available.

4 Ecology has established the following "rule" for dealing with the mutagenic effects of vinyl chloride; refer to for details: https://fortress.wa.gov/ecy/clarc/FocusSheets/VinylChloride.pdf. EPA R10 has accepted this approach for this site.

Abbreviations:

CAS Chemical abstract number
Ecology Washington State Department of Ecology
EPA U.S. Environmental Protection Agency
RSL Regional screening level

Table A.2b
Soil Standards, Criteria, and Risk-based Calculations

CAS Number	Chemical[1]	Residential: EPA — EPA RSL Residential Includes Ingestion, Dermal, and Inhalation[2] (mg/kg)	Residential: Ecology — MTCA Method B Unrestricted Land Use Includes CLARC Toxicity Factors[3] (mg/kg)	Industrial: EPA Modified — EPA RSL Industrial Includes Ingestion, Dermal, and Inhalation[4] (mg/kg)	Industrial: Ecology — MTCA Method C Industrial Land Use Includes CLARC Toxicity Factors[3] (mg/kg)	Sediment Protection: Ecology — SMS Sediment Quality Standards[5] (mg/kg dry weight)	Groundwater Protection: Ecology — Soil Level to Protect Groundwater Using Three-phase Model[6] (mg/kg)	EPA Proposed Soil TMCL to Protect All Pathways (mg/kg)	EPA Proposed Soil TMCL to Protect All Pathways: Exposure Pathway Basis of TMCL
Volatile Organic Constituents									
67-64-1	Acetone	6.1E+04	7.2E+04	3.7E+05	3.1E+06	--	5.1E+02	5.1E+02	Soil to protect groundwater for Tribal seafood.
71-43-2	Benzene	1.1E+00	1.8E+01	4.9E+01	2.4E+03	--	9.3E-02	9.3E-02	Soil to protect groundwater for Tribal seafood.
78-93-3	2-Butanone (MEK)	2.8E+04	4.8E+04	1.5E+05	2.1E+06	--	4.3E+02	4.3E+02	Soil to protect groundwater for Tribal seafood.
75-15-0	Carbon Disulfide	8.2E+02	8.0E+03	3.6E+03	3.5E+05	--	7.5E+01	7.5E+01	Soil to protect groundwater for Tribal seafood.
56-23-5	Carbon Tetrachloride	6.1E-01	1.4E+01	2.8E+01	1.9E+03	--	2.1E-02	2.1E-02	Soil to protect groundwater for Tribal seafood.
108-90-7	Chlorobenzene	2.9E+02	1.6E+03	1.3E+03	7.0E+04	--	2.6E+01	2.6E+01	Soil to protect groundwater for Tribal seafood.
75-00-3	Chloroethane	1.4E+04	--	6.1E+04	--	--	2.8E+02	2.8E+02	Surrogate Value: soil to protect groundwater for drinking water use.
67-66-3	Chloroform	3.0E-01	8.0E+02	1.5E+01	3.5E+04	--	2.0E-01	2.0E-01	Soil to protect groundwater for Tribal seafood.
74-87-3	Chloromethane	1.2E+02	--	5.0E+02	--	--	1.6E+00	1.6E+00	Surrogate Value: soil to protect groundwater for drinking water use.
106-43-4	4-Chlorotoluene	--	--	--	--	--	4.0E+02	4.0E+02	Surrogate Value: soil to protect groundwater for drinking water use.
95-50-1	1,2-Dichlorobenzene	1.9E+03	7.2E+03	8.9E+03	3.1E+05	--	6.8E+01	6.8E+01	Soil to protect groundwater for Tribal seafood.
106-46-7	1,4-Dichlorobenzene	2.4E+00	--	1.2E+02	--	--	3.5E-01	3.5E-01	Soil to protect groundwater for Tribal seafood.
75-34-3	1,1-Dichloroethane	3.3E+00	1.6E+04	1.6E+02	7.0E+05	--	7.1E-01	7.1E-01	Soil to protect groundwater for Tribal seafood.
107-06-2	1,2-Dichloroethane	4.3E-01	1.1E+01	2.0E+01	1.4E+03	--	7.0E-02	7.0E-02	Soil to protect groundwater for Tribal seafood.
75-35-4	1,1-Dichloroethene	2.4E+02	4.0E+03	1.0E+03	1.7E+05	--	8.1E-02	8.1E-02	Soil to protect groundwater for Tribal seafood.
156-59-2	*cis* -1,2-Dichloroethene	1.6E+02	1.6E+02	1.0E+03	7.0E+03	--	2.6E+00	2.6E+00	Soil to protect groundwater for Tribal seafood.
156-60-5	*trans* -1,2-Dichloroethene	1.6E+03	1.6E+03	1.0E+04	7.0E+04	--	1.9E+01	1.9E+01	Soil to protect groundwater for Tribal seafood.
78-87-5	1,2-Dichloropropane	8.9E-01	--	4.2E+01	--	--	9.2E-02	9.2E-02	Soil to protect groundwater for Tribal seafood.
100-41-4	Ethylbenzene	5.4E+00	8.0E+03	2.4E+02	3.5E+05	--	2.3E-01	2.3E-01	Soil to protect groundwater for Tribal seafood.
98-82-8	Isopropylbenzene(cumene)	2.1E+03	8.0E+03	9.5E+03	3.5E+05	--	7.8E+01	7.8E+01	Soil to protect groundwater for Tribal seafood.
591-78-6	2-Hexanone	2.1E+02	4.0E+02	1.1E+03	1.7E+04	--	3.2E+01	3.2E+01	Soil to protect groundwater for Tribal seafood.
75-09-2	Methylene Chloride	1.1E+01	1.3E+02	4.7E+02	1.8E+04	--	6.5E-01	6.5E-01	Soil to protect groundwater for Tribal seafood.
108-10-1	Methyl Isobutyl Ketone	5.3E+03	6.4E+03	3.2E+04	2.8E+05	--	1.7E+02	1.7E+02	Soil to protect groundwater for Tribal seafood.
91-20-3	Naphthalene	3.6E+00	1.6E+03	1.8E+02	7.0E+04	2.1E+00	1.6E+01	3.6E+00	EPA RSL Residential Including Ingestion, Dermal, and Inhalation.
100-42-5	Styrene	6.3E+03	1.6E+04	3.1E+04	7.0E+05	--	2.1E+04	6.3E+03	EPA RSL Residential Including Ingestion, Dermal, and Inhalation.
79-34-5	1,1,2,2-Tetrachloroethane	5.6E-01	5.0E+00	2.3E+01	6.6E+02	--	1.3E-02	1.3E-02	Soil to protect groundwater for Tribal seafood.
127-18-4	Tetrachloroethene (PCE)	5.6E-01	8.0E+02	1.8E+01	3.5E+04	--	1.6E-03	1.6E-03	Soil to protect groundwater for Tribal seafood.
108-88-3	Toluene	5.0E+03	6.4E+03	2.9E+04	2.8E+05	--	1.0E+02	1.0E+02	Soil to protect groundwater for Tribal seafood.
71-55-6	1,1,1-Trichloroethane	8.7E+03	1.6E+05	3.7E+04	7.0E+06	--	1.9E+03	1.9E+03	Soil to protect groundwater for Tribal seafood.
79-00-5	1,1,2-Trichloroethane	1.1E+00	1.8E+01	4.8E+01	2.3E+03	--	7.3E-02	7.3E-02	Soil to protect groundwater for Tribal seafood.
79-01-6	Trichloroethene (TCE)	2.7E-01	1.1E+01	1.3E+01	1.0E+03	--	1.8E-02	1.8E-02	Soil to protect groundwater for Tribal seafood.
120-82-1	1,2,4-trichlorobenzene	2.2E+01	3.4E+01	4.9E+02	4.5E+03	--	8.0E-02	8.0E-02	Soil to protect groundwater for Tribal seafood.
75-69-4	Trichlorofluoromethane	7.8E+02	2.4E+04	3.3E+03	1.0E+06	--	2.0E+02	2.0E+02	Soil to protect groundwater for Tribal seafood.
76-13-1	1,1,2-Trichlorotrifluoroethane	4.3E+02	2.4E+06	1.8E+03	1.0E+08	--	7.1E+03	4.3E+02	EPA RSL Residential Including Ingestion, Dermal, and Inhalation.
75-01-4	Vinyl chloride[7]	8.1E-05	6.7E-01	4.1E-03	8.8E+01	--	3.4E-02	8.1E-05	EPA RSL Residential Including Ingestion, Dermal, and Inhalation.
108-38-3	m-Xylene	3.4E+03	1.6E+04	1.5E+04	7.0E+05	--	1.6E+02	1.6E+02	Soil to protect groundwater for Tribal seafood.
95-47-6	o-Xylene	3.8E+03	1.6E+04	1.8E+04	7.0E+05	--	2.0E+02	2.0E+02	Soil to protect groundwater for Tribal seafood.
106-42-3	p-Xylene	3.4E+03	1.6E+04	1.6E+04	7.0E+05	--	2.3E+02	2.3E+02	Soil to protect groundwater for Tribal seafood.
10330-20-7	Xylenes (total)	6.3E+02	1.6E+04	2.7E+03	7.0E+05	--	2.0E+02	2.0E+02	Soil to protect groundwater for Tribal seafood.

Notes:

1 Not all chemicals are constituents needing TMCLs at Boeing Plant 2.
2 EPA RSL calculations using EPA toxicity factors and exposure parameters as presented in associated tables in this attachment.
3 MTCA Method B uses WAC 173-340-740, equations 740-1 and 740-2; MTCA Method C uses WAC-173-340-745, equations 745-1 and 745-2 (Ecology 2007); specific parameters are presented in associated tables in this attachment; CLARC toxicity values updated (refer to Toxicity Factor Table).
4 EPA RSL Worker scenario has been modified to a 1 in 100,000 excess individual lifetime cancer risk and a soil ingestion rate of 200 mg/kg-day by an EPA Region 10 risk management decision.
5 Sediment Management Standards Sediment Quality Standards Chemical Criteria (WAC-173-204-320[a]); expressed as their equivalent dry weight values.
6 Soil to Groundwater cleanup values are based on the MTCA fixed parameter three-phase partitioning model (WAC 173-340-747, equation 747-1), using partitioning factors presented in associated tables in this attachment.
7 Ecology has established the following "rule" for dealing with the mutagenic effects of vinyl chloride; refer to for details: https://fortress.wa.gov/ecy/clarc/FocusSheets/VinylChloride.pdf. EPA R10 has accepted this approach for this site.

Abbreviations:

CAS Chemical abstract number
CLARC Cleanup Levels and Risk Calculation
Ecology Washington State Department of Ecology
EPA U.S. Environmental Protection Agency
MTCA Model Toxics Control Act
RSL Regional screening level
SMS Sediment Management Standards

Table A.2c
Groundwater Standards, Criteria, and Risk-based Calculations

		Protection of Drinking Water[2]				Protection of Aquatic Species						Protection of Human Health for Consumption of Fish and Shellfish in Marine Waters				EPA Proposed TMCL for Surface Water and Groundwater Discharging to Surface Water in the Lower Duwamish Waterway	
		Drinking Water Standard/Criteria[3]				Freshwater Standards			Marine Standards								
		Federal Primary Drinking Water Standards[4]	EPA RSL Tap Water Criteria[5]	State Primary Drinking Water Standards[6]	MTCA B Groundwater Cleanup Level[7]	Federal National Toxics Rule[8]	Federal Ambient Water Quality Criteria[9, 10]	Washington Surface Water Quality Standards[9, 11]	Federal National Toxics Rule[8]	Federal Ambient Water Quality Criteria[9]	Washington Surface Water Quality Standards[10, 11]	Federal National Toxics Rule[8]	Federal Ambient Water Quality Criteria[9]	Lowest of Tribal and Asian/Pacific Islander Exposure Scenarios[11, 12]	MTCA Method B Surface Water[11, 13]		
		EPA MCLs		Washington MCLs		Chronic	Chronic	Chronic	Chronic	Chronic	Chronic	Organism Only			Fish/Shellfish		
CAS Number	Chemical[1]	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	µg/L	µg/L	µg/L	µg/L	(µg/L)			(µg/L)	(µg/L)	Exposure Pathway Basis of TMCL
67-64-1	Acetone	--	2.2E+04	--	7.2E+03	--	--	--	--	--	--	--	--	1.1E+05	7.4E+05	1.1E+05	EPA R10 Tribal Consumption of Seafood.
71-43-2	Benzene	5.00E+00	4.1E-01	5.00E+00	8.0E-01	--	--	--	--	--	--	7.1E+01	5.1E+01	2.0E+00	1.4E+01	2.0E+00	EPA R10 Tribal Consumption of Seafood.
78-93-3	2-Butanone (MEK)	--	7.1E+03	--	4.8E+03	--	--	--	--	--	--	--	--	7.3E+04	4.9E+05	7.3E+04	EPA R10 Tribal Consumption of Seafood.
75-15-0	Carbon Disulfide	--	1.0E+03	--	8.0E+02	--	--	--	--	--	--	--	--	3.9E+03	2.6E+04	3.9E+03	EPA R10 Tribal Consumption of Seafood.
56-23-5	Carbon Tetrachloride	5.00E+00	4.4E-01	5.00E+00	6.3E-01	--	--	--	--	--	--	4.4E+00	1.6E+00	4.6E-01	3.2E+00	4.6E-01	EPA R10 Tribal Consumption of Seafood.
108-90-7	Chlorobenzene	1.00E+02	9.1E+01	1.00E+02	1.6E+02	--	--	--	--	--	--	2.1E+04	1.6E+03	2.7E+02	1.8E+03	2.7E+02	EPA R10 Tribal Consumption of Seafood.
75-00-3	Chloroethane	--	2.1E+04	--	--	--	--	--	--	--	--	--	--	--	--	2.1E+04	Surrogate Value: EPA RSL Tap Water Criteria.
67-66-3	Chloroform	8.00E+01	1.9E-01	8.00E+01	8.0E+01	--	--	--	--	--	--	4.7E+02	4.7E+02	9.4E+00	6.6E+01	9.4E+00	EPA R10 Tribal Consumption of Seafood.
74-87-3	Chloromethane	--	1.9E+02	--	--	--	--	--	--	--	--	--	--	--	--	1.9E+02	Surrogate Value: EPA RSL Tap Water Criteria.
106-43-4	4-Chlorotoluene	--	2.6E+03	--	--	--	--	--	--	--	--	--	--	--	--	2.6E+03	Surrogate Value: EPA RSL Tap Water Criteria.
95-50-1	1,2-Dichlorobenzene	6.00E+02	3.7E+02	6.00E+02	7.2E+02	--	--	--	--	--	--	1.7E+04	1.3E+03	4.4E+02	2.9E+03	4.4E+02	EPA R10 Tribal Consumption of Seafood.
106-46-7	1,4-Dichlorobenzene	7.50E+01	4.3E-01	7.50E+01	--	--	--	--	--	--	--	2.6E+03	1.9E+02	1.7E+00	1.2E+01	1.7E+00	EPA R10 Tribal Consumption of Seafood.
75-34-3	1,1-Dichloroethane	--	2.4E+00	--	1.6E+03	--	--	--	--	--	--	--	--	3.3E+01	2.3E+02	3.3E+01	EPA R10 Tribal Consumption of Seafood.
107-06-2	1,2-Dichloroethane	5.00E+00	1.5E-01	5.00E+00	4.8E-01	--	--	--	--	--	--	9.9E+01	3.7E+01	3.6E+00	2.5E+01	3.6E+00	EPA R10 Tribal Consumption of Seafood.
75-35-4	1,1-Dichloroethene	7.00E+00	3.4E+02	7.00E+00	4.0E+02	--	--	--	--	--	--	3.2E+00	7.1E+03	2.3E+03	1.6E+04	3.2E+00	NTR to protect human consumption of seafood.
156-59-2	*cis* -1,2-Dichloroethene	7.00E+01	7.3E+01	7.00E+01	1.6E+01	--	--	--	--	--	--	--	--	1.3E+02	9.0E+02	1.3E+02	EPA R10 Tribal Consumption of Seafood.
156-60-5	*trans* -1,2-Dichloroethene	1.00E+02	1.1E+02	1.00E+02	1.6E+02	--	--	--	--	--	--	--	1.0E+04	9.4E+02	6.3E+03	9.4E+02	EPA R10 Tribal Consumption of Seafood.
78-87-5	1,2-Dichloropropane	5.00E+00	3.9E-01	5.00E+00	--	--	--	--	--	--	--	--	1.5E+01	3.7E+00	2.6E+01	3.7E+00	EPA R10 Tribal Consumption of Seafood.
100-41-4	Ethylbenzene	7.00E+02	1.5E+00	7.00E+02	8.0E+02	--	--	--	--	--	--	2.9E+04	2.1E+03	1.7E+00	1.2E+01	1.7E+00	EPA R10 Tribal Consumption of Seafood.
98-82-8	Isopropylbenzene(cumene)	--	6.8E+02	--	8.0E+02	--	--	--	--	--	--	--	--	2.7E+02	1.8E+03	2.7E+02	EPA R10 Tribal Consumption of Seafood.
591-78-6	2-Hexanone	--	4.7E+01	--	4.0E+01	--	--	--	--	--	--	--	--	3.2E+03	2.2E+04	3.2E+03	EPA R10 Tribal Consumption of Seafood.
75-09-2	Methylene Chloride	5.00E+00	4.8E+00	5.00E+00	5.8E+00	--	--	--	--	--	--	1.6E+03	5.9E+02	6.1E+01	4.3E+02	6.1E+01	EPA R10 Tribal Consumption of Seafood.
108-10-1	Methyl Isobutyl Ketone	--	2.0E+03	--	6.4E+02	--	--	--	--	--	--	--	--	1.9E+04	1.2E+05	1.9E+04	EPA R10 Tribal Consumption of Seafood.
91-20-3	Naphthalene	--	1.4E-01	--	1.6E+02	--	--	--	--	--	--	--	--	2.6E+01	1.7E+02	2.6E+01	EPA R10 Tribal Consumption of Seafood.
100-42-5	Styrene	1.00E+02	1.6E+03	1.00E+02	1.6E+03	--	--	--	--	--	--	--	--	7.7E+04	5.2E+05	7.7E+04	EPA R10 Tribal Consumption of Seafood.
79-34-5	1,1,2,2-Tetrachloroethane	--	6.7E-02	--	2.2E-01	--	--	--	--	--	--	1.1E+01	4.0E+00	3.3E-01	2.3E+00	3.3E-01	EPA R10 Tribal Consumption of Seafood.
127-18-4	Tetrachloroethene (PCE)	5.00E+00	1.1E-01	5.00E+00	8.0E+01	--	--	--	--	--	--	8.9E+00	3.3E+00	2.1E-02	1.4E-01	2.1E-02	EPA R10 Tribal Consumption of Seafood.
108-88-3	Toluene	1.00E+03	2.3E+03	1.00E+03	6.4E+02	--	--	--	--	--	--	2.0E+05	1.5E+04	1.3E+03	8.7E+03	1.3E+03	EPA R10 Tribal Consumption of Seafood.
71-55-6	1,1,1-Trichloroethane	2.00E+02	9.1E+03	2.00E+02	1.6E+04	--	--	--	--	--	--	--	--	4.6E+04	3.1E+05	4.6E+04	EPA R10 Tribal Consumption of Seafood.
79-00-5	1,1,2-Trichloroethane	5.00E+00	1.5E+02	5.00E+00	7.7E-01	--	--	--	--	--	--	4.2E+01	1.6E+01	2.3E+00	1.6E+01	2.3E+00	EPA R10 Tribal Consumption of Seafood.
79-01-6	Trichloroethene (TCE)	5.00E+00	2.0E+00	5.00E+00	4.9E-01	--	--	--	--	--	--	8.1E+01	3.0E+01	5.1E-01	3.6E+00	5.1E-01	EPA R10 Tribal Consumption of Seafood.
120-82-1	1,2,4-trichlorobenzene	7.00E+01	2.3E+00	7.00E+01	1.5E+00	--	--	--	--	--	--	--	7.0E+01	1.3E-01	9.3E-01	1.3E-01	EPA R10 Tribal Consumption of Seafood.
75-69-4	Trichlorofluoromethane	--	1.3E+03	--	2.4E+03	--	--	--	--	--	--	--	--	6.9E+03	4.6E+04	6.9E+03	EPA R10 Tribal Consumption of Seafood.
76-13-1	1,1,2-Trichlorotrifluoroethane	--	5.9E+04	--	2.4E+05	--	--	--	--	--	--	--	--	--	--	5.9E+04	Surrogate Value: EPA RSL Tap Water Criteria.
75-01-4	Vinyl chloride	2.0E+00	1.6E-02	2.00E+00	2.9E-02	--	--	--	--	--	--	5.3E+02	2.4E+00	--	--	2.4E+00	EPA AWQC to protect human consumption of seafood.
108-38-3	m-Xylene	--	1.2E+03	--	1.6E+03	--	--	--	--	--	--	--	--	1.3E+03	8.9E+03	1.3E+03	EPA R10 Tribal Consumption of Seafood.
95-47-6	o-Xylene	--	1.2E+03	--	1.6E+03	--	--	--	--	--	--	--	--	1.6E+03	1.1E+04	1.6E+03	EPA R10 Tribal Consumption of Seafood.
106-42-3	p-Xylene	--	1.2E+03	--	1.6E+03	--	--	--	--	--	--	--	--	1.6E+03	1.1E+04	1.6E+03	EPA R10 Tribal Consumption of Seafood.
10330-20-7	Xylenes (total)	1.0E+04	2.0E+02	1.00E+04	1.6E+03	--	--	--	--	--	--	--	--	1.5E+03	1.0E+04	1.5E+03	EPA R10 Tribal Consumption of Seafood.

Notes:

1 Not all chemicals are constituents needing TMCLs at Boeing Plant 2.
2 Drinking water standards/criteria are not applicable to Boeing Plant 2 unless no other applicable standard exists for a constituent needing a TMCL in groundwater.
3 The standards are potentially applicable to groundwater that may be used for drinking water supplies. Ecology determines the maximum beneficial use of groundwater, which may or may not include drinking.
4 National Primary Drinking Water Regulations, Maximum Contaminant Levels (MCLs); http://water.epa.gov/drink/contaminants/index.cfm
5 EPA RSL, Residential Tapwaters; http://www.epa.gov/region9/superfund/prg/.
6 Washington Primary Drinking Water Standards WAC 246-290-130, Maximum Contaminant Levels (MCLs).
7 Standard MTCA Method B uses WAC 173-340-740, equations 730-1 and 730-2 (Ecology 2007). Parameters and toxicity factors can be found in associated tables in this attachment.
8 National Toxics Rule (NTR), 40 CFR 131.36.
9 EPA Ambient Water Quality Criteria (AWQCs), Clean Water Action Section 304.
10 Washington Surface Water Quality Standards; WAC 173-201A, Surface Water Quality Criteria.
11 EPA and Ecology fish consumption scenarios are based on MTCA Method B Surface Water Equations (equations 730-1 and 730-2); however, they use different exposure assumptions. Details are given in associated tables in this attachment.
12 This column uses the approach described in Note 8, but selects the lower concentrations that are protective of special populations including Tribal and Asian/Pacific Islander; the lowest concentration is always associated with Tribal exposure.
13 This column is included for comparison only and is based on the default exposure scenario in MTCA 173-340-730.

Abbreviations:

CAS Chemcial abstract number
Ecology Washington State Department of Ecology
EPA U.S. Environmental Protection Agency
MCL Maximum contaminant level
MTCA Model Toxics Control Act
R10 Region 10
RSL Regional screening level

Table A.2d
Ambient Air Calculations

CAS Number	Chemical	EPA RSL Calculations				Ecology Calculations			
		Residential		Worker (Target Risk Modified)[1]		Residential (MTCA B)		Worker (Exposure Frequency Modified)[2]	
		Cancer ($\mu g/m^3$)	Non-cancer ($\mu g/m^3$)	Cancer ($\mu g/m^3$)	Non-cancer ($\mu g/m^3$)	Cancer ($\mu g/m^3$)	Non-cancer ($\mu g/m^3$)	Cancer ($\mu g/m^3$)	Non-cancer ($\mu g/m^3$)
67-64-1	Acetone	--	3.2E+04	--	1.4E+05	--	1.4E+03	--	7.9E+03
71-43-2	Benzene	3.1E-01	3.1E+01	1.6E+01	1.3E+02	3.2E-01	6.4E+00	3.2E+00	3.5E+01
78-93-3	2-Butanone (MEK)	--	5.2E+03	--	2.2E+04	--	9.6E+02	--	5.2E+03
75-15-0	Carbon Disulfide	--	7.3E+02	--	3.1E+03	--	1.6E+02	--	8.7E+02
56-23-5	Carbon Tetrachloride	4.1E-01	1.0E+02	2.0E+01	4.4E+02	4.2E-01	6.4E+00	4.2E+00	3.5E+01
108-90-7	Chlorobenzene	--	5.2E+01	--	2.2E+02	--	3.2E+01	--	1.7E+02
75-00-3	Chloroethane	--	1.0E+04	--	4.4E+04	--	--	--	--
67-66-3	Chloroform	1.1E-01	1.0E+02	5.3E+00	4.3E+02	1.1E-01	1.6E+01	1.1E+00	8.7E+01
74-87-3	Chloromethane	--	9.4E+01	--	3.9E+02	1.4E+00	--	1.4E+01	--
106-43-4	4-Chlorotoluene	--	--	--	--	--	--	--	--
95-50-1	1,2-Dichlorobenzene	--	2.1E+02	--	8.8E+02	--	1.4E+02	--	7.9E+02
106-46-7	1,4-Dichlorobenzene	2.2E-01	8.3E+02	1.1E+01	3.5E+03	--	1.1E+02	--	6.1E+02
75-34-3	1,1-Dichloroethane	1.5E+00	--	7.7E+01	--	--	3.2E+02	--	1.7E+03
107-06-2	1,2-Dichloroethane	9.4E-02	2.5E+03	4.7E+00	1.1E+04	9.6E-02	--	9.6E-01	--
75-35-4	1,1-Dichloroethene	--	2.1E+02	--	8.8E+02	--	8.0E+01	--	4.4E+02
156-59-2	*cis* -1,2-Dichloroethene[3]	--	--	--	--	--	3.2E+00	--	1.7E+01
156-60-5	*trans* -1,2-Dichloroethene[3]	--	--	--	--	--	3.2E+01	--	1.7E+02
78-87-5	1,2-Dichloropropane	2.4E-01	4.2E+00	1.2E+01	1.8E+01	--	1.4E+02	--	7.9E+02
100-41-4	Ethylbenzene	9.7E-01	1.0E+03	4.9E+01	4.4E+03	--	1.6E+02	--	8.7E+02
98-82-8	Isopropylbenzene(cumene)	--	4.2E+02	--	1.8E+03	--	1.6E+02	--	8.7E+02
591-78-6	2-Hexanone	--	3.1E+01	--	1.3E+02	--	8.0E+00	--	4.4E+01
75-09-2	Methylene Chloride	5.2E+00	1.0E+03	2.6E+02	4.4E+03	5.3E+00	9.6E+01	5.3E+01	5.2E+02
108-10-1	Methyl Isobutyl Ketone	--	3.1E+03	--	1.3E+04	--	1.3E+02	--	7.0E+02
91-20-3	Naphthalene	7.2E-02	3.1E+00	3.6E+00	1.3E+01	--	3.2E+01	--	1.7E+02
100-42-5	Styrene	--	1.0E+03	--	4.4E+03	--	3.2E+02	--	1.7E+03
79-34-5	1,1,2,2-Tetrachloroethane	4.2E-02	--	2.1E+00	--	--	3.2E+01	--	1.7E+02
127-18-4	Tetrachloroethene (PCE)	4.1E-01	2.4E+03	2.1E+01	9.9E+03	--	1.6E+01	--	8.7E+01
108-88-3	Toluene	--	5.2E+03	--	2.2E+04	--	1.3E+02	--	7.0E+02
71-55-6	1,1,1-Trichloroethane	--	5.2E+03	--	2.2E+04	--	3.2E+03	--	1.7E+04
79-00-5	1,1,2-Trichloroethane	1.5E-01	--	7.7E+00	--	1.6E-01	6.4E+00	1.6E+00	3.5E+01
79-01-6	Trichloroethene (TCE)	1.2E-01	1.0E+04	6.1E+00	4.4E+04	--	4.8E-01	--	2.6E+00
120-82-1	1,2,4-trichlorobenzene[3]	--	--	--	--	--	1.6E+01	--	8.7E+01
75-69-4	Trichlorofluoromethane	--	7.3E+02	--	3.1E+03	--	4.8E+02	--	2.6E+03
76-13-1	1,1,2-Trichlorotrifluoroethane	--	3.1E+02	--	1.3E+03	--	4.8E+04	--	2.6E+05
75-01-4	Vinyl chloride[4]	2.8E-01	1.0E+02	1.4E+01	4.4E+02	2.8E-01	4.8E+00	2.8E+00	2.6E+01
108-38-3	m-Xylene	--	7.3E+02	--	3.1E+03	--	3.2E+02	--	1.7E+03
95-47-6	o-Xylene	--	7.3E+02	--	3.1E+03	--	3.2E+02	--	1.7E+03
106-42-3	p-Xylene	--	7.3E+02	--	3.1E+03	--	3.2E+02	--	1.7E+03
10330-20-7	Xylenes (total)	--	1.0E+02	--	4.4E+02	--	3.2E+02	--	1.7E+03

Notes:

1 EPA Region 10 (R10) has made a risk management decision to use a 1 in 100,000 excess individual lifetime risk for cancer for workers at Boeing Plant 2. Calculations are based on the EPA RSL equations modified for a total risk of 1.0E-5.

2 Ecology worker exposure was modified from full time (365 days/year x 24 hours/day) to the work week allowed under industrial soil exposure (10 hours/day x 7 days/week x 50 weeks/year) which is consistent with actual work practices at Boeing Plant 2 and is higher than EPA's industrial exposure assumptions. The Ecology Method C (Industrial Air) Cleanup Level does not include this modification.

3 No inhalation toxicity factors are available.

4 Ecology has established the following "rule" for dealing with the mutagenic effects of vinyl chloride; refer to for details: https://fortress.wa.gov/ecy/clarc/FocusSheets/VinylChloride.pdf. EPA R10 has accepted this approach for this site.

Abbreviations:

CAS Chemical abstract number
Ecology Washington State Department of Ecology
EPA U.S. Environmental Protection Agency
MTCA Model Toxics Control Act
RSL Regional screening level

Table A.2e
Ambient Air Equations and Parameters

EPA RSL — **Air Screening Levels from Non-cancer Toxicity**

$$\text{Air Screening Level } (\mu g/m^3) = \frac{(HQ \times AT \times UCF1)}{(EF \times ED \times ET \times UCF2) \times (1/RfC)} = RfC \times \frac{(HQ \times AT \times UCF1)}{(EF \times ED \times ET \times UCF2)}$$

HQ = Hazard quotient (unitless)
AT = Averaging time in days = 365 day/year * Lifetime (years)
ED = Exposure duration (years)
UCF1 = 1,000 g/mg
EF = Exposure frequency (days/year)
ET = Exposure time (hours/day)
UCF2 = 1/24 day/hours
RfC = Reference dose (mg/m^3)

Source: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

Exposure Scenarios	HQ (unitless)	AT (days)	ED (years)	EF (days/year)	ET (hours/day)	RfC (mg/m^3)
EPA RSL Residential	1	10,950	30	350	24	<table>
EPA RSL Worker	1	9,125	25	250	8	<table>

Ecology — **Air Cleanup Levels from Non-cancer Toxicity**

Equation 750-1
Non-cancer

$$\text{Air Cleanup Level} = \frac{(RfD \times ABW \times UCF1 \times HQ \times AT)}{(BR \times ABS \times ED \times EF)} = RfD \times \frac{ABW \times UCF \times HQ \times AT}{BR \times ED \times EF \times ABS}$$

RfD = Reference dose as specified in WAC 173-340-708(7)
ABW = Average body weight (kg) over the exposure duration
UCF1 = 1,000 µg/mg
BR = Breathing rate (m^3/day)
ABS = Inhalation absorption fraction (unitless)
HQ = Hazard quotient (unitless)
AT = Averaging time (years)
ED = Exposure duration (years)
EF = Exposure frequency (unitless fraction of full-time exposure, see below)

Exposure Scenarios	RfD (mg/kg-day)	ABW (kg)	HQ (unitless)	AT (years)	BR (m^3/day)	ABS (unitless)	ED (years)	EF (unitless)	Assumptions for Unitless EF Term: hours/day (unitless)	days/week (unitless)	weeks/year (unitless)
DEFAULT MTCA Method B	<table>	16	1	6	10	1	6	1.00	24	7	52
DEFAULT MTCA Method C	<table>	70	1	6	20	1	6	1.00	24	7	52
MTCA with Standard Worker Exposure	<table>	70	1	6	20	1	6	0.23	8	5	50
MTCA with MTCA Soil Exposure[1]	<table>	70	1	6	20	1	6	0.40	10	7	50

EPA RSL — **Air Screening Levels for Cancer Risk**

$$\text{Air Screening Level } (\mu g/m^3) = \frac{(TR \times AT)}{(EF \times ED \times ET \times UCF1 \times IUR)} = \frac{1}{IUR} \times \frac{(TR \times AT)}{(EF \times ED \times ET \times UCF1)}$$

TR = Target excess individual lifetime cancer risk (unitless)
AT = Averaging time in days = 365 day/year * Lifetime (years)
LT = Life time (years)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
ET = Exposure time (hours/day)
UCF1 = 1/24 day/hours
IUR = Inhalation unit risk ($m^3/\mu g$)

Source: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

Exposure Scenarios	TR (unitless)	AT (days)	LT (years)	ED (years)	EF (days/year)	ET (hours/day)	IUR (mg/m^3)
EPA RSL Residential	1.00E-06	25,550	70	30	350	24	<table>
EPA RSL Worker, Modified[2]	1.00E-05	25,550	70	25	250	8	<table>

Ecology — **Air Cleanup Levels from Cancer Risk**

Equation 750-2
Cancer

$$\text{Air Cleanup Level} = \frac{(RISK \times ABW \times AT \times UCF1)}{(CPF_i \times BR \times ABS \times ED \times EF)} = \frac{1}{CPF_i} \times \frac{(RISK \times ABW \times AT \times UCF1)}{(BR \times ABS \times ED \times EF)}$$

RISK = Acceptable excess individual lifetime cancer risk level (unitless)
ABW = Average body weight (kg) over the exposure duration
AT = Averaging time (years)
UCF1 = 1,000 mg/kg
CPF_i = Carcinogenic potency factor as specified in WAC 173-340-708(8)
BR = Breathing rate (m^3/day)
ABS = Inhalation absorption fraction (unitless)
ED = Exposure duration (years)
EF = Exposure frequency (unitless fraction of full-time exposure, see below)

Exposure Scenarios	RISK (unitless)	ABW (kg)	AT (years)	CPF_i (kg-day/mg)	BR (m^3/day)	ABS (unitless)	ED (years)	EF (unitless)	Assumptions for Unitless EF Term: hours/day (unitless)	days/week (unitless)	weeks/year (unitless)
DEFAULT MTCA Method B	1.00E-06	70	75	<table>	20	1	30	1	24	7	52
DEFAULT MTCA Method C	1.00E-05	70	75	<table>	20	1	30	1	24	7	52
MTCA with Standard Worker Exposure	1.00E-05	70	75	<table>	20	1	20	0.23	8	5	50
MTCA with MTCA Soil Exposure[1]	1.00E-05	70	75	<table>	20	1	20	0.40	10	7	50

Notes:

1 Ecology worker exposure was modified from full time (365 days/year x 24 hours/day) to the work week allowed under industrial soil exposure (10 hours/day x 7 days/week x 50 weeks/year).
2 EPA Region 10 (R10) has made a risk management decision to use a 1 in 100,000 risk for excess individual lifetime cancer for workers at Boeing Plant 2. Calculations are based on the EPA RSL equations modified for a total risk of 1.0E-5.

Abbreviations:

Ecology Washington State Department of Ecology
EPA U.S. Environmental Protection Agency
MTCA Model Toxics Control Act
RSL Regional screening level

Table A.2f
Soil Calculations

		Direct Contact Exposures																								Protection of Groundwater	
		Ecology Default Calculations				EPA RSL Calculations with Site-specific Factors																Proposed TMCLs				MTCA Three-phase Model for Unsaturated Soils	
		Residential		Industrial		Residential Exposure								Worker Exposure[1]								Direct Contact Exposure					
		MTCA Method B with CLARC Values		MTCA Method C with CLARC Values		Cancer Risk with EPA RSL Calculations, Parameters, and Toxicity Factors				Non-cancer Risk with EPA RSL Calculations, Parameters, and Toxicity Factors				Cancer Risk with EPA RSL Calculations, Parameters, and Toxicity Factors				Non-cancer Risk with EPA RSL Calculations, Parameters, and Toxicity Factors				Residential		Industrial/Worker		Groundwater Target to be Protected[2]	Three-phase Partitioning Between Soil, Soil Vapor, and Groundwater using MTCA Equation[3]
CAS Number	Chemical	Cancer (mg/kg)	Non-cancer (mg/kg)	Cancer (mg/kg)	Non-cancer (mg/kg)	Ingestion (mg/kg)	Dermal (mg/kg)	Inhalation (mg/kg)	TOTAL (mg/kg)	Ingestion (mg/kg)	Dermal (mg/kg)	Inhalation (mg/kg)	TOTAL (mg/kg)	Ingestion (mg/kg)	Dermal (mg/kg)	Inhalation (mg/kg)	TOTAL (mg/kg)	Ingestion (mg/kg)	Dermal (mg/kg)	Inhalation (mg/kg)	TOTAL (mg/kg)	MTCA B (mg/kg)	EPA RSL (mg/kg)	MTCA C (mg/kg)	Modified EPA RSL (mg/kg)	(µg/L)	(mg/kg)
67-64-1	Acetone	--	7.2E+04	--	3.1E+06	--	--	--	--	7.0E+04	--	4.8E+05	6.1E+04	--	--	--	--	4.6E+05	--	2.0E+06	3.7E+05	7.2E+04	6.1E+04	3.1E+06	3.7E+05	1.1E+05	5.1E+02
71-43-2	Benzene	1.8E+01	3.2E+02	2.4E+03	1.4E+04	1.2E+01	--	1.2E+00	1.1E+00	3.1E+02	--	1.2E+02	8.6E+01	2.6E+02	--	6.0E+01	4.9E+01	2.0E+03	--	5.0E+02	4.0E+02	1.8E+01	1.1E+00	2.4E+03	4.9E+01	2.0E+00	9.3E-02
78-93-3	2-Butanone (MEK)	--	4.8E+04	--	2.1E+06	--	--	--	--	4.7E+04	--	6.8E+04	2.8E+04	--	--	--	--	3.1E+05	--	2.9E+05	1.5E+05	4.8E+04	2.8E+04	2.1E+06	1.5E+05	7.3E+04	4.3E+02
75-15-0	Carbon Disulfide	--	8.0E+03	--	3.5E+05	--	--	--	--	7.8E+03	--	9.2E+02	8.2E+02	--	--	--	--	5.1E+04	--	3.9E+03	3.6E+03	8.0E+03	8.2E+02	3.5E+05	3.6E+03	3.9E+03	7.5E+01
56-23-5	Carbon Tetrachloride	1.4E+01	3.2E+02	1.9E+03	1.4E+04	9.1E+00	--	6.5E-01	6.1E-01	3.1E+02	--	1.7E+02	1.1E+02	2.0E+02	--	3.3E+01	2.8E+01	2.0E+03	--	7.1E+02	5.2E+02	1.4E+01	6.1E-01	1.9E+03	2.8E+01	4.6E-01	2.1E-02
108-90-7	Chlorobenzene	--	1.6E+03	--	7.0E+04	--	--	--	--	1.6E+03	--	3.6E+02	2.9E+02	--	--	--	--	1.0E+04	--	1.5E+03	1.3E+03	1.6E+03	2.9E+02	7.0E+04	1.3E+03	2.7E+02	2.6E+01
75-00-3	Chloroethane	--	--	--	--	--	--	--	--	--	--	1.4E+04	1.4E+04	--	--	--	--	--	--	6.1E+04	6.1E+04	--	1.4E+04	--	6.1E+04	2.1E+04	2.8E+02
67-66-3	Chloroform	--	8.0E+02	--	3.5E+04	2.1E+01	--	3.0E-01	3.0E-01	7.8E+02	--	2.9E+02	2.1E+02	4.6E+02	--	1.5E+01	1.5E+01	5.1E+03	--	1.2E+03	9.8E+02	8.0E+02	3.0E-01	3.5E+04	1.5E+01	9.4E+00	2.0E-01
74-87-3	Chloromethane	--	--	--	--	--	--	--	--	--	--	1.2E+02	1.2E+02	--	--	--	--	--	--	5.0E+02	5.0E+02	--	1.2E+02	--	5.0E+02	1.9E+02	1.6E+00
106-43-4	4-Chlorotoluene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.6E+03	4.0E+02
95-50-1	1,2-Dichlorobenzene	--	7.2E+03	--	3.1E+05	--	--	--	--	7.0E+03	--	2.6E+03	1.9E+03	--	--	--	--	4.6E+04	--	1.1E+04	8.9E+03	7.2E+03	1.9E+03	3.1E+05	8.9E+03	4.4E+02	6.8E+01
106-46-7	1,4-Dichlorobenzene	--	--	--	--	1.2E+02	--	2.5E+00	2.4E+00	5.5E+03	--	9.3E+03	3.5E+03	2.6E+03	--	1.2E+02	1.2E+02	3.6E+04	--	3.9E+04	1.9E+04	--	2.4E+00	--	1.2E+02	1.7E+00	3.5E-01
75-34-3	1,1-Dichloroethane	--	1.6E+04	--	7.0E+05	1.1E+02	--	3.4E+00	3.3E+00	1.6E+04	--	--	1.6E+04	2.5E+03	--	1.7E+02	1.6E+02	1.0E+05	--	--	1.0E+05	1.6E+04	3.3E+00	7.0E+05	1.6E+02	3.3E+01	7.1E-01
107-06-2	1,2-Dichloroethane	1.1E+01	1.6E+03	1.4E+03	7.0E+04	7.0E+00	--	4.6E-01	4.3E-01	--	--	1.2E+04	1.2E+04	1.6E+02	--	2.3E+01	2.0E+01	--	--	5.2E+04	5.2E+04	1.1E+01	4.3E-01	1.4E+03	2.0E+01	3.6E+00	7.0E-02
75-35-4	1,1-Dichloroethene	--	4.0E+03	--	1.7E+05	--	--	--	--	3.9E+03	--	2.6E+02	2.4E+02	--	--	--	--	2.6E+04	--	1.1E+03	1.0E+03	4.0E+03	2.4E+02	1.7E+05	1.0E+03	3.2E+00	8.1E-02
156-59-2	*cis* -1,2-Dichloroethene	--	1.6E+02	--	7.0E+03	--	--	--	--	1.6E+02	--	--	1.6E+02	--	--	--	--	1.0E+03	--	--	1.0E+03	1.6E+02	1.6E+02	7.0E+03	1.0E+03	1.3E+02	2.6E+00
156-60-5	*trans* -1,2-Dichloroethene	--	1.6E+03	--	7.0E+04	--	--	--	--	1.6E+03	--	--	1.6E+03	--	--	--	--	1.0E+04	--	--	1.0E+04	1.6E+03	1.6E+03	7.0E+04	1.0E+04	9.4E+02	1.9E+01
78-87-5	1,2-Dichloropropane	--	--	--	--	1.8E+01	--	9.4E-01	8.9E-01	7.0E+03	--	1.6E+01	1.6E+01	4.0E+02	--	4.7E+01	4.2E+01	4.6E+04	--	6.8E+01	6.8E+01	--	8.9E-01	--	4.2E+01	3.7E+00	9.2E-02
100-41-4	Ethylbenzene	--	8.0E+03	--	3.5E+05	5.8E+01	--	5.9E+00	5.4E+00	7.8E+03	--	6.4E+03	3.5E+03	1.3E+03	--	3.0E+02	2.4E+02	5.1E+04	--	2.7E+04	1.8E+04	8.0E+03	5.4E+00	3.5E+05	2.4E+02	1.7E+00	2.3E-01
98-82-8	Isopropylbenzene(cumene)	--	8.0E+03	--	3.5E+05	--	--	--	--	7.8E+03	--	2.8E+03	2.1E+03	--	--	--	--	5.1E+04	--	1.2E+04	9.5E+03	8.0E+03	2.1E+03	3.5E+05	9.5E+03	2.7E+02	7.8E+01
591-78-6	2-Hexanone	--	4.0E+02	--	1.7E+04	--	--	--	--	3.9E+02	--	4.5E+02	2.1E+02	--	--	--	--	2.6E+03	--	1.9E+03	1.1E+03	4.0E+02	2.1E+02	1.7E+04	1.1E+03	3.2E+03	3.2E+01
75-09-2	Methylene Chloride	1.3E+02	4.8E+03	1.8E+04	2.1E+05	8.5E+01	--	1.2E+01	1.1E+01	4.7E+03	--	2.5E+03	1.6E+03	1.9E+03	--	6.2E+02	4.7E+02	3.1E+04	--	1.0E+04	7.7E+03	1.3E+02	1.1E+01	1.8E+04	4.7E+02	6.1E+01	6.5E-01
108-10-1	Methyl Isobutyl Ketone	--	6.4E+03	--	2.8E+05	--	--	--	--	6.3E+03	--	3.6E+04	5.3E+03	--	--	--	--	4.1E+04	--	1.5E+05	3.2E+04	6.4E+03	5.3E+03	2.8E+05	3.2E+04	1.9E+04	1.7E+02
91-20-3	Naphthalene	--	1.6E+03	--	7.0E+04	--	--	3.6E+00	3.6E+00	1.6E+03	4.3E+03	1.6E+02	1.4E+02	--	--	1.8E+02	1.8E+02	1.0E+04	2.4E+04	6.6E+02	6.0E+02	1.6E+03	3.6E+00	7.0E+04	1.8E+02	2.6E+01	1.6E+01
100-42-5	Styrene	--	1.6E+04	--	7.0E+05	--	--	--	--	1.6E+04	--	1.1E+04	6.3E+03	--	--	--	--	1.0E+05	--	4.4E+04	3.1E+04	1.6E+04	6.3E+03	7.0E+05	3.1E+04	7.7E+04	2.1E+04
79-34-5	1,1,2,2-Tetrachloroethane	5.0E+00	1.6E+03	6.6E+02	7.0E+04	3.2E+00	--	6.8E-01	5.6E-01	1.6E+03	--	--	1.6E+03	7.2E+01	--	3.4E+01	2.3E+01	1.0E+04	--	--	1.0E+04	5.0E+00	5.6E-01	6.6E+02	2.3E+01	3.3E-01	1.3E-02
127-18-4	Tetrachloroethene (PCE)	--	8.0E+02	--	3.5E+04	1.2E+00	--	1.0E+00	5.6E-01	7.8E+02	--	6.0E+03	6.9E+02	2.6E+01	--	5.3E+01	1.8E+01	5.1E+03	--	2.5E+04	4.2E+03	8.0E+02	5.6E-01	3.5E+04	1.8E+01	2.1E-02	1.6E-03
108-88-3	Toluene	--	6.4E+03	--	2.8E+05	--	--	--	--	6.3E+03	--	2.4E+04	5.0E+03	--	--	--	--	4.1E+04	--	1.0E+05	2.9E+04	6.4E+03	5.0E+03	2.8E+05	2.9E+04	1.3E+03	1.0E+02
71-55-6	1,1,1-Trichloroethane	--	1.6E+05	--	7.0E+06	--	--	--	--	1.6E+05	--	9.2E+03	8.7E+03	--	--	--	--	1.0E+06	--	3.9E+04	3.7E+04	1.6E+05	8.7E+03	7.0E+06	3.7E+04	4.6E+04	1.9E+03
79-00-5	1,1,2-Trichloroethane	1.8E+01	3.2E+02	2.3E+03	1.4E+04	1.1E+01	--	1.2E+00	1.1E+00	3.1E+02	--	--	3.1E+02	2.5E+02	--	6.0E+01	4.8E+01	2.0E+03	--	--	2.0E+03	1.8E+01	1.1E+00	2.3E+03	4.8E+01	2.3E+00	7.3E-02
79-01-6	Trichloroethene (TCE)	1.1E+01	2.4E+01	1.5E+03	1.0E+03	4.9E+00	--	2.9E-01	2.7E-01	2.3E+01	--	2.5E+04	2.3E+01	1.1E+02	--	1.5E+01	1.3E+01	1.5E+02	--	1.0E+05	1.5E+02	1.1E+01	2.7E-01	1.0E+03	1.3E+01	5.1E-01	1.8E-02
120-82-1	1,2,4-trichlorobenzene	3.4E+01	8.0E+02	4.5E+03	3.5E+04	2.2E+01	--	--	2.2E+01	7.8E+02	--	--	7.8E+02	4.9E+02	--	--	4.9E+02	5.1E+03	--	--	5.1E+03	3.4E+01	2.2E+01	4.5E+03	4.9E+02	1.3E-01	8.0E-02
75-69-4	Trichlorofluoromethane	--	2.4E+04	--	1.0E+06	--	--	--	--	2.3E+04	--	8.1E+02	7.8E+02	--	--	--	--	1.5E+05	--	3.4E+03	3.3E+03	2.4E+04	7.8E+02	1.0E+06	3.3E+03	6.9E+03	2.0E+02
76-13-1	1,1,2-Trichlorotrifluoroethane	--	2.4E+06	--	1.0E+08	--	--	--	--	2.3E+06	--	4.3E+02	4.3E+02	--	--	--	--	1.5E+07	--	1.8E+03	1.8E+03	2.4E+06	4.3E+02	1.0E+08	1.8E+03	5.9E+04	7.1E+03
75-01-4	Vinyl chloride[4]	6.7E-01	2.4E+02	8.8E+01	1.0E+04	4.3E-01	--	8.1E-05	8.1E-05	2.3E+02	--	1.1E+02	7.4E+01	9.5E+00	--	4.1E-03	4.1E-03	1.5E+03	--	4.5E+02	3.5E+02	6.7E-01	8.1E-05	8.8E+01	4.1E-03	2.4E+00	3.4E-02
108-38-3	m-Xylene	--	1.6E+04	--	7.0E+05	--	--	--	--	1.6E+04	--	4.3E+03	3.4E+03	--	--	--	--	1.0E+05	--	1.8E+04	1.5E+04	1.6E+04	3.4E+03	7.0E+05	1.5E+04	1.3E+03	1.6E+02
95-47-6	o-Xylene	--	1.6E+04	--	7.0E+05	--	--	--	--	1.6E+04	--	5.1E+03	3.8E+03	--	--	--	--	1.0E+05	--	2.1E+04	1.8E+04	1.6E+04	3.8E+03	7.0E+05	1.8E+04	1.6E+03	2.0E+02
106-42-3	p-Xylene	--	1.6E+04	--	7.0E+05	--	--	--	--	1.6E+04	--	4.4E+03	3.4E+03	--	--	--	--	1.0E+05	--	1.8E+04	1.6E+04	1.6E+04	3.4E+03	7.0E+05	1.6E+04	1.6E+03	2.3E+02
10330-20-7	Xylenes (total)	--	1.6E+04	--	7.0E+05	--	--	--	--	1.6E+04	--	6.5E+02	6.3E+02	--	--	--	--	1.0E+05	--	2.7E+03	2.7E+03	1.6E+04	6.3E+02	7.0E+05	2.7E+03	1.5E+03	2.0E+02

Notes:

1 EPA RSL Worker scenario has been modified to a 1 in 100,000 excess individual lifetime cancer risk and a soil ingestion rate of 200 mg/kg-day by an EPA Region 10 risk management decision.
2 Refer to Table A.2b, Groundwater Standards, Criteria, and Risk-based Calculations, of this attachment.
3 Soil to Groundwater cleanup values are based on the MTCA fixed parameter three-phase partitioning model (WAC 173-340-747, equations 747-1 and 747-2), using partitioning factors presented in associated tables in this attachment.
4 Ecology has established the following "rule" for dealing with the mutagenic effects of vinyl chloride; refer to for details: https://fortress.wa.gov/ecy/clarc/FocusSheets/VinylChloride.pdf. EPA R10 has accepted this approach for this site.

Abbreviations:

CAS Chemical abstract number
CLARC Cleanup Levels and Risk Calculation
Ecology Washington State Department of Ecology
EPA U.S. Environmental Protection Agency
MTCA Model Toxics Control Act
RSL Regional screening level

Table A.2g
Soil Equations and Parameters

Ecology — **Soil Cleanup Levels from Non-Cancer Effects for Ingestion Only**

Equation 740-1
Non-cancer

Soil Cleanup Level (mg/kg)= **EPA $SSL_{SOIL\text{-}NC\text{-}ING}$ =**

$$\frac{(RfD_o \times ABW \times UCF \times HQ \times AT)}{(SIR \times AB1 \times EF \times ED)}$$

Terminology in MTCA		Terminology in EPA RSL Equation	
RfD_o = Reference dose (mg/kg-day) as specified in WAC 173-340-708(7)			
ABW = Average body weight (kg) over the exposure duration	=	BW	Body weight (kg)
UCF = Unit coversion factor (mg/kg)	=	same	
SIR = Soil ingestion rate (mg/kg)	=	IRS	Ingestion rate soil (mg/day)
AB1 = Gastrointestinal absorption fraction	=	not used	
HQ = Hazard quotient (unitless)	=	THQ	Target hazard quotient (unitless)
AT = Averaging time (years)	=	AT	Averaging time (days)
ED = Exposure duration (years)	=	ED	Exposure duration (years)
EF = Exposure frequency (fraction of time)	=	EF	Exposure frequency (days/year)

Exposure Scenarios	RfD_o (mg/kg-day)	ABW (kg)	HQ (unitless)	AT (years)	SIR (mg/day)	AB1 (unitless)	EF (unitless)	ED (years)	Assumptions for Unitless EF Term: Total Days (unitless)	hours/day (unitless)	days/week (unitless)	weeks/year (unitless)
MTCA Method B Residential Child	<table>	16	1	6	200	1	1.00	6	365	24	7	52
MTCA Method C Worker	<table>	70	1	20	50	1	0.40	20	350	10	7	50
EPA RSL Residental Child	<table>	15	1	6	200	1	0.96	6	350			
EPA RSL Residental Adult	<table>	70	1	25	100	1	0.96	25	350			
Modified EPA RSL Worker[1,2]	<table>	70	1	25	200	1	0.69	25	250			

EPA RSL — **Soil Screening Levels from Non-cancer Effects**

Soil Screening level (mg/kg) =

$$\frac{1}{\overbrace{\frac{1}{SSL_{SOIL\text{-}NC\text{-}ING}}}^{\text{< ---------- Ingestion of Soil Term ---------->}} + \overbrace{\frac{1}{SSL_{SOIL\text{-}NC\text{-}DER}}}^{\text{< ------ Dermal Contact with Soil Term ------>}} + \overbrace{\frac{1}{SSL_{SOIL\text{-}NC\text{-}INH}}}^{\text{< ---------- Inhalation of Dust ---------->}}}$$

$SSL_{SOIL\text{-}NC\text{-}ING}$ = **Use the MTCA equation above for ingestion**

$$SSL_{SOIL\text{-}NC\text{-}DER} = \frac{THQ \times BW \times AT \times RfD_d \times UCF1}{EF \times ED \times SA \times AF \times ABS_d} = \frac{RfD_d}{ABS_d} \times \frac{THQ \times BW \times AT \times UCF1}{EF \times ED \times SA \times AF}$$

$$SSL_{SOIL\text{-}NC\text{-}INH} = \frac{THQ \times AT}{(1/RfC_i) \times EF \times ED \times ET \times UCF2 \times [(1/PEF) + (1/VF)]} = \frac{RfC_i}{[1/VF + 1/PEF]} \times \frac{THQ \times AT}{EF \times ED \times ET \times UCF2}$$

THQ = Target Hazard Quotient (or HQ Hazard Quotient), unitless
BW = Body Weight (kg)
AT = Averaging Time (total number of days in the averaging time: 6 yrs for children; 25 years for workers)
RfD_d = Dermal reference dose (mg/kg-day) = RfD_o * GI-abs
GI-abs = GI absorption factor correction
UCF1 = 1,000,000 mg/kg
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
ET = Exposure time (hours/day)
SA = Surface area exposed (cm^2/day)
AF = Adherence factor (mg/cm^2)
ABS_d = Skin absorption factor (unitless)
RfC_i = Reference concentration, inhalation (mg/m^3; chemical specific)
PEF = Particulate emission factor used for dusts (m^3/kg; 1.4 E+9 from EPA RSL User Manual)
VF = Volatilization factor used for volatile organic compounds (m^3/kg; chemical specific)
UCF2 = 1/24 day/hours

Source: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

Exposure Scenarios	THQ (unitless)	BW (kg)	AT (days)	RfD_d (mg/kg-day)	ED (years)	EF (days/year)	ET (hours/day)	IRS (mg/day)	SA (cm^2/day)	AF (mg/cm^2)	ABS_d (unitless)	RfC_i (mg/m^3)	VF (m^3/kg)	PEF (m3/kg)	1/VF + 1/PEF (m^3/kg)
EPA RSL Residential (Child)	1	15	2,190	<table>	6	350	24	200	2,800	0.2	<table>	<table>	<table>	1.36E+09	<table>
Modified EPA RSL Worker[1,2]	1	70	9,125	<table>	25	250	8	200	3,300	0.2	<table>	<table>	<table>	1.36E+09	<table>

Ecology — **Soil Cleanup Levels from Cancer Risk for Ingestion Only**

Equation 740-2
Cancer

Soil Cleanup Level (mg/kg) =

$$\frac{(RISK \times ABW \times AT \times UCF)}{(CPF_o \times SIR \times AB1 \times ED \times EF)}$$

RISK = Acceptable excess individual lifetime cancer risk level (unitless)
ABW = Average body weight (kg) over the exposure duration
AT = Averaging time (years)
UCF = 1,000,000 mg/kg
CPF_o = Carcinogenic potency factor (kg-day/mg)
SIR = Soil ingestion rate (mg/day)
AB1 = Gastrointestinal absorbtion fraction (unitless)
ED = Exposure duration (years)
EF = Exposure frequency (unitless)

Exposure Scenarios	RISK (unitless)	ABW (kg)	AT (years)	CPF_o (kg-day/mg)	SIR (mg/day)	AB1 (unitless)	ED (years)	EF (unitless)	Assumptions for Unitless EF Term: hours/day (unitless)	days/week (unitless)	weeks/year (unitless)
DEFAULT MTCA Method B	1.00E-06	16	75	<table>	200	1	6	1	24	7	52
DEFAULT MTCA Method C	1.00E-05	70	75	<table>	50	1	20	0.4	24	7	52

Table A.2g
Soil Equations and Parameters

EPA RSL — Soil Screening level for Cancer Risk for Residents (childhood corrected) and Workers

< ---------- Ingestion of Soil Term ----------> < ------ Dermal Contact with Soil Term -------> < ---------- Inhalation of Dust ----------->

$$\text{Soil Screening level (mg/kg)} = \frac{1}{\frac{1}{SSL_{SOIL\text{-}CA\text{-}ING}} + \frac{1}{SSL_{SOIL\text{-}CA\text{-}DER}} + \frac{1}{SSL_{SOIL\text{-}CA\text{-}INH}}}$$

$$SSL_{SOIL\text{-}CA\text{-}ING} = \frac{TR \times AT}{CSF_o \times EF \times IFS \times UCF1} \quad \text{where} \quad IFS = \frac{ED_c \times IRS_c}{BW_c} + \frac{ED_a \times IRS_a}{BW_a}$$

$$SSL_{SOIL\text{-}CA\text{-}DER} = \frac{TR \times AT}{CSF_d \times EF \times DFS \times ABS_d \times UCF1} \quad \text{where} \quad DFS = \frac{ED_c \times SA_c \times AF_c}{BW_c} + \frac{ED_a \times SA_a \times AF_a}{BW_a}$$

$$SSL_{SOIL\text{-}NC\text{-}INH} = \frac{TR \times AT}{IUR \times UCF2 \times EF \times ED \times ET \times UCF3 \times [(1/PEF) + (1/VF)]} = \frac{1}{IUR*[1/VF + 1/PEF]} \times \frac{TR \times AT}{UCF2 \times EF \times ED \times ET \times UCF3}$$

TR = Target excess individual lifetime cancer risk (unitless)
AT = Averaging time in days = 365 day/year * Lifetime (years)
CSF_o = Oral cancer slope factor (kg-day/mg)
EF = Exposure frequency (days/year)
IFS = Resident soil ingestion rate; age-adjusted (mg-year/kg-day)
UCF1 = 1/1,000,000 kg/mg
ED_c = Exposure duration, child (years)
IRS_c = Resident soil ingestion rate, child; age-adjusted (mg-year/kg-day)
BW_c = Body weight, child (kg)
ED_a = Exposure duration, adult (years)
IRS_a = Resident soil ingestion rate, adult; age-adjusted (mg-year/kg-day)
BW_a = Body weight, adult (kg)
CSF_d = Cancer slope factor, dermal
GI-abs = GI absorption factor correction (unitless)
DFS = Resident soil dermal contact factor; age-adjusted (mg-year/kg-day)
ABS_d = Skin absorption factor (chemical specific)
SA_c = Surface area, child (cm^2/day)
AF_c = Adherence factor, child (mg/cm^2)
SA_a = Surface area, adult (cm^2/day)
AF_a = Adherence factor, adult (mg/cm^2)
IUR = Inhalation unit rate (m^3/µg)
UCF2 = 1,000 µg/m)
UCF3 = 1/24 day/hours
ED = Exposure duration (years)
ET = Exposure time (hours/day)
PEF = Particulate emission factor used for dusts (m^3/kg)
VF = Volatilization factor used for volatile organic compounds (m^3/kg)

Source: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

Exposure Scenarios	TR (unitless)	AT (days)	LT (years)	CSF_o (kg-day/mg)	EF (days/year)	ET (hours/day)	IFS (mg-year/kg-day)	IRS (mg-year/kg-day)	ED (years)	BW (kg)	DFS (mg-year/kg-day)	SA (cm^2/day)	AF (mg/cm^2)	ABS_d (unitless)	IUR (m^3/µg)	PEF (m^3/kg)	VF (m^3/kg)	1/VF + 1/PEF (kg/m^3)
EPA RSL Resident	1.00E-06	25,550	70	<table>	350	24	114		30		361			<table>	<table>	1.40E+09	<table>	<table>
Contribution During Childhood								200	6	15	224	2,800	0.2					
Contribution During Adult Years								100	24	70	137	5,700	0.07					
Modified EPA RSL Worker[1,2]	1.00E-05	25,550	70	<table>	250	8	71	200	25	70	236	3,300	0.2	<table>	<table>	1.40E+09	<table>	<table>

Ecology — Three-phase Partitioning Between Soil, Soil Vapor, and Groundwater Using MTCA Equation

Equation 747-1

$$\text{Soil Concentration (mg/kg)} = C_s = C_w \times UCF \times DF \times \left(K_d + \frac{(\theta w + \theta_a H_{cc})}{\rho_b}\right) = C_w \times UCF \times DF \times K_d + \frac{C_w \times UCF \times DF \times \theta_w}{\rho_b} + \frac{C_w \times UCF \times DF \times \theta_a \times H_{cc}}{\rho_b} = C_w * (C1*K_d + C2 + C3*H_{cc})$$

where

$C1 = UCF \times DF$

$C2 = \frac{UCF \times DF \times \theta_w}{\rho_b}$

$C3 = \frac{UCF \times DF \times \theta_a}{\rho_b}$

C_w = Ground water cleanup level established under WAC 173-340-720 (µg/L)
UCF = 1/1,000 mg/µg
DF = Dilution factor (dimensionless)
Kd = Distribution coefficient (L/kg)
θ_w = Water-filled soil porosity (ml water/ml soil)
θ_a = Air-filled soil porosity (ml air/ml soil)
H_{cc} = Henry's law constant (dimensionless)
ρ_b = Dry soil bulk density (kg/L)

Exposure Scenarios	C_w (µg/L)	DF (unitless)	K_d (L/kg)	θ_w (ml water/ ml soil)	θ_a (ml air/ ml soil)	H_{cc} (unitless)	ρ_b (kg/L)	C1 (mg/µg)	C2 (L-ml water/ ml soil)	C3 (L-ml air/ ml soil)
Soil Concentration for Saturated Soil	<table>	20	<table>	0.3	0.13	<table>	1.5	0.02	0.004	0.002

Notes:

[ ] Indicates no value is required in calculations for the associated exposure scenario indicated.

<table> Indicates a chemical-specific factor is available in the associated tables of this attachment.

1 EPA RSL Worker scenario has been modified to a 1 in 100,000 excess individual lifetime cancer risk and a soil ingestion rate of 200 mg/kg-day by an EPA Region 10 risk management decision.

2 Exposure frequency taken to be 250 days/year. This value was selected based on Region 9 EPA RSL tables last updated November 2010, which uses parameters associated with an indoor worker to calculate risk.

Abbreviations:

EPA U.S. Environmental Protection Agency
MTCA Model Toxics Control Act
RSL Regional screening level
SSL Soil Screening Level

Subscripts:

CA Cancer
DER Dermal
ING Ingestion
INH Inhalation
NC Non-cancer

Table A.2h
Groundwater Calculations

		Surface Water to Fish Consumption Pathway														Drinking Water Pathways			
		EPA Tribal Calculations				Ecology MTCA Calculations						Proposed Water to Fish Consumption TMCLs				EPA		Ecology	
		Tribal Consumption Child Includes EPA BCFs and Toxicity Factors[1]		Tribal Consumption Adult Includes EPA BCFs and Toxicity Factors[1]		Default (Recreational) Includes EPA BCFs and Toxicity Factors[2]		Asian/Pacific Islander Consumption Child Includes EPA BCFs and Toxicity Factors[3]		Asian/Pacific Islander Consumption Adult Includes EPA BCFs and Toxicity Factors[3]		MTCA Default Consumption Rate Modified to Use EPA Toxicity and Partitioning Coefficients		Tribal and/or Asian/Pacific Islander Modified to Use EPA Toxicity and Partitioning Coefficients		EPA RSL Tap Water[4]		MTCA Method B Groundwater to Protect Drinking Water Use[5]	
CAS Number	Chemical	Cancer (µg/L)	Non-cancer (µg/L)	Cancer (µg/L)	Non-cancer (µg/L)	Cancer (µg/L)	Non-cancer (µg/L)	Cancer (µg/L)	Non-cancer (µg/L)	Cancer (µg/L)	Non-cancer (µg/L)	TMCL (µg/L)	Source (µg/L)	TMCL (µg/L)	Source (µg/L)	Cancer (µg/L)	Non-cancer (µg/L)	Cancer (µg/L)	Non-cancer (µg/L)
67-64-1	Acetone	--	1.1E+05	--	2.4E+05	--	7.4E+05	--	1.9E+05	--	3.1E+05	7.4E+05	MTCA B	1.1E+05	Tribal Child	3.3E+04	2.2E+04	--	7.2E+03
71-43-2	Benzene	9.9E+00	1.9E+02	2.0E+00	4.1E+02	1.4E+01	1.3E+03	1.7E+01	3.2E+02	7.1E+00	5.3E+02	1.4E+01	MTCA B	2.0E+00	Tribal Adult	4.1E-01	4.4E+01	8.0E-01	3.2E+01
78-93-3	2-Butanone (MEK)	--	7.3E+04	--	1.6E+05	--	4.9E+05	--	1.2E+05	--	2.1E+05	4.9E+05	MTCA B	7.3E+04	Tribal Child	--	7.1E+03	--	4.8E+03
75-15-0	Carbon Disulfide	--	3.9E+03	--	8.5E+03	--	2.6E+04	--	6.6E+03	--	1.1E+04	2.6E+04	MTCA B	3.9E+03	Tribal Child	--	1.0E+03	--	8.0E+02
56-23-5	Carbon Tetrachloride	2.3E+00	5.4E+01	4.6E-01	1.2E+02	3.2E+00	3.6E+02	3.8E+00	9.1E+01	1.6E+00	1.5E+02	3.2E+00	MTCA B	4.6E-01	Tribal Adult	4.4E-01	8.6E+01	6.3E-01	3.2E+01
108-90-7	Chlorobenzene	--	2.7E+02	--	5.9E+02	--	1.8E+03	--	4.6E+02	--	7.7E+02	1.8E+03	MTCA B	2.7E+02	Tribal Child	--	9.1E+01	--	1.6E+02
75-00-3	Chloroethane	--	--	--	--	--	--	--	--	--	--	--	--	--	Tribal Child	--	2.1E+04	--	--
67-66-3	Chloroform	4.6E+01	1.2E+03	9.4E+00	2.7E+03	6.6E+01	8.2E+03	7.8E+01	2.1E+03	3.3E+01	3.5E+03	6.6E+01	MTCA B	9.4E+00	Tribal Adult	1.9E-01	1.3E+02	--	8.0E+01
74-87-3	Chloromethane	--	--	--	--	--	--	--	--	--	--	--	--	--	Tribal Child	--	1.9E+02	--	--
106-43-4	4-Chlorotoluene	--	--	--	--	--	--	--	--	--	--	--	--	--	Tribal Child	--	2.6E+03	--	--
95-50-1	1,2-Dichlorobenzene	--	4.4E+02	--	9.5E+02	--	2.9E+03	--	7.3E+02	--	1.2E+03	2.9E+03	MTCA B	4.4E+02	Tribal Child	--	3.7E+02	--	7.2E+02
106-46-7	1,4-Dichlorobenzene	8.4E+00	2.7E+02	1.7E+00	6.0E+02	1.2E+01	1.8E+03	1.4E+01	4.6E+02	6.0E+00	7.8E+02	1.2E+01	MTCA B	1.7E+00	Tribal Child	4.3E-01	1.0E+03	--	--
75-34-3	1,1-Dichloroethane	1.6E+02	1.6E+04	3.3E+01	3.5E+04	2.3E+02	1.1E+05	2.7E+02	2.7E+04	1.2E+02	4.5E+04	2.3E+02	MTCA B	3.3E+01	Tribal Adult	2.4E+00	7.3E+03	--	1.6E+03
107-06-2	1,2-Dichloroethane	1.7E+01	--	3.6E+00	--	2.5E+01	--	2.9E+01	--	1.2E+01	--	2.5E+01	MTCA B	3.6E+00	Tribal Adult	1.5E-01	6.4E+02	4.8E-01	1.6E+02
75-35-4	1,1-Dichloroethene	--	2.3E+03	--	5.1E+03	--	1.6E+04	--	3.9E+03	--	6.7E+03	1.6E+04	MTCA B	2.3E+03	Tribal Child	--	3.4E+02	--	4.0E+02
156-59-2	*cis* -1,2-Dichloroethene	--	1.3E+02	--	2.9E+02	--	9.0E+02	--	2.3E+02	--	3.8E+02	9.0E+02	MTCA B	1.3E+02	Tribal Child	--	7.3E+01	--	1.6E+01
156-60-5	*trans* -1,2-Dichloroethene	--	9.4E+02	--	2.0E+03	--	6.3E+03	--	1.6E+03	--	2.7E+03	6.3E+03	MTCA B	9.4E+02	Tribal Child	--	1.1E+02	--	1.6E+02
78-87-5	1,2-Dichloropropane	1.8E+01	5.0E+03	3.7E+00	1.1E+04	2.6E+01	3.4E+04	3.1E+01	8.5E+03	1.3E+01	1.4E+04	2.6E+01	MTCA B	3.7E+00	Tribal Child	3.9E-01	8.3E+00	--	--
100-41-4	Ethylbenzene	8.4E+00	8.0E+02	1.7E+00	1.7E+03	1.2E+01	5.3E+03	1.4E+01	1.3E+03	6.0E+00	2.3E+03	1.2E+01	MTCA B	1.7E+00	Tribal Adult	1.5E+00	1.3E+03	--	8.0E+02
98-82-8	Isopropylbenzene(cumene)	--	2.7E+02	--	6.0E+02	--	1.8E+03	--	4.6E+02	--	7.8E+02	1.8E+03	MTCA B	2.7E+02	Tribal Child	--	6.8E+02	--	8.0E+02
591-78-6	2-Hexanone	--	3.2E+03	--	7.0E+03	--	2.2E+04	--	5.4E+03	--	9.2E+03	2.2E+04	MTCA B	3.2E+03	Tribal Child	--	4.7E+01	--	4.0E+01
75-09-2	Methylene Chloride	3.0E+02	1.2E+04	6.1E+01	2.5E+04	4.3E+02	7.8E+04	5.1E+02	2.0E+04	2.1E+02	3.3E+04	4.3E+02	MTCA B	6.1E+01	Tribal Adult	4.8E+00	1.1E+03	5.8E+00	4.8E+02
108-10-1	Methyl Isobutyl Ketone	--	1.9E+04	--	4.0E+04	--	1.2E+05	--	3.1E+04	--	5.3E+04	1.2E+05	MTCA B	1.9E+04	Tribal Child		2.0E+03	--	6.4E+02
91-20-3	Naphthalene	--	2.6E+01	--	5.6E+01	--	1.7E+02	--	4.3E+01	--	7.4E+01	1.7E+02	MTCA B	2.6E+01	Tribal Child	1.4E-01	6.2E+00	--	1.6E+02
100-42-5	Styrene	--	7.7E+04	--	1.7E+05	--	5.2E+05	--	1.3E+05	--	2.2E+05	5.2E+05	MTCA B	7.7E+04	Tribal Child	--	1.6E+03	--	1.6E+03
79-34-5	1,1,2,2-Tetrachloroethane	1.6E+00	5.5E+02	3.3E-01	1.2E+03	2.3E+00	3.7E+03	2.7E+00	9.3E+02	1.1E+00	1.6E+03	2.3E+00	MTCA B	3.3E-01	Tribal Adult	6.7E-02	7.3E+02	2.2E-01	1.6E+02
127-18-4	Tetrachloroethene (PCE)	1.0E-01	4.7E+01	2.1E-02	1.0E+02	1.4E-01	3.1E+02	1.7E-01	7.9E+01	7.2E-02	1.3E+02	1.4E-01	MTCA B	2.1E-02	Tribal Adult	1.1E-01	2.2E+02	--	8.0E+01
108-88-3	Toluene	--	1.3E+03	--	2.8E+03	--	8.7E+03	--	2.2E+03	--	3.7E+03	8.7E+03	MTCA B	1.3E+03	Tribal Child	--	2.3E+03	--	6.4E+02
71-55-6	1,1,1-Trichloroethane	--	4.6E+04	--	1.0E+05	--	3.1E+05	--	7.8E+04	--	1.3E+05	3.1E+05	MTCA B	4.6E+04	Tribal Child	--	9.1E+03	--	1.6E+04
79-00-5	1,1,2-Trichloroethane	1.1E+01	2.2E+02	2.3E+00	4.9E+02	1.6E+01	1.5E+03	1.9E+01	3.8E+02	8.2E+00	6.4E+02	1.6E+01	MTCA B	2.3E+00	Tribal Adult	--	1.5E+02	7.7E-01	3.2E+01
79-01-6	Trichloroethene (TCE)	2.5E+00	8.3E+00	5.1E-01	1.8E+01	3.6E+00	5.6E+01	4.2E+00	1.4E+01	1.8E+00	2.4E+01	3.6E+00	MTCA B	5.1E-01	Tribal Adult	2.0E+00	--	4.9E-01	2.4E+00
120-82-1	1,2,4-trichlorobenzene	6.5E-01	1.6E+01	1.3E-01	3.5E+01	9.3E-01	1.1E+02	1.1E+00	2.7E+01	4.6E-01	4.6E+01	9.3E-01	MTCA B	1.3E-01	Tribal Adult	2.3E+00	4.1E+00	1.5E+00	8.0E+01
75-69-4	Trichlorofluoromethane	--	6.9E+03	--	1.5E+04	--	4.6E+04	--	1.2E+04	--	2.0E+04	4.6E+04	MTCA B	6.9E+03	Tribal Child	--	1.3E+03	--	2.4E+03
76-13-1	1,1,2-Trichlorotrifluoroethane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.10E+06	5.90E+04	--	2.4E+05
75-01-4	Vinyl chloride[7]	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.6E-02	7.2E+01	2.9E-02	2.4E+01
108-38-3	m-Xylene	--	1.3E+03	--	2.9E+03	--	8.9E+03	--	2.2E+03	--	3.8E+03	8.9E+03	MTCA B	1.3E+03	Tribal Child	--	1.2E+03	--	1.6E+03
95-47-6	o-Xylene	--	1.6E+03	--	3.4E+03	--	1.1E+04	--	2.7E+03	--	4.5E+03	1.1E+04	MTCA B	1.6E+03	Tribal Child	--	1.2E+03	--	1.6E+03
106-42-3	p-Xylene	--	1.6E+03	--	3.5E+03	--	1.1E+04	--	2.7E+03	--	4.5E+03	1.1E+04	MTCA B	1.6E+03	Tribal Child	--	1.2E+03	--	1.6E+03
10330-20-7	Xylenes (total)	--	1.5E+03	--	3.4E+03	--	1.0E+04	--	2.6E+03	--	4.4E+03	1.0E+04	MTCA B	1.5E+03	Tribal Child	--	2.0E+02	--	1.6E+03

Notes:

1 MTCA Method B Equations 730-1 and 730-2 modified to apply Tribal fish ingestion rates, body weights, and exposure duration (Ecology 2007). Refer to associated tables in this attachment for toxicity factors, bioconcentration factors, and exposure parameters.
2 MTCA Method B Equations 730-1 and 730-2 using default exposure assumptions. Refer to associated tables in this attachment for toxicity factors, bioconcentration factors, and exposure parameters.
3 MTCA Method B Equations 730-1 and 730-2 modified to apply Asian/Pacific Islander fish ingestion rates, body weights, and exposure duration (Ecology 2007). Refer to associated tables in this attachment for toxicity factors, bioconcentration factors, and exposure parameters.
4 EPA RSL, Residential Tapwaters; http://www.epa.gov/region9/superfund/prg/.
5 MTCA Method B Equations 720-1 and 720-2; groundwater cleanup levels to protect drinking water uses.
6 Vinyl chloride is considered mutagenic by EPA; its values are from the November 2010 EPA RSL Tables; http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/pdf/resair_sl_table_run_NOVEMBER2010.pdf

Abbreviations:

BCF Bioconcentration factor
CAS Chemical abstract number
Ecology Washington State Deparment of Ecology
EPA U.S. Environmental Protection Agency
MTCA Model Toxics Control Act
RSL Regional screening level

Table A.2i
Groundwater Equations and Parameters

Surface Water to Fish Consumption by Humans: Non-cancer Effects

$$\text{Surface Water Cleanup or Screening Level } (\mu g/L) = \frac{(RfD_o \times ABW \times UCF1 \times UCF2 \times HQ \times AT)}{(BCF \times FCR \times FDF \times ED)}$$

RfD_o = Oral reference dose (mg/kg-day)
ABW = Average body weight (kg)
UCF1 = 1,000 g/mg
UCF2 = 1,000 g/L
HQ = Hazard quotient (unitless)
AT = Averaging time (years)
BCF = Bioconcentration factor (L/kg)
FCR = Fish consumption rate (g/day)
FDF = Fish diet fraction (unitless)
ED = Exposure duration (years)

Exposure Scenarios	RfD_o (mg/kg-day)	ABW (kg)	HQ (unitless)	AT (years)	BCF (L/kg)	FCR (g/day)	FDF (unitless)	ED (years)
MTCA Default[1]	<table>	70	1	30	<table>	54	0.5	30
MTCA Asian/Pacific Islander Child[2,3]	<table>	15	1	6	<table>	23	1	6
MTCA Asian/Pacific Islander Adult[2,3]	<table>	63	1	24	<table>	57.1	1	24
EPA Tribal Child[3,4]	<table>	15	1	6	<table>	38.8	1	6
EPA Tribal Adult[3,4]	<table>	81.8	1	64	<table>	97.1	1	64

Surface Water to Fish Consumption by Humans: Cancer

$$\text{Surface Water Cleanup or Screening Level } (\mu g/L) = \frac{(RISK \times ABW \times UCF1 \times UCF2 \times AT)}{(CPF_o \times BCF \times FCR \times FDF \times ED)}$$

Risk = Target excess individual lifetime cancer risk level (unitless)
ABW = Average body weight (kg)
UCF1 = 1,000 µg/mg
UCF2 = 1,000 g/L
AT = Averaging time (years)
CPF_o = Cancer potency factor (kg-day/mg)
BCF = Bioconcentration factor (L/kg)
FCR = Fish consumption rate (g/day)
FDF = Fish diet fraction (unitless)
ED = Exposure duration (years)

Exposure Scenarios	Risk (unitless)	ABW (kg)	AT (years)	CPF_o (kg-day/mg)	BCF (L/kg)	FCR (g/day)	FDF (unitless)	ED (years)
MTCA Default[1]	1.00E-06	70	75	<table>	<table>	54	0.5	30
MTCA Asian/Pacific Islander Child[2,3]	1.00E-06	15	70	<table>	<table>	23	1	6
MTCA Asian/Pacific Islander Adult[2,3]	1.00E-06	63	70	<table>	<table>	57.1	1	24
EPA Tribal Child[3,4]	1.00E-06	15	70	<table>	<table>	38.8	1	6
EPA Tribal Adult[3,4]	1.00E-06	81.8	70	<table>	<table>	97.1	1	64

Groundwater (as Drinking Water) Cleanup Levels: Non-cancer Effects

$$\text{Surface Water Cleanup or Screening Level } (\mu g/L) = \frac{(RfD_o \times ABW \times UCF \times HQ \times AT)}{(DWIR \times INH \times DWF \times ED)}$$

RfD_o = Oral reference dose (mg/kg-day)
ABW = Average body weight (kg)
UCF = 1,000 µg/mg
HQ = Hazard quotient (unitless)
AT = Averaging time (years)
DWIR = Drinking water ingestion rate (L/day)
INH = Inhalation correction factor (unitless)
DWF = Drinking water fraction (unitless)
ED = Exposure duration (years)

Exposure Scenarios	RfD_o (mg/kg-day)	ABW (kg)	HQ (unitless)	AT (years)	DWIR (L/day)	INH (unitless)	DWF (unitless)	ED (years)
MTCA Default[1]	<table>	16	1	6	1	2	1	6

Groundwater (as Drinking Water) Cleanup Levels: Cancer

$$\text{Surface Water Cleanup or Screening Level } (\mu g/L) = \frac{(RISK \times ABW \times UCF \times AT)}{(CPF_o \times DWIR \times INH \times DWF \times ED)}$$

Risk = Target excess individual lifetime cancer risk level (unitless)
ABW = Average body weight (kg)
UCF = 1000 µg/mg
AT = Averaging time (years)
CPF_o = Cancer potency factor (kg-day/mg)
DWIR = Drinking water ingestion rate (L/day)
INH = Inhalation correction factor (unitless)
DWF = Drinking water fraction (unitless)
ED = Exposure duration (years)

Exposure Scenarios	Risk (unitless)	ABW (kg)	AT (years)	CPF_o (kg-day/mg)	DWIR (L/day)	INH (unitless)	DWF (unitless)	ED (years)
MTCA Default[1]	1.00E-06	70	75	<table>	2	2	1	30

Notes:

<table> Indicates a chemical-specific factor is available in the associated tables of this attachment.

1 All parameters derived from Model Toxics Control Act (MTCA) WAC 173-340-730, equations 720-1 and 720-2.

2 Fish consumption rates derived from Washington State Department of Ecology (Ecology) 2009: MTCA Regulation Update Summary, Fish Consumption Rates for High Exposure Populations.

3 Fish consumption rates include both finfish and shellfish, and exclude salmon.

4 All parameters derived from U.S. Environmental Protection Agency (EPA) Region 10, 2007: Framework for Selecting and Using Tribal Fish and Shellfish Consumption Rates for Risk-based Decision Making.

Table A.2j
Cross-Media Factors

		Other Chemical Factors					Bioconcentration Factors							
		EPA R10					EPA R10		Ecology MTCA/CLARC		Others		Selected for Use[4]	
CAS Number	Chemical	GI Absorption Conversion Factor (unitless)	Dermal Absorption Fraction (unitless)	Volatilization Factor (m^3/kg)	Source For All Factors	(1/VF + 1/PEF)[1] (kg/m^3)	Water to Fish BCF[2] (L/kg)	Source	Water to Fish BCF[3] (L/kg)	Source	Water to Fish BCF (L/kg)	Source	Water to Fish BCF (L/kg)	Source
67-64-1	Acetone	1.0E+00	--	1.5E+04	EPA RSL 2010	6.8E-05	3.2E+00	HHRAP	--	--	--	--	3.2E+00	HHRAP
71-43-2	Benzene	1.0E+00	--	3.8E+03	EPA RSL 2010	2.6E-04	8.3E+00	HHRAP	5.2E+00	AWQC (Gold Book)	--	--	8.3E+00	HHRAP
78-93-3	2-Butanone (MEK)	1.0E+00	--	1.3E+04	EPA RSL 2010	7.6E-05	3.2E+00	HHRAP	--	--	--	--	3.2E+00	HHRAP
75-15-0	Carbon Disulfide	1.0E+00	--	1.3E+03	EPA RSL 2010	7.9E-04	9.9E+00	HHRAP	--	--	--	--	9.9E+00	HHRAP
56-23-5	Carbon Tetrachloride	1.0E+00	--	1.6E+03	EPA RSL 2010	6.2E-04	2.9E+01	HHRAP	1.9E+01	AWQC (Gold Book)	--	--	2.9E+01	HHRAP
108-90-7	Chlorobenzene	1.0E+00	--	6.9E+03	EPA RSL 2010	1.4E-04	2.9E+01	HHRAP	1.0E+01	AWQC (Gold Book)	--	--	2.9E+01	HHRAP
75-00-3	Chloroethane	1.0E+00	--	1.4E+03	EPA RSL 2010	7.2E-04	2.4E+00	HHRAP	--	--	--	--	2.4E+00	HHRAP
67-66-3	Chloroform	1.0E+00	--	2.8E+03	EPA RSL 2010	3.5E-04	3.2E+00	HHRAP	3.8E+00	AWQC (Gold Book)	--	--	3.2E+00	HHRAP
74-87-3	Chloromethane	1.0E+00	--	1.3E+03	EPA RSL 2010	7.9E-04	6.9E+00	HHRAP	3.8E+00	AWQC (Gold Book)	--	--	6.9E+00	HHRAP
106-43-4	4-Chlorotoluene	1.0E+00	--	7.9E+03	EPA RSL 2010	1.3E-04	2.3E+02	EPA DW	--	--	7.3E+01	OECD SIDS 2005	2.3E+02	EPA DW
95-50-1	1,2-Dichlorobenzene	1.0E+00	--	1.3E+04	EPA RSL 2010	7.9E-05	8.0E+01	HHRAP	5.6E+01	AWQC (Gold Book)	--	--	8.0E+01	HHRAP
106-46-7	1,4-Dichlorobenzene	1.0E+00	--	1.1E+04	EPA RSL 2010	8.9E-05	9.9E+01	HHRAP	5.6E+01	AWQC (Gold Book)	--	--	9.9E+01	HHRAP
75-34-3	1,1-Dichloroethane	1.0E+00	--	2.2E+03	EPA RSL 2010	4.5E-04	4.9E+00	HHRAP	--	--	--	--	4.9E+00	HHRAP
107-06-2	1,2-Dichloroethane	1.0E+00	--	4.9E+03	EPA RSL 2010	2.0E-04	2.9E+00	HHRAP	1.2E+00	AWQC (Gold Book)	--	--	2.9E+00	HHRAP
75-35-4	1,1-Dichloroethene	1.0E+00	--	1.2E+03	EPA RSL 2010	8.1E-04	8.3E+00	HHRAP	5.6E+00	AWQC (Gold Book)	--	--	8.3E+00	HHRAP
156-59-2	*cis* -1,2-Dichloroethene	1.0E+00	--	2.7E+03	EPA RSL 2010	3.7E-04	5.8E+00	HHRAP	--	--	--	--	5.8E+00	HHRAP
156-60-5	*trans* -1,2-Dichloroethene	1.0E+00	--	2.7E+03	EPA RSL 2010	3.7E-04	8.3E+00	HHRAP	1.6E+00	AWQC (Gold Book)	--	--	8.3E+00	HHRAP
78-87-5	1,2-Dichloropropane	1.0E+00	--	3.9E+03	EPA RSL 2010	2.6E-04	6.9E+00	HHRAP	4.1E+00	AWQC (Gold Book)	--	--	6.9E+00	HHRAP
100-41-4	Ethylbenzene	1.0E+00	--	6.1E+03	EPA RSL 2010	1.6E-04	4.9E+01	HHRAP	3.8E+01	AWQC (Gold Book)	--	--	4.9E+01	HHRAP
98-82-8	Isopropylbenzene(cumene)	1.0E+00	--	6.7E+03	EPA RSL 2010	1.5E-04	1.4E+02	HHRAP	--	--	--	--	1.4E+02	HHRAP
591-78-6	2-Hexanone	1.0E+00	--	1.4E+04	EPA RSL 2010	7.0E-05	6.0E-01	HHRAP	--	--	--	--	6.0E-01	HHRAP
75-09-2	Methylene Chloride	1.0E+00	--	2.4E+03	EPA RSL 2010	4.2E-04	2.0E+00	HHRAP	9.0E-01	AWQC (Gold Book)	--	--	2.0E+00	HHRAP
108-10-1	Methyl Isobutyl Ketone	1.0E+00	--	1.1E+04	EPA RSL 2010	8.8E-05	1.7E+00	HHRAP	--	--	--	--	1.7E+00	HHRAP
91-20-3	Naphthalene	1.0E+00	1.3E-01	5.0E+04	EPA RSL 2010	2.0E-05	6.9E+01	HHRAP	1.1E+01	AWQC (Gold Book)	3.0E+02	McCarthy 1985[8]	3.0E+02	McCarthy 1985[8]
100-42-5	Styrene	1.0E+00	--	1.0E+04	EPA RSL 2010	9.9E-05	1.0E+00	HHRAP	--	--	--	--	1.0E+00	HHRAP
79-34-5	1,1,2,2-Tetrachloroethane	1.0E+00	--	1.6E+04	EPA RSL 2010	6.1E-05	1.4E+01	HHRAP	5.0E+00	AWQC (Gold Book)	--	--	1.4E+01	HHRAP
127-18-4	Tetrachloroethene (PCE)	1.0E+00	--	2.5E+03	EPA RSL 2010	4.0E-04	8.3E+01	HHRAP	3.1E+01	AWQC (Gold Book)	--	--	8.3E+01	HHRAP
108-88-3	Toluene	1.0E+00	--	4.6E+03	EPA RSL 2010	2.2E-04	2.4E+01	HHRAP	1.1E+01	AWQC (Gold Book)	--	--	2.4E+01	HHRAP
71-55-6	1,1,1-Trichloroethane	1.0E+00	--	1.8E+03	EPA RSL 2010	5.6E-04	1.7E+01	HHRAP	5.6E+00	AWQC (Gold Book)	--	--	1.7E+01	HHRAP
79-00-5	1,1,2-Trichloroethane	1.0E+00	--	7.8E+03	EPA RSL 2010	1.3E-04	6.9E+00	HHRAP	4.5E+00	AWQC (Gold Book)	--	--	6.9E+00	HHRAP
79-01-6	Trichloroethene (TCE)	1.0E+00	--	2.4E+03	EPA RSL 2010	4.2E-04	1.4E+01	HHRAP	1.1E+01	AWQC (Gold Book)	--	--	1.4E+01	HHRAP
120-82-1	1,2,4-trichlorobenzene	1.0E+00	--	3.2E+04	EPA RSL 2010	3.1E-05	2.4E+02	HHRAP	1.1E+02	AWQC (Gold Book)	--	--	2.4E+02	HHRAP
75-69-4	Trichlorofluoromethane	1.0E+00	--	1.1E+03	EPA RSL 2010	9.0E-04	1.7E+01	HHRAP	--	--	--	--	1.7E+01	HHRAP
76-13-1	1,1,2-Trichlorotrifluoroethane	1.0E+00	--	1.4E+03	EPA RSL 2010	7.2E-04	--	--	--	--	--	--	--	--
75-01-4	Vinyl chloride	1.0E+00	--	1.0E+03	EPA RSL 2010	9.7E-04	--[7]	--	1.2E+00	AWQC (Gold Book)	--	--	--	--
108-38-3	m-Xylene	1.0E+00	--	5.9E+03	EPA RSL 2010	1.7E-04	5.8E+01	HHRAP	--	--	--	--	5.8E+01	HHRAP
95-47-6	o-Xylene	1.0E+00	--	7.0E+03	EPA RSL 2010	1.4E-04	4.9E+01	HHRAP	--	--	--	--	4.9E+01	HHRAP
106-42-3	p-Xylene	1.0E+00	--	6.0E+03	EPA RSL 2010	1.7E-04	4.9E+01	HHRAP	--	--	--	--	4.9E+01	HHRAP
10330-20-7	Xylenes (total)	1.0E+00	--	6.3E+03	EPA RSL 2010	1.6E-04	--	--	--	--	5.0E+01	Estimate	5.0E+01	Estimate

Table A.2j
Cross-Media Factors

CAS Number	Chemical	Henry's Law Constant[5]						Vapor Pressure at 25°C		Soil Organic Carbon to Water Partitioning Coefficient (K_{oc})								Soil to Water Partitioning Coefficient ($K_d = K_{oc} \times f_{oc}$)							
		EPA R10		Ecology MTCA/CLARC		Selected for Use		EPA R10		EPA R10		Ecology MTCA/CLARC		Others		Selected for Use		EPA R10		Ecology MTCA/CLARC		Others[6]		Selected for Use[6]	
		H_{cc} (unitless)	Source	H_{cc} (unitless)	Source	H_{cc} (unitless)	Source	VP (mm Hg)	Source	K_{oc} (L/kg)	Source	K_{oc} (L/kg)	Source	K_{oc} (L/kg)	Source	K_{oc} (L/kg)	Source	K_d (L/kg)	Source	K_d (L/kg)	Source	K_d (L/kg)	Source	K_d (L/kg)	Source
67-64-1	Acetone	1.4E-03	EPI Suite 2010	1.6E-03	EPA SSL 01	1.5E-03	Average	2.3E+02	EPI Suite 2010	2.4E+00	EPI Suite 2010	5.8E-01	EPA SSL 01	--	--	1.5E+00	Average	2.4E-03	RSL K_{oc}*0.001	5.8E-04	C K_{oc}*0.001	2.9E-02	K_{oc}*0.02	2.9E-02	K_{oc}*0.02
71-43-2	Benzene	2.3E-01	EPI Suite 2010	2.3E-01	EPA SSL 96	2.3E-01	Average	9.5E+01	EPI Suite 2010	1.5E+02	EPI Suite 2010	6.2E+01	EPA SSL 96	--	--	1.0E+02	Average	1.5E-01	RSL K_{oc}*0.001	6.2E-02	C K_{oc}*0.001	2.1E+00	K_{oc}*0.02	2.1E+00	K_{oc}*0.02
78-93-3	2-Butanone (MEK)	2.3E-03	EPI Suite 2010	--	--	2.3E-03	Average	9.1E+01	EPI Suite 2010	4.5E+00	EPI Suite 2010	--	--	--	--	4.5E+00	Average	4.5E-03	RSL K_{oc}*0.001	--	--	9.0E-02	K_{oc}*0.02	9.0E-02	K_{oc}*0.02
75-15-0	Carbon Disulfide	5.9E-01	EPI Suite 2010	1.2E+00	EPA SSL 01	9.1E-01	Average	3.6E+02	EPI Suite 2010	2.2E+01	EPI Suite 2010	4.6E+01	EPA SSL 01	--	--	3.4E+01	Average	2.2E-02	RSL K_{oc}*0.001	4.6E-02	C K_{oc}*0.001	6.7E-01	K_{oc}*0.02	6.7E-01	K_{oc}*0.02
56-23-5	Carbon Tetrachloride	1.1E+00	EPI Suite 2010	1.3E+00	EPA SSL 96	1.2E+00	Average	1.2E+02	EPI Suite 2010	4.4E+01	EPI Suite 2010	1.5E+02	EPA SSL 96	--	--	9.8E+01	Average	4.4E-02	RSL K_{oc}*0.001	1.5E-01	C K_{oc}*0.001	2.0E+00	K_{oc}*0.02	2.0E+00	K_{oc}*0.02
108-90-7	Chlorobenzene	1.3E-01	EPI Suite 2010	1.5E-01	EPA SSL 96	1.4E-01	Average	1.2E+01	EPI Suite 2010	2.3E+02	EPI Suite 2010	2.2E+02	EPA SSL 96	--	--	2.3E+02	Average	2.3E-01	RSL K_{oc}*0.001	2.2E-01	C K_{oc}*0.001	4.6E+00	K_{oc}*0.02	4.6E+00	K_{oc}*0.02
75-00-3	Chloroethane	4.5E-01	EPI Suite 2010	--	--	4.5E-01	Average	1.0E+03	EPI Suite 2010	2.2E+01	EPI Suite 2010	--	--	--	--	2.2E+01	Average	2.2E-02	RSL K_{oc}*0.001	--	--	4.3E-01	K_{oc}*0.02	4.3E-01	K_{oc}*0.02
67-66-3	Chloroform	1.5E-01	EPI Suite 2010	1.5E-01	EPA SSL 96	1.5E-01	Average	2.0E+02	EPI Suite 2010	3.2E+01	EPI Suite 2010	5.3E+01	EPA SSL 96	--	--	4.2E+01	Average	3.2E-02	RSL K_{oc}*0.001	5.3E-02	C K_{oc}*0.001	8.5E-01	K_{oc}*0.02	8.5E-01	K_{oc}*0.02
74-87-3	Chloromethane	3.6E-01	EPI Suite 2010	--	--	3.6E-01	Average	4.3E+03	EPI Suite 2010	1.3E+01	EPI Suite 2010	6.0E+00	EPA SSL 96	--	--	9.6E+00	Average	1.3E-02	RSL K_{oc}*0.001	6.0E-03	C K_{oc}*0.001	1.9E-01	K_{oc}*0.02	1.9E-01	K_{oc}*0.02
106-43-4	4-Chlorotoluene	1.8E-01	OECD SIDS 2005	--	--	1.8E-01	Average	3.5E+02	OECD SIDS 2005	3.8E+02	OECD SIDS 2005	--	--	--	--	3.8E+02	Average	3.8E-01	RSL K_{oc}*0.001	--	--	7.5E+00	K_{oc}*0.02	7.5E+00	K_{oc}*0.02
95-50-1	1,2-Dichlorobenzene	7.8E-02	EPI Suite 2010	7.8E-02	EPA SSL 96	7.8E-02	Average	1.4E+00	EPI Suite 2010	3.8E+02	EPI Suite 2010	3.8E+02	EPA SSL 96	--	--	3.8E+02	Average	3.8E-01	RSL K_{oc}*0.001	3.8E-01	C K_{oc}*0.001	7.6E+00	K_{oc}*0.02	7.6E+00	K_{oc}*0.02
106-46-7	1,4-Dichlorobenzene	9.9E-02	EPI Suite 2010	1.0E-01	EPA SSL 96	9.9E-02	Average	1.7E+00	EPI Suite 2010	3.8E+02	EPI Suite 2010	6.2E+02	EPA SSL 96	--	--	5.0E+02	Average	3.8E-01	RSL K_{oc}*0.001	6.2E-01	C K_{oc}*0.001	9.9E+00	K_{oc}*0.02	9.9E+00	K_{oc}*0.02
75-34-3	1,1-Dichloroethane	2.3E-01	EPI Suite 2010	2.3E-01	EPA SSL 96	2.3E-01	Average	2.3E+02	EPI Suite 2010	3.2E+01	EPI Suite 2010	5.3E+01	EPA SSL 96	--	--	4.2E+01	Average	3.2E-02	RSL K_{oc}*0.001	5.3E-02	C K_{oc}*0.001	8.5E-01	K_{oc}*0.02	8.5E-01	K_{oc}*0.02
107-06-2	1,2-Dichloroethane	4.8E-02	EPI Suite 2010	4.0E-02	EPA SSL 96	4.4E-02	Average	7.9E+01	EPI Suite 2010	4.0E+01	EPI Suite 2010	3.8E+01	EPA SSL 96	--	--	3.9E+01	Average	4.0E-02	RSL K_{oc}*0.001	3.8E-02	C K_{oc}*0.001	7.8E-01	K_{oc}*0.02	7.8E-01	K_{oc}*0.02
75-35-4	1,1-Dichloroethene	1.1E+00	EPI Suite 2010	1.1E+00	EPA SSL 96	1.1E+00	Average	6.0E+02	EPI Suite 2010	3.2E+01	EPI Suite 2010	6.5E+01	EPA SSL 96	--	--	4.8E+01	Average	3.2E-02	RSL K_{oc}*0.001	6.5E-02	C K_{oc}*0.001	9.7E-01	K_{oc}*0.02	9.7E-01	K_{oc}*0.02
156-59-2	*cis* -1,2-Dichloroethene	1.7E-01	EPI Suite 2010	1.7E-01	EPA SSL 01	1.7E-01	Average	2.0E+02	EPI Suite 2010	4.0E+01	EPI Suite 2010	3.6E+01	EPA SSL 01	--	--	3.8E+01	Average	4.0E-02	RSL K_{oc}*0.001	3.6E-02	C K_{oc}*0.001	7.5E-01	K_{oc}*0.02	7.5E-01	K_{oc}*0.02
156-60-5	*trans* -1,2-Dichloroethene	1.7E-01	EPI Suite 2010	3.9E-01	EPA SSL 96	2.8E-01	Average	3.3E+02	EPI Suite 2010	4.0E+01	EPI Suite 2010	3.8E+01	EPA SSL 96	--	--	3.9E+01	Average	4.0E-02	RSL K_{oc}*0.001	3.8E-02	C K_{oc}*0.001	7.8E-01	K_{oc}*0.02	7.8E-01	K_{oc}*0.02
78-87-5	1,2-Dichloropropane	1.2E-01	EPI Suite 2010	1.2E-01	EPA SSL 96	1.2E-01	Average	5.0E+01	EPA DW	6.1E+01	EPI Suite 2010	4.7E+01	EPA SSL 96	4.7E+01	EPA DW	5.2E+01	Average	6.1E-02	RSL K_{oc}*0.001	4.7E-02	C K_{oc}*0.001	1.0E+00	K_{oc}*0.02	1.0E+00	K_{oc}*0.02
100-41-4	Ethylbenzene	3.2E-01	EPI Suite 2010	3.2E-01	EPA SSL 96	3.2E-01	Average	9.6E+00	EPI Suite 2010	4.5E+02	EPI Suite 2010	2.0E+02	EPA SSL 96	--	--	3.3E+02	Average	4.5E-01	RSL K_{oc}*0.001	2.0E-01	C K_{oc}*0.001	6.5E+00	K_{oc}*0.02	6.5E+00	K_{oc}*0.02
98-82-8	Isopropylbenzene(cumene)	4.7E-01	EPI Suite 2010	--	--	4.7E-01	Average	4.5E+00	EPI Suite 2010	7.0E+02	EPI Suite 2010	--	--	--	--	7.0E+02	Average	7.0E-01	RSL K_{oc}*0.001	--	--	1.4E+01	K_{oc}*0.02	1.4E+01	K_{oc}*0.02
591-78-6	2-Hexanone	3.8E-03	EPI Suite 2010	--	--	3.8E-03	Average	1.2E+01	EPI Suite 2010	1.5E+01	EPI Suite 2010	--	--	--	--	1.5E+01	Average	1.5E-02	RSL K_{oc}*0.001	--	--	3.0E-01	K_{oc}*0.02	3.0E-01	K_{oc}*0.02
75-09-2	Methylene Chloride	1.3E-01	EPI Suite 2010	9.0E-02	EPA SSL 96	1.1E-01	Average	4.4E+02	EPI Suite 2010	2.2E+01	EPI Suite 2010	1.0E+01	EPA SSL 96	--	--	1.6E+01	Average	2.2E-02	RSL K_{oc}*0.001	1.0E-02	C K_{oc}*0.001	3.2E-01	K_{oc}*0.02	3.2E-01	K_{oc}*0.02
108-10-1	Methyl Isobutyl Ketone	5.6E-03	EPI Suite 2010	--	--	5.6E-03	Average	2.0E+01	EPI Suite 2010	1.3E+01	EPI Suite 2010	--	--	--	--	1.3E+01	Average	1.3E-02	RSL K_{oc}*0.001	--	--	2.5E-01	K_{oc}*0.02	2.5E-01	K_{oc}*0.02
91-20-3	Naphthalene	1.8E-02	EPI Suite 2010	2.0E-02	EPA SSL 96	1.9E-02	Average	8.5E-02	EPI Suite 2010	1.5E+03	ATSDR 2005	1.2E+03	EPA SSL 96	2.0E+03	Cal/EPA	1.6E+03	Average	1.5E+00	RSL K_{oc}*0.001	1.2E+00	C K_{oc}*0.001	3.2E+01	K_{oc}*0.02	3.2E+01	K_{oc}*0.02
100-42-5	Styrene	1.1E-01	EPI Suite 2010	1.1E-01	EPA SSL 96	1.1E-01	Average	6.4E+00	EPI Suite 2010	4.5E+02	EPI Suite 2010	9.1E+02	EPA SSL 96	--	--	6.8E+02	Average	4.5E-01	RSL K_{oc}*0.001	9.1E-01	C K_{oc}*0.001	1.4E+01	K_{oc}*0.02	1.4E+01	K_{oc}*0.02
79-34-5	1,1,2,2-Tetrachloroethane	1.5E-02	EPI Suite 2010	1.4E-02	EPA SSL 96	1.5E-02	Average	4.6E+00	EPI Suite 2010	9.5E+01	EPI Suite 2010	7.9E+01	EPA SSL 96	--	--	8.7E+01	Average	9.5E-02	RSL K_{oc}*0.001	7.9E-02	C K_{oc}*0.001	1.7E+00	K_{oc}*0.02	1.7E+00	K_{oc}*0.02
127-18-4	Tetrachloroethene (PCE)	7.2E-01	EPI Suite 2010	7.5E-01	EPA SSL 96	7.4E-01	Average	1.9E+01	EPI Suite 2010	9.5E+01	EPI Suite 2010	2.7E+02	EPA SSL 96	--	--	1.8E+02	Average	9.5E-02	RSL K_{oc}*0.001	2.7E-01	C K_{oc}*0.001	3.6E+00	K_{oc}*0.02	3.6E+00	K_{oc}*0.02
108-88-3	Toluene	2.7E-01	EPI Suite 2010	2.7E-01	EPA SSL 96	2.7E-01	Average	2.8E+01	EPI Suite 2010	2.3E+02	EPI Suite 2010	1.4E+02	EPA SSL 96	--	--	1.9E+02	Average	2.3E-01	RSL K_{oc}*0.001	1.4E-01	C K_{oc}*0.001	3.7E+00	K_{oc}*0.02	3.7E+00	K_{oc}*0.02
71-55-6	1,1,1-Trichloroethane	7.0E-01	EPI Suite 2010	7.1E-01	EPA SSL 96	7.0E-01	Average	1.2E+02	EPI Suite 2010	4.4E+01	EPI Suite 2010	1.4E+02	EPA SSL 96	--	--	8.9E+01	Average	4.4E-02	RSL K_{oc}*0.001	1.4E-01	C K_{oc}*0.001	1.8E+00	K_{oc}*0.02	1.8E+00	K_{oc}*0.02
79-00-5	1,1,2-Trichloroethane	3.4E-02	EPI Suite 2010	3.7E-02	EPA SSL 96	3.6E-02	Average	2.3E+01	EPI Suite 2010	6.1E+01	EPI Suite 2010	7.5E+01	EPA SSL 96	--	--	6.8E+01	Average	6.1E-02	RSL K_{oc}*0.001	7.5E-02	C K_{oc}*0.001	1.4E+00	K_{oc}*0.02	1.4E+00	K_{oc}*0.02
79-01-6	Trichloroethene (TCE)	4.0E-01	EPI Suite 2010	4.2E-01	EPA SSL 96	4.1E-01	Average	6.9E+01	EPI Suite 2010	6.1E+01	EPI Suite 2010	9.4E+01	EPA SSL 96	--	--	7.7E+01	Average	6.1E-02	RSL K_{oc}*0.001	9.4E-02	C K_{oc}*0.001	1.5E+00	K_{oc}*0.02	1.5E+00	K_{oc}*0.02
120-82-1	1,2,4-trichlorobenzene	5.8E-02	EPI Suite 2010	5.8E-02	EPA SSL 96	5.8E-02	Average	4.6E-01	EPI Suite 2010	1.4E+03	Kd/0.001	1.7E+03	EPA SSL 96	--	--	1.5E+03	Average	1.4E+00	RSL K_{oc}*0.001	1.7E+00	C K_{oc}*0.001	3.0E+01	K_{oc}*0.02	3.0E+01	K_{oc}*0.02
75-69-4	Trichlorofluoromethane	4.0E+00	EPI Suite 2010	--	--	4.0E+00	Average	8.0E+02	EPI Suite 2010	4.4E+01	EPI Suite 2010	--	--	--	--	4.4E+01	Average	4.4E-02	RSL K_{oc}*0.001	--	--	8.8E-01	K_{oc}*0.02	8.8E-01	K_{oc}*0.02
76-13-1	1,1,2-Trichlorotrifluoroethane	2.2E+01	EPI Suite 2010	--	--	2.2E+01	Average	3.6E+02	EPI Suite 2010	2.0E+02	EPI Suite 2010	--	--	--	--	2.0E+02	Average	2.0E-01	RSL K_{oc}*0.001	--	--	3.9E+00	K_{oc}*0.02	3.9E+00	K_{oc}*0.02
75-01-4	Vinyl chloride	1.1E+00	EPI Suite 2010	1.1E+00	EPA SSL 01	1.1E+00	Average	3.0E+03	EPI Suite 2010	2.2E+01	EPI Suite 2010	1.9E+01	EPA SSL 01	--	--	2.0E+01	Average	2.2E-02	RSL K_{oc}*0.001	1.9E-02	C K_{oc}*0.001	4.0E-01	K_{oc}*0.02	4.0E-01	K_{oc}*0.02
108-38-3	m-Xylene	2.8E-01	EPI Suite 2010	3.0E-01	EPA SSL 96	2.9E-01	Average	8.3E+00	EPI Suite 2010	3.8E+02	EPI Suite 2010	2.0E+02	EPA SSL 96	--	--	2.9E+02	Average	3.8E-01	RSL K_{oc}*0.001	2.0E-01	C K_{oc}*0.001	5.7E+00	K_{oc}*0.02	5.7E+00	K_{oc}*0.02
95-47-6	o-Xylene	2.9E-01	EPI Suite 2010	2.1E-01	EPA SSL 96	2.5E-01	Average	6.6E+00	EPI Suite 2010	3.8E+02	EPI Suite 2010	2.4E+02	EPA SSL 96	--	--	3.1E+02	Average	3.8E-01	RSL K_{oc}*0.001	2.4E-01	C K_{oc}*0.001	6.2E+00	K_{oc}*0.02	6.2E+00	K_{oc}*0.02
106-42-3	p-Xylene	2.1E-01	EPI Suite 2010	3.1E-01	EPA SSL 96	2.6E-01	Average	8.8E+00	EPI Suite 2010	3.8E+02	EPI Suite 2010	3.1E+02	EPA SSL 96	--	--	3.5E+02	Average	3.8E-01	RSL K_{oc}*0.001	3.1E-01	C K_{oc}*0.001	6.9E+00	K_{oc}*0.02	6.9E+00	K_{oc}*0.02
10330-20-7	Xylenes (total)	2.1E-01	EPI Suite 2010	2.8E-01	TPH WG 97	2.5E-01	Average	9.0E+00	EPI Suite 2010	3.8E+02	EPI Suite 2010	2.3E+02	TPH WG 97	--	--	3.1E+02	Average	3.8E-01	RSL K_{oc}*0.001	2.3E-01	C K_{oc}*0.001	6.2E+00	K_{oc}*0.02	6.2E+00	K_{oc}*0.02

Notes:

1 If VF is not available (i.e., is presented as "--" in table), this term simplifies to one divided by the particulate emission factor (1/PEF).
2 BCFs derived from Meylan, et al. ,1999 (in EPA Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities [HHRAP] Guidance, 2005, EPA520-R-05-006).
3 BCFs derived from CLARC database, originally sourced from EPA Quality Criteria for Water (AWQC Gold Book 1986), EPA 440/5-86-001.
4 In general, the more recent BCFs are from the HHRAP summary; many of these are calculated using the method of Meylan, et al. 1999 (refer to Note 1); emperical values from other studies may be more appropirate for specific sites.
5 From: https://fortress.wa.gov/ecy/clarc/FocusSheets/Physical&ChemicalParameters.htm
6 A site-specific f_{oc} was developed for Boeing Plant 2 using areas with no or limited organic contamination to represent the actual fraction of organic carbon present in the alluvial soils; this value is 0.02.
7 Vinyl chloride has never been detected in fish/shellfish in any known study; therefore, the calculated BCF has been rejected due to insufficient data to confirm vinyl chloride uptake into seafood.
8 McCarthy, John F. and Braulio D. Jimenez. 1985. Reduction in Bioavailibility to Bluegills of Polycylic Aromatic Hydrocarbons Bound to Dissolved Humic Material. Environmental Toxicology and Chemistry Vol. 4: 511-521.

When literature values of Henry's Law Constant were given with unit specific values, they were converted to the unitless Henry's Law Constant provided in the table above by division with the unit-specific quantity RT. Conversion factors and their units are provided below:

If original units were given in:	Use RT with value of:
atms-m^3/mol	2.4E-02 atms-m^3/mol
Pa-m^3/mol	2.5E+03 Pa-m^3/mol

Abbreviations:

ATSDR Agency for Toxic Substances and Disease Registry
AWQC Ambient Water Quality Criteria
Cal/EPA California Environmental Protection Agency
EPI Suite EPA Estimation Program Interface Suite located online at http://www.epa.gov/oppt/exposure/pubs/episuite.htm
EPA DW Chemical FactSheets from EPA Office of Drinking Water (dates varies)
EPA SSG 96 EPA Soil Screening Guidance: Technical Background Document (1996)
EPA SSL 01 EPA Guidance for Developing Soil Screening Levels Table C-1 (1996/2001 Update)
HEAST Health Effects Assessment Summary Tables
IRIS Integrated Risk Information System
NJEPA New Jersey Environmental Protection Agency
OECD SIDS 2005 Organization of Economic Cooperation and Development Screening Information Data Set located online at http://www.dow.com/productsafety/chemical/oecd.htm
TPH WG 97 TPH Criteria Working Group Series Volume 3 (GWG, 1997)
VF Volatilization factor

Table A.2k
Toxicological Factors

		EPA R10[1]												Ecology[2]									
		Oral/Ingestion Toxicity Factors				Dermal Toxicity Factors[3]				Inhalation Toxicity Factors				Oral/Ingestion Toxicity Factors				Dermal Toxicity Factors[4]				Inhalation Toxicity Factors	
CAS Number	Constituent	Cancer Slope Factor (CSF_o) (kg-day/mg)	Source	Reference Dose (RfD_o) (mg/kg-day)	Source	Cancer Slope Factor (CSF_d) (kg-day/mg)	Source	Reference Dose (RfD_d) (mg/kg-day)	Source	Inhalation Unit Risk (IUR) ($m^3/\mu g$)	Source	Reference Concentration (RfC_i) (mg/m^3)	Source	Cancer Potency Factor (CPF_o) (kg-day/mg)	Source	Reference Dose (RfD_o) (mg/kg-day)	Source	Cancer Potency Factor (CPF_d) (kg-day/mg)	Source	Reference Dose (RfD_d) (mg/kg-day)	Source	Cancer Potency Factor (CPF_i) (kg-day/mg)	Source
67-64-1	Acetone	--	--	9.0E-01	IRIS	--	--	9.0E-01	RfD_o*GI-abs	--	--	3.1E+01	IRIS	--	--	9.0E-01	IRIS	--	--	7.2E-01	RfD_o*GI-abs	--	--
71-43-2	Benzene	5.5E-02	IRIS	4.0E-03	IRIS	5.5E-02	CSF_o/GI-abs	4.0E-03	RfD_o*GI-abs	7.8E-06	IRIS	3.0E-02	IRIS	5.5E-02	IRIS	4.0E-03	IRIS	6.9E-02	CPF_o/GI-abs	3.2E-03	RfD_o*GI-abs	2.7E-02	HEAST
78-93-3	2-Butanone (MEK)	--	--	6.0E-01	IRIS	--	--	6.0E-01	RfD_o*GI-abs	--	--	5.0E+00	IRIS	--	--	6.0E-01	IRIS	--	--	4.8E-01	RfD_o*GI-abs	--	--
75-15-0	Carbon Disulfide	--	--	1.0E-01	IRIS	--	--	1.0E-01	RfD_o*GI-abs	--	--	7.0E-01	IRIS	--	--	1.0E-01	IRIS	--	--	8.0E-02	RfD_o*GI-abs	--	--
56-23-5	Carbon Tetrachloride	7.0E-02	IRIS	4.0E-03	IRIS	7.0E-02	CSF_o/GI-abs	4.0E-03	RfD_o*GI-abs	6.0E-06	IRIS	1.0E-01	IRIS	7.0E-02	IRIS	4.0E-03	IRIS	8.8E-02	CPF_o/GI-abs	3.2E-03	RfD_o*GI-abs	2.1E-02	HEAST
108-90-7	Chlorobenzene	--	--	2.0E-02	IRIS	--	--	2.0E-02	RfD_o*GI-abs	--	--	5.0E-02	HEAST	--	--	2.0E-02	IRIS	--	--	1.6E-02	RfD_o*GI-abs	--	--
75-00-3	Chloroethane	--	--	--	--	--	--	--	RfD_o*GI-abs	--	--	1.0E+01	IRIS	--	--	--	--	--	--	--	--	--	--
67-66-3	Chloroform	3.1E-02	Cal/EPA	1.0E-02	IRIS	3.1E-02	CSF_o/GI-abs	1.0E-02	RfD_o*GI-abs	2.3E-05	IRIS	9.8E-02	ATSDR	--	--	1.0E-02	IRIS	--	--	8.0E-03	RfD_o*GI-abs	8.1E-02	HEAST
74-87-3	Chloromethane	--	--	--	--	--	--	--	RfD_o*GI-abs	--	--	9.0E-02	IRIS	--	--	--	--	--	--	--	--	6.3E-03	HEAST
106-43-4	4-Chlorotoluene	--	--	--	--	--	--	--	RfD_o*GI-abs	--	--	--	--	--	--	--	--	--	--	--	--	--	--
95-50-1	1,2-Dichlorobenzene	--	--	9.0E-02	IRIS	--	--	9.0E-02	RfD_o*GI-abs	--	--	2.0E-01	HEAST	--	--	9.0E-02	IRIS	--	--	7.2E-02	RfD_o*GI-abs	--	--
106-46-7	1,4-Dichlorobenzene	5.4E-03	Cal/EPA	7.0E-02	ATSDR	5.4E-03	--	7.0E-02	RfD_o*GI-abs	1.1E-05	Cal/EPA	8.0E-01	IRIS	--	--	--	--	--	--	--	--	--	--
75-34-3	1,1-Dichloroethane	5.7E-03	Cal/EPA	2.0E-01	PPRTV	5.7E-03	CSF_o/GI-abs	2.0E-01	RfD_o*GI-abs	1.6E-06	Cal/EPA	--	--	--	--	2.0E-01	IRIS	--	--	1.6E-01	RfD_o*GI-abs	--	--
107-06-2	1,2-Dichloroethane	9.1E-02	IRIS	--	--	9.1E-02	CSF_o/GI-abs	--	RfD_o*GI-abs	2.6E-05	IRIS	2.4E+00	EPA RSL[7]	9.1E-02	IRIS	2.0E-02	IRIS	1.1E-01	CPF_o/GI-abs	1.6E-02	RfD_o*GI-abs	9.1E-02	HEAST
75-35-4	1,1-Dichloroethene	--	--	5.0E-02	IRIS	--	--	5.0E-02	RfD_o*GI-abs	--	--	2.0E-01	IRIS	--		5.0E-02	IRIS	--	--	4.0E-02	RfD_o*GI-abs	--	--
156-59-2	*cis* -1,2-Dichloroethene	--	--	2.0E-03	IRIS	--	--	2.0E-03	RfD_o*GI-abs	--	--	--	--	--	--	2.0E-03	IRIS	--	--	1.6E-03	RfD_o*GI-abs	--	--
156-60-5	*trans* -1,2-Dichloroethene	--	--	2.0E-02	IRIS	--	--	2.0E-02	RfD_o*GI-abs	--	--	--	--	--	--	2.0E-02	IRIS	--	--	1.6E-02	RfD_o*GI-abs	--	--
78-87-5	1,2-Dichloropropane	3.6E-02	Cal/EPA	9.0E-02	ATSDR	3.6E-02	CSF_o/GI-abs	9.0E-02	RfD_o*GI-abs	1.0E-05	Cal/EPA	4.0E-03	IRIS	--	--	--	--	--	--	--	--	--	--
100-41-4	Ethylbenzene	1.1E-02	Cal/EPA	1.0E-01	IRIS	1.1E-02	CSF_o/GI-abs	1.0E-01	RfD_o*GI-abs	2.5E-06	Cal/EPA	1.0E+00	IRIS	--	--	1.0E-01	IRIS	--	--	8.0E-02	RfD_o*GI-abs	--	--
98-82-8	Isopropylbenzene(cumene)	--	--	1.0E-01	IRIS	--	--	1.0E-01	RfD_o*GI-abs	--	--	4.0E-01	IRIS	--	--	1.0E-01	IRIS	--	--	8.0E-02	RfD_o*GI-abs	--	--
591-78-6	2-Hexanone	--	--	5.0E-03	IRIS	--	--	5.0E-03	RfD_o*GI-abs	--	--	3.0E-02	IRIS	--	--	5.0E-03	EPA RSL	--	--	4.0E-03	RfD_o*GI-abs	--	--
75-09-2	Methylene Chloride	7.5E-03	IRIS	6.0E-02	IRIS	7.5E-03	CSF_o/GI-abs	6.0E-02	RfD_o*GI-abs	4.7E-07	IRIS	1.0E+00	ATSDR	7.5E-03	IRIS	6.0E-02	IRIS	9.4E-03	CPF_o/GI-abs	4.8E-02	RfD_o*GI-abs	1.6E-03	HEAST
108-10-1	Methyl Isobutyl Ketone	--	--	8.0E-02	HEAST	--	--	8.0E-02	RfD_o*GI-abs	--	--	3.0E+00	IRIS	--	--	8.0E-02	Heast	--	--	6.4E-02	RfD_o*GI-abs	--	--
91-20-3	Naphthalene	--	--	2.0E-02	IRIS	--	--	2.0E-02	RfD_o*GI-abs	3.4E-05	Cal/EPA	3.0E-03	IRIS	--	--	2.0E-02	IRIS	--	--	1.6E-02	RfD_o*GI-abs	--	--
100-42-5	Styrene	--	--	2.0E-01	IRIS	--	--	2.0E-01	RfD_o*GI-abs	--	--	1.0E+00	IRIS	--	--	2.0E-01	IRIS	--	--	1.6E-01	RfD_o*GI-abs	--	--
79-34-5	1,1,2,2-Tetrachloroethane	2.0E-01	IRIS	2.0E-02	IRIS	2.0E-01	CSF_o/GI-abs	2.0E-02	RfD_o*GI-abs	5.8E-05	IRIS	--	--	2.0E-01	IRIS	2.0E-02	IRIS	2.5E-01	CPF_o/GI-abs	1.6E-02	RfD_o*GI-abs	--	--
127-18-4	Tetrachloroethene (PCE)	5.4E-01	Cal/EPA	1.0E-02	IRIS	5.4E-01	CSF_o/GI-abs	1.0E-02	RfD_o*GI-abs	5.9E-06	IRIS	2.3E+00	ATSDR	--	--	1.0E-02	IRIS	--	--	8.0E-03	RfD_o*GI-abs	--	--
108-88-3	Toluene	--	--	8.0E-02	IRIS	--	--	8.0E-02	RfD_o*GI-abs	--	--	5.0E+00	IRIS	--	--	8.0E-02	IRIS	--	--	6.4E-02	RfD_o*GI-abs	--	--
71-55-6	1,1,1-Trichloroethane	--	--	2.0E+00	IRIS	--	--	2.0E+00	RfD_o*GI-abs	--	--	5.0E+00	IRIS	--	--	2.0E+00	IRIS	--	--	1.6E+00	RfD_o*GI-abs	--	--
79-00-5	1,1,2-Trichloroethane	5.7E-02	IRIS	4.0E-03	IRIS	5.7E-02	CSF_o/GI-abs	4.0E-03	RfD_o*GI-abs	1.6E-05	IRIS	--	--	5.7E-02	IRIS	4.0E-03	IRIS	7.1E-02	CPF_o/GI-abs	3.2E-03	RfD_o*GI-abs	5.6E-02	HEAST
79-01-6	Trichloroethene (TCE)[5]	1.3E-01	EPA R10	3.0E-04	EPA R10	1.3E-01	CSF_o/GI-abs	3.0E-04	RfD_o*GI-abs	2.0E-05	EPA R10	1.0E+01	EPA R10	8.9E-02	EPA R10	3.0E-04	EPA R10	1.1E-01	CPF_o/GI-abs	2.4E-04	RfD_o*GI-abs	--	--
120-82-1	1,2,4-trichlorobenzene	2.9E-02	IRIS	1.0E-02	IRIS	2.9E-02	CSF_o/GI-abs	1.0E-02	RfD_o*GI-abs	--	--	--	--	2.9E-02	IRIS	1.0E-02	IRIS	3.6E-02	CPF_o/GI-abs	8.0E-03	RfD_o*GI-abs	--	--
75-69-4	Trichlorofluoromethane	--	--	3.0E-01	IRIS	--	--	3.0E-01	RfD_o*GI-abs	--	--	7.0E-01	Heast	--	--	3.0E-01	IRIS	--	--	2.4E-01	RfD_o*GI-abs	--	--
76-13-1	1,1,2-Trichlorotrifluoroethane	--	--	3.0E+01	IRIS	--	--	3.0E+01	RfD_o*GI-abs	--	--	3.0E-01	Heast	--	--	3.0E+01	IRIS	--	--	2.4E+01	RfD_o*GI-abs	--	--
75-01-4	Vinyl chloride[6]	1.5E+00	EPA R10	3.0E-03	IRIS	1.5E+00	CSF_o/GI-abs	3.0E-03	RfD_o*GI-abs	8.8E-06	EPA R10	1.0E-01	IRIS	1.5E+00	EPA R10	3.0E-03	IRIS	1.9E+00	CPF_o/GI-abs	2.4E-03	RfD_o*GI-abs	3.1E-02	EPA R10
108-38-3	m-Xylene	--	--	2.0E-01	IRIS	--	--	2.0E-01	RfD_o*GI-abs	--	--	7.0E-01	IRIS	--	--	2.0E-01	IRIS	--	--	1.6E-01	RfD_o*GI-abs	--	--
95-47-6	o-Xylene	--	--	2.0E-01	IRIS	--	--	2.0E-01	RfD_o*GI-abs	--	--	7.0E-01	Cal/EPA	--	--	2.0E-01	IRIS	--	--	1.6E-01	RfD_o*GI-abs	--	--
106-42-3	p-Xylene	--	--	2.0E-01	IRIS	--	--	2.0E-01	RfD_o*GI-abs	--	--	7.0E-01	Cal/EPA	--	--	2.0E-01	IRIS	--	--	1.6E-01	RfD_o*GI-abs	--	--
10330-20-7	Xylenes (total)	--	--	2.0E-01	IRIS	--	--	2.0E-01	RfD_o*GI-abs	--	--	1.0E-01	IRIS	--	--	2.0E-01	IRIS	--	--	1.6E-01	RfD_o*GI-abs	--	--

Notes:

1 Toxicity factors are from the November 2010 EPA RSL Tables unless otherwise noted.

2 All toxicity factors derived from the CLARC database effective January 30, 2011 unless more recent toxicity factors were available in IRIS; MTCA Air Equation modified to use RfC_i from EPA, rather than RfD_i from CLARC.

3 EPA dermal toxicity factors are calculated based on the oral toxicity factors as follows: $CSF_d = CSF_o$/GI-abs; $RfD_d = RfD_o$ x GI-abs. GI-abs is the gastrointestinal absorption conversion factor, which is equal to 1.0 except where otherwise specified (usually only for metals).

4 MTCA dermal toxicity factors are calculated based on the oral toxicity factors as follows: $CSF_d = CSF_o$/GI-abs; $RfD_d = RfD_o$ x GI-abs. GI-abs is the gastrointestinal absorption conversion factor, which is equal to 0.8 for VOCs (see Equations 740-4 and 740-5).

5 Ecology has established toxicity factors for TCE until such time as new factors are available in IRIS; refer to for details: https://fortress.wa.gov/ecy/clarc/FocusSheets/TCE PCE Oct 2004 Final.pdf. EPA R10 has accepted this approach for this site.

6 Ecology has established the following "rule" for dealing with the mutagenic effects of vinyl chloride; refer to for details: https://fortress.wa.gov/ecy/clarc/FocusSheets/VinylChloride.pdf. EPA R10 has accepted this approach for this site.

7 IRIS does not list an RfC_i for 1,2-dichloroethane, which is confirmed by ATSDR. Cannot confirm this value other than it is reported on the November 2010 update of the EPA RSLs and lists ATSDR as the source on the EPA RSL table.

Abbreviations:

ATSDR Agency for Toxic Substances and Disease Registry
Cal/EPA California Environmental Protection Agency
Ecology Washington State Department of Ecology
EPA U.S. Environmental Protection Agency
RSL Regional screening level
EPA RSL 2010 Regional Screening Levels, November 2010; https://www.epa.gov/region9/superfund/prg/.
HEAST Health Effects Assessment Summary Tables
IRIS Integrated Risk Information System
MTCA Model Toxics Control Act
NJEPA New Jersey Environmental Protection Agency
R10 Region 10
VOC Volatile organic compound

Table A.3a
Soil Standards, Criteria, and Risk-based Calculations

		Residential			Industrial			Sediment Protection	Groundwater Protection	EPA Proposed Soil TMCL to Protect All Pathways	
		EPA		Ecology	EPA Modified		Ecology	Ecology	Ecology		
CAS Number	Chemical[1]	EPA RSL Residential Includes Ingestion, Dermal, and Inhalation[2] (mg/kg)	TSCA High Occupancy No Cap[3] (mg/kg)	MTCA Method B Unrestricted Land Use Includes CLARC Toxicity Factors[4] (mg/kg)	EPA RSL Industrial Includes Ingestion, Dermal, and Inhalation[5] (mg/kg)	TSCA High Occupancy With Cap[3] (mg/kg)	MTCA Method C Industrial Land Use Includes CLARC Toxicity Factors[4] (mg/kg)	SMS Sediment Quality Standards[6] (mg/kg dry weight)	Soil Level to Protect Groundwater Using Three-phase Model[7] (mg/kg)	(mg/kg)	Exposure Pathway Basis of TMCL
Semivolatile Organic Compounds (SVOCs)											
83-32-9	Acenaphthene	3.4E+03	--	4.8E+03	2.1E+04	--	2.1E+05	5.0E-01	2.3E+02	2.3E+02	Soil to protect groundwater for Tribal seafood.
208-96-8	Acenaphthylene	--	--	--	--	--	--	1.3E+00	--	--	SMS SQS may be appropriate for bank soils.
120-12-7	Anthracene	1.7E+04	--	2.4E+04	1.1E+05	--	1.1E+06	9.6E-01	1.6E+03	1.6E+03	Soil to protect groundwater for Tribal seafood.
191-24-2	Benzo(g,h,i)perylene	--	--	--	--	--	--	--	--	--	--
117-81-7	Bis(2-ethylhexyl)phthalate	3.5E+01	--	7.1E+01	7.7E+02	--	9.4E+03	1.3E+00	5.7E+01	3.5E+01	EPA RSL Residential Including Ingestion, Dermal, and Inhalation.
85-68-7	Butylbenzyl phthalate	2.6E+02	--	5.3E+02	5.7E+03	--	6.9E+04	6.3E-02	1.7E+00	1.7E+00	Soil to protect groundwater for Tribal seafood.
59-50-7	4-chloro-3-methylphenol	6.1E+03	--	8.0E+03	3.8E+04	--	3.5E+05	--	7.4E+02	7.4E+02	Surrogate Value: soil to protect groundwater for drinking water use
132-64-9	*Dibenzofuran [8]*	--	--	*0.0E+00*	--	--	*0.0E+00*	*5.4E-01*	--	*0.0E+00*	*Semi-quantitative: soil to protect groundwater for drinking water use.*
84-74-2	Di-n-butylphthalate	6.1E+03	--	8.0E+03	3.8E+04	--	3.5E+05	1.4E+00	2.6E+01	2.6E+01	Soil to protect groundwater for Tribal seafood.
84-66-2	Diethylphthalate	4.9E+04	--	6.4E+04	3.1E+05	--	2.8E+06	2.0E-01	7.6E+02	7.6E+02	Soil to protect groundwater for Tribal seafood.
105-67-9	2,4-Dimethylphenol	1.2E+03	--	1.6E+03	7.7E+03	--	7.0E+04	2.9E-02	9.5E+01	9.5E+01	Soil to protect groundwater for Tribal seafood.
131-11-3	Dimethylphthalate	--	--	--	--	--	--	7.1E-02	--	--	SMS SQS may be appropriate for bank soils.
117-84-0	Di-n-octyl phthalate	--	--	--	--	--	--	6.2E+00	--	--	SMS SQS may be appropriate for bank soils.
206-44-0	Fluoranthene	2.3E+03	--	3.2E+03	1.4E+04	--	1.4E+05	1.7E+00	2.3E+02	2.3E+02	Soil to protect groundwater for Tribal seafood.
86-73-7	Fluorene	2.3E+03	--	3.2E+03	1.4E+04	--	1.4E+05	5.4E-01	1.5E+02	1.5E+02	Soil to protect groundwater for Tribal seafood.
7440-62-2	1-Methylnaphthalene	1.6E+01	--	3.4E+01	3.5E+02	--	4.5E+03	1.6E+01	--	1.6E+01	EPA RSL Residential Including Ingestion, Dermal, and Inhalation.
91-57-6	2-Methylnaphthalene	2.3E+02	--	3.2E+02	1.4E+03	--	1.4E+04	6.7E-01	--	2.3E+02	EPA RSL Residential Including Ingestion, Dermal, and Inhalation.
95-48-7	2-Methylphenol (o-cresol)	3.1E+03	--	4.0E+03	1.9E+04	--	1.8E+05	6.3E-02	2.5E+02	2.5E+02	Soil to protect groundwater for Tribal seafood.
106-44-5	4-Methylphenol (p-cresol)	3.1E+02	--	4.0E+02	1.9E+03	--	1.8E+04	6.7E-01	4.1E+01	4.1E+01	Soil to protect groundwater for Tribal seafood.
91-20-3	Naphthalene	3.6E+00	--	1.6E+03	1.8E+02	--	7.0E+04	2.1E+00	1.6E+01	3.6E+00	EPA RSL Residential Including Ingestion, Dermal, and Inhalation.
85-01-8	Phenanthrene	--	--	--	--	--	--	1.5E+00	--	--	SMS SQS may be appropriate for bank soils.
108-95-2	Phenol	1.8E+04	--	2.4E+04	1.2E+05	--	1.1E+06	4.2E-01	1.9E+03	1.9E+03	Soil to protect groundwater for Tribal seafood.
129-00-0	Pyrene	1.7E+03	--	2.4E+03	1.1E+04	--	1.1E+05	2.6E+00	2.4E+02	2.4E+02	Soil to protect groundwater for Tribal seafood.
Polychlorinated Biphenyls (PCBs)											
53469-21-9	Aroclor 1016/1242	2.2E-01	--	5.0E-01	4.9E+00	--	6.6E+01	--	7.2E-04	7.2E-04	Soil to protect groundwater for Tribal seafood.
12672-29-6	Aroclor 1248	2.2E-01	--	5.0E-01	4.9E+00	--	6.6E+01	--	--	2.2E-01	EPA RSL Residential Including Ingestion, Dermal, and Inhalation.
11097-69-1	Aroclor 1254	2.2E-01	--	5.0E-01	4.9E+00	--	6.6E+01	--	2.9E-04	2.9E-04	Soil to protect groundwater for Tribal seafood.
37324-23-2	Aroclor 1260	2.2E-01	--	5.0E-01	4.9E+00	--	6.6E+01	--	5.4E-03	5.4E-03	Soil to protect groundwater for Tribal seafood.
1336-36-3	Total PCBs	2.2E-01	1.0E+00	5.0E-01	4.9E+00	1.0E+01	6.6E+01	1.3E-01	1.8E-03	1.8E-03	Soil to protect groundwater for Tribal seafood.

Notes:

1 Not all chemicals are constituents needing TMCLs at Boeing Plant 2.
2 EPA RSL calculations using EPA toxicity factors and exposure parameters as presented in associated tables in this attachment.
3 Cleanup level derived using the Toxic Substances Control Act, 40 CFR 761.61.
4 MTCA Method B uses WAC 173-340-740, equations 740-1 and 740-2; MTCA Method C uses WAC-173-340-745, equations 745-1 and 745-2 (Ecology 2007); specific parameters are presented in associated tables in this attachment
5 EPA RSL calculations using EPA toxicity factors and exposure parameters as presented in associated tables in this attachment. EPA RSL Worker scenario has been modified to a 1 in 100,000 excess individual lifetime cancer risk and a soil ingestion rate of 200 mg/kg-day by an EPA Region 10 risk management decision.
6 Sediment Management Standards Sediment Quality Standards Chemical Criteria (dry weight) (WAC-173-204-320[a]).
7 Soil to Groundwater cleanup values are based on the MTCA fixed parameter three-phase partitioning model (WAC 173-340-747, equation 747-1), using partitioning factors presented in associated tables in this attachment.
8 The provisional toxicity factors for this chemical are semi-quantative and should be used for screening purposes only.

Abbreviations:

CAS Chemical abstract number
CLARC Cleanup Levels and Risk Calculation
Ecology Washington State Department of Ecology
EPA U.S. Environmental Protection Agency
MTCA Model Toxics Control Act
RSL Regional screening level
SMS Sediment Management Standards
SQS Sediment Quality Standards
TSCA Toxic Substances Control Act

Table A.3b
Groundwater Standards, Criteria, and Risk-based Calculations

		Protection of Drinking Water[2]				Protection of Aquatic Species						Protection of Human Health for Consumption of Fish and Shellfish in Marine Waters				EPA Proposed TMCL for Surface Water and Groundwater Discharging to Surface Water in the Lower Duwamish Waterway	
		Drinking Water Standard/Criteria[3]				Freshwater Standards			Marine Standards								
		Federal Primary Drinking Water Standards[4]	EPA RSL Tap Water Criteria[5]	State Primary Drinking Water Standards[6]	MTCA B Groundwater Cleanup Level[7]	Federal National Toxics Rule[8]	Federal Ambient Water Quality Criteria[9, 10]	Washington Surface Water Quality Standards[10, 11]	Federal National Toxics Rule[8]	Federal Ambient Water Quality Criteria[9]	Washington Surface Water Quality Standards[10, 11]	Federal National Toxics Rule[8]	Federal Ambient Water Quality Criteria[9]	EPA R10 Tribal Scenarios[11, 12]	MTCA Method B Surface Water[11,13]		
		EPA MCLs		Washington MCLs		Chronic	Chronic	Chronic	Chronic	Chronic	Chronic	Organism Only			Fish/Shellfish		
CAS Number	Chemical[1]	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)			(µg/L)	(µg/L)	Exposure Pathway Basis of TMCL
Semivolatile Organic Compounds (SVOCs)																	
83-32-9	Acenaphthene	--	2.2E+03	--	9.6E+02	--	--	--	--	--	--	--	9.9E+02	1.2E+02	7.7E+02	1.2E+02	EPA R10 Tribal Consumption of Seafood.
208-96-8	Acenaphthylene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
120-12-7	Anthracene	--	1.1E+04	--	4.8E+03	--	--	--	--	--	--	1.1E+05	4.0E+04	2.0E+02	1.3E+03	2.0E+02	EPA R10 Tribal Consumption of Seafood.
191-24-2	Benzo(g,h,i)perylene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
117-81-7	Bis(2-ethylhexyl)phthalate	6.0E+00	4.8E+00	--	6.3E+00	--	--	--	--	--	--	5.9E+00	2.2E+00	1.2E+00	8.7E+00	1.2E+00	EPA R10 Tribal Consumption of Seafood.
85-68-7	Butylbenzyl phthalate	--	3.5E+01	--	4.6E+01	--	--	--	--	--	--	--	1.9E+03	4.1E-01	2.9E+00	4.1E-01	EPA R10 Tribal Consumption of Seafood.
59-50-7	4-chloro-3-methylphenol	--	3.7E+03	--	--	--	--	--	--	--	--	--	--	--	--	3.7E+03	Surrogate Value: EPA RSL Tap Water Criteria.
132-64-9	*Dibenzofuran [14]*	--	*3.7E+01*	--	*0.0E+00*	--	--	--	--	--	--	--	--	--	--	--	--
84-74-2	Di-n-butylphthalate	--	3.7E+03	--	1.6E+03	--	--	--	--	--	--	1.2E+04	4.5E+03	4.7E+01	3.1E+02	4.7E+01	EPA R10 Tribal Consumption of Seafood.
84-66-2	Diethylphthalate	--	2.9E+04	--	1.3E+04	--	--	--	--	--	--	1.2E+05	4.4E+04	1.8E+04	1.2E+05	1.8E+04	EPA R10 Tribal Consumption of Seafood.
105-67-9	2,4-Dimethylphenol	--	7.3E+02	--	3.2E+02	--	--	--	--	--	--	--	8.5E+02	6.6E+02	4.4E+03	6.6E+02	EPA R10 Tribal Consumption of Seafood.
131-11-3	Dimethylphthalate	--	--	--	--	--	--	--	--	--	--	2.9E+06	1.1E+06	--	--	1.1E+06	Marine Chronic AWQC to protect human consumption of seafood.
117-84-0	Di-n-octyl phthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
206-44-0	Fluoranthene	--	1.5E+03	--	6.4E+02	--	--	--	--	--	--	3.7E+02	1.4E+02	1.1E+01	7.4E+01	1.1E+01	EPA R10 Tribal Consumption of Seafood.
86-73-7	Fluorene	--	1.5E+03	--	6.4E+02	--	--	--	--	--	--	1.4E+04	5.3E+03	4.5E+01	3.0E+02	4.5E+01	EPA R10 Tribal Consumption of Seafood.
7440-62-2	1-Methylnaphthalene	--	2.3E+00	--	--	--	--	--	--	--	--	--	--	--	--	2.3E+00	Surrogate Value: EPA RSL Tap Water Criteria.
91-57-6	2-Methylnaphthalene	--	1.5E+02	--	6.4E+01	--	--	--	--	--	--	--	--	--	--	6.4E+01	Surrogate Value: MTCA B groundwater to protect drinking water.
95-48-7	2-Methylphenol (o-cresol)	--	1.8E+03	--	8.0E+02	--	--	--	--	--	--	--	--	3.1E+03	2.0E+04	3.1E+03	EPA R10 Tribal Consumption of Seafood.
106-44-5	4-Methylphenol (p-cresol)	--	1.8E+02	--	8.0E+01	--	--	--	--	--	--	--	--	3.3E+02	2.2E+03	3.3E+02	EPA R10 Tribal Consumption of Seafood.
91-20-3	Naphthalene[15]	--	1.4E-01	--	1.6E+02	--	--	--	--	--	--	--	--	2.6E+01	1.7E+02	2.6E+01	EPA R10 Tribal Consumption of Seafood.
85-01-8	Phenanthrene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
108-95-2	Phenol	--	1.1E+04	--	4.8E+03	--	--	--	--	--	--	4.6E+06	8.6E+05	4.1E+04	2.7E+05	4.1E+04	EPA R10 Tribal Consumption of Seafood.
129-00-0	Pyrene	--	1.1E+03	--	4.8E+02	--	--	--	--	--	--	1.1E+04	4.0E+03	9.8E+00	6.6E+01	9.8E+00	EPA R10 Tribal Consumption of Seafood.
Polychlorinated Biphenyls (PCBs)																	
53469-21-9	Aroclor 1016/1242	--	3.4E-02	--	4.4E-02	--	--	--	--	--	--	--	--	2.3E-05	1.6E-04	2.3E-05	EPA R10 Tribal Consumption of Seafood.
12672-29-6	Aroclor 1248	--	3.4E-02	--	4.4E-02	--	--	--	--	--	--	--	--	2.3E-05	1.6E-04	2.3E-05	EPA R10 Tribal Consumption of Seafood.
11097-69-1	Aroclor 1254	--	3.4E-02	--	4.4E-02	--	--	--	3.0E-02	--	--	--	--	5.5E-06	3.9E-05	5.5E-06	EPA R10 Tribal Consumption of Seafood.
37324-23-2	Aroclor 1260	--	3.4E-02	--	4.4E-02	--	--	--	3.0E-02	--	--	--	--	2.3E-05	1.6E-04	2.3E-05	EPA R10 Tribal Consumption of Seafood.
1336-36-3	Total PCBs	--	3.4E-02	--	4.4E-02	--	1.4E-02	1.4E-02	--	3.0E-02	3.0E-02	1.7E-04	6.4E-05	2.3E-05	1.6E-04	2.3E-05	EPA R10 Tribal Consumption of Seafood.

Notes:

1 Not all chemicals are constituents needing TMCLs at Boeing Plant 2.
2 Drinking water standards/criteria are not applicable to Boeing Plant 2 unless no other applicable standard exists for a constituent needing a TMCL in groundwater
3 The standards are potentially applicable to groundwater that may be used for drinking water supplies. Ecology determines the maximum beneficial use of groundwater, which may or may not include drinking
4 National Primary Drinking Water Regulations, Maximum Contaminant Levels (MCLs); http://water.epa.gov/drink/contaminants/index.cfm
5 EPA RSL, Residential Tapwaters; http://www.epa.gov/region9/superfund/prg/.
6 Washington Primary Drinking Water Standards WAC 246-290-130, Maximum Contaminant Levels (MCLs).
7 Standard MTCA Method B uses WAC 173-340-740; equations 730-1 and 730-2 (Ecology 2007). Parameters and toxicity factors can be found in associated tables in this attachment.
8 National Toxics Rule (NTR), 40 CFR 131.36.
9 EPA Ambient Water Quality Criteria (AWQCs), Clean Water Action Section 304.
10 Washington Surface Water Quality Standards; WAC 173-201A, Surface Water Quality Criteria
11 EPA and Ecology fish consumption scenarios are based on MTCA Method B Surface Water Equations (equations 730-1 and 730-2); however, they use different exposure assumptions. Details are given in associated tables in this attachment
12 This column uses the approach described in Note 8, but selects the lower concentrations that are protective of special populations including Tribal and Asian/Pacific Islander; the lowest concentration is always associated with Tribal exposure
13 This column is included for comparison only and is based on the default exposure scenario in MTCA 173-340-730.
14 The provisional toxicity factors for this chemical are semi-quantative and should be used for screening purposes only.
15 Naphthalene is treated as a volatile organic compound (VOC) for MTCA Groundwater calculations and therefore uses an Inhalation Correction Factor of 2 instead of 1.

Abbreviations:

CAS Chemical abstract factor
Ecology Washington State Department of Ecology
EPA U.S. Environmental Protection Agency
MTCA Model Toxics Control Act
CLARC Cleanup Levels and Risk Calculation
R10 Region 10
RSL Regional screening level

Table A.3c
Soil Calculations

		Direct Contact Exposures																								Protection of Groundwater	
		Ecology Default Calculations				EPA RSL Calculations with Site-Specific Factors																Proposed TMCLs				MTCA Three-Phase Model for Unsaturated Soils	
		Residential		Industrial		Residential Exposure								Worker Exposure								Direct Contact Exposure					
		MTCA Method B with CLARC Values		MTCA Method C with CLARC Values		Cancer Risk with EPA RSL Calculations, Parameters, and Toxicity Factors				Non-cancer Risk with EPA RSL Calculations, Parameters, and Toxicity Factors				Cancer Risk with EPA RSL Calculations, Parameters, and Toxicity Factors; Modified to 10-5 Cancer Risk and Ingestion Rate of 200 mg/day				Non-cancer Risk with EPA RSL Calculations, Parameters, and Toxicity Factors				Residential		Industrial		Groundwater Target to be Protected[1]	Three-phase Partitioning Between Soil, Soil Vapor, and Groundwater using MTCA Equation[2]
CAS Number	Chemical	Cancer (mg/kg)	Non-cancer (mg/kg)	Cancer (mg/kg)	Non-cancer (mg/kg)	Ingestion (mg/kg)	Dermal (mg/kg)	Inhalation (mg/kg)	TOTAL (mg/kg)	Ingestion (mg/kg)	Dermal (mg/kg)	Inhalation (mg/kg)	TOTAL (mg/kg)	Ingestion (mg/kg)	Dermal (mg/kg)	Inhalation (mg/kg)	TOTAL (mg/kg)	Ingestion (mg/kg)	Dermal (mg/kg)	Inhalation (mg/kg)	TOTAL (mg/kg)	Cancer (mg/kg)	Non-cancer (mg/kg)	Cancer (mg/kg)	Non-cancer (mg/kg)	(mg/kg)	(mg/kg)
Semivolatile Organic Compounds (SVOCs)																											
83-32-9	Acenaphthene	--	4.8E+03	--	2.1E+05	--	--	--	--	4.7E+03	1.3E+04	--	3.4E+03	--	--	--	--	3.1E+04	7.1E+04	--	2.1E+04	--	3.4E+03	--	2.1E+04	1.2E+02	2.3E+02
208-96-8	Acenaphthylene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
120-12-7	Anthracene	--	2.4E+04	--	1.1E+06	--	--	--	--	2.3E+04	6.4E+04	--	1.7E+04	--	--	--	--	1.5E+05	3.6E+05	--	1.1E+05	--	1.7E+04	--	1.1E+05	2.0E+02	1.6E+03
191-24-2	Benzo(g,h,i)perylene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
117-81-7	Bis(2-ethylhexyl)phthalate	7.1E+01	1.6E+03	9.4E+03	7.0E+04	4.6E+01	1.4E+02	1.4E+06	3.5E+01	1.6E+03	5.6E+03	--	1.2E+03	1.0E+03	3.1E+03	6.9E+07	7.7E+02	1.0E+04	3.1E+04	--	7.7E+03	3.5E+01	1.2E+03	7.7E+02	7.7E+03	1.2E+00	5.7E+01
85-68-7	Butylbenzyl phthalate	5.3E+02	1.6E+04	6.9E+04	7.0E+05	3.4E+02	1.1E+03	--	2.6E+02	1.6E+04	5.6E+04	--	1.2E+04	7.5E+03	2.3E+04	--	5.7E+03	1.0E+05	3.1E+05	--	7.7E+04	2.6E+02	1.2E+04	5.7E+03	7.7E+04	4.1E-01	1.7E+00
59-50-7	4-chloro-3-methylphenol	--	8.0E+03	--	3.5E+05	--	--	--	--	7.8E+03	2.8E+04	--	6.1E+03	--	--	--	--	5.1E+04	1.5E+05	--	3.8E+04	--	6.1E+03	--	3.8E+04	3.7E+03	7.4E+02
132-64-9	*Dibenzofuran*[3]	--	--	--	--	--	--	--	--	*7.8E+01*	--	--	7.8E+01	--	--	--	--	5.1E+02	--	--	*5.1E+02*	--	*7.8E+01*	--	*5.1E+02*	--	--
84-74-2	Di-n-butylphthalate	--	8.0E+03	--	3.5E+05	--	--	--	--	7.8E+03	2.8E+04	--	6.1E+03	--	--	--	--	5.1E+04	1.5E+05	--	3.8E+04	--	6.1E+03	--	3.8E+04	4.7E+01	2.6E+01
84-66-2	Diethylphthalate	--	6.4E+04	--	2.8E+06	--	--	--	--	6.3E+04	2.2E+05	--	4.9E+04	--	--	--	--	4.1E+05	1.2E+06	--	3.1E+05	--	4.9E+04	--	3.1E+05	1.8E+04	7.6E+02
105-67-9	2,4-Dimethylphenol	--	1.6E+03	--	7.0E+04	--	--	--	--	1.6E+03	5.6E+03	--	1.2E+03	--	--	--	--	1.0E+04	3.1E+04	--	7.7E+03	--	1.2E+03	--	7.7E+03	6.6E+02	9.5E+01
131-11-3	Dimethylphthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.1E+06	--
117-84-0	Di-n-octyl phthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
206-44-0	Fluoranthene	--	3.2E+03	--	1.4E+05	--	--	--	--	3.1E+03	8.6E+03	--	2.3E+03	--	--	--	--	2.0E+04	4.8E+04	--	1.4E+04	--	2.3E+03	--	1.4E+04	1.1E+01	2.3E+02
86-73-7	Fluorene	--	3.2E+03	--	1.4E+05	--	--	--	--	3.1E+03	8.6E+03	--	2.3E+03	--	--	--	--	2.0E+04	4.8E+04	--	1.4E+04	--	2.3E+03	--	1.4E+04	4.5E+01	1.5E+02
7440-62-2	1-Methylnaphthalene	3.4E+01	--	4.5E+03	--	2.2E+01	5.4E+01	--	1.6E+01	5.5E+03	1.5E+04	--	4.0E+03	4.9E+02	1.2E+03	--	3.5E+02	3.6E+04	8.3E+04	--	2.5E+04	1.6E+01	4.0E+03	3.5E+02	2.5E+04	2.3E+00	--
91-57-6	2-Methylnaphthalene	--	3.2E+02	--	1.4E+04	--	--	--	--	3.1E+02	8.6E+02	--	2.3E+02	--	--	--	--	2.0E+03	4.8E+03	--	1.4E+03	--	2.3E+02	--	1.4E+03	6.4E+01	--
95-48-7	2-Methylphenol (o-cresol)	--	4.0E+03	--	1.8E+05	--	--	--	--	3.9E+03	1.4E+04	--	3.1E+03	--	--	--	--	2.6E+04	7.7E+04	--	1.9E+04	--	3.1E+03	--	1.9E+04	3.1E+03	2.5E+02
106-44-5	4-Methylphenol (p-cresol)	--	4.0E+02	--	1.8E+04	--	--	--	--	3.9E+02	1.4E+03	--	3.1E+02	--	--	--	--	2.6E+03	7.7E+03	--	1.9E+03	--	3.1E+02	--	1.9E+03	3.3E+02	4.1E+01
91-20-3	Naphthalene	--	1.6E+03	--	7.0E+04	--	--	3.6E+00	3.6E+00	1.6E+03	4.3E+03	1.6E+02	1.4E+02	--	--	1.8E+02	1.8E+02	1.0E+04	2.4E+04	6.6E+02	6.0E+02	3.6E+00	1.4E+02	1.8E+02	6.0E+02	2.6E+01	1.6E+01
85-01-8	Phenanthrene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
108-95-2	Phenol	--	2.4E+04	--	1.1E+06	--	--	--	--	2.3E+04	8.4E+04	--	1.8E+04	--	--	--	--	1.5E+05	4.6E+05	--	1.2E+05	--	1.8E+04	--	1.2E+05	4.1E+04	1.9E+03
129-00-0	Pyrene	--	2.4E+03	--	1.1E+05	--	--	--	--	2.3E+03	6.4E+03	--	1.7E+03	--	--	--	--	1.5E+04	3.6E+04	--	1.1E+04	--	1.7E+03	--	1.1E+04	9.8E+00	2.4E+02
Polychlorinated Biphenyls (PCBs)																											
53469-21-9	Aroclor 1016/1242	5.0E-01	--	6.6E+01	--	3.2E-01	7.2E-01	--	2.2E-01	--	--	--	--	7.2E+00	1.5E+01	--	4.9E+00	--	--	--	--	2.2E-01	--	4.9E+00	--	2.3E-05	7.2E-04
12672-29-6	Aroclor 1248	5.0E-01	--	6.6E+01	--	3.2E-01	7.2E-01	--	2.2E-01	--	--	--	--	7.2E+00	1.5E+01	--	4.9E+00	--	--	--	--	2.2E-01	--	4.9E+00	--	2.3E-05	--
11097-69-1	Aroclor 1254	5.0E-01	1.6E+00	6.6E+01	7.0E+01	3.2E-01	7.2E-01	--	2.2E-01	1.6E+00	4.0E+00	--	1.1E+00	7.2E+00	1.5E+01	--	4.9E+00	1.0E+01	2.2E+01	--	7.0E+00	2.2E-01	1.1E+00	4.9E+00	7.0E+00	5.5E-06	2.9E-04
37324-23-2	Aroclor 1260	5.0E-01	--	6.6E+01	--	3.2E-01	7.2E-01	--	2.2E-01	--	--	--	--	7.2E+00	1.5E+01	--	4.9E+00	--	--	--	--	2.2E-01	--	4.9E+00	--	2.3E-05	5.4E-03
1336-36-3	Total PCBs	5.0E-01	--	6.6E+01	--	3.2E-01	7.2E-01	--	2.2E-01	--	--	--	--	7.2E+00	1.5E+01	--	4.9E+00	--	--	--	--	2.2E-01	--	4.9E+00	--	2.3E-05	1.8E-03

Notes:

1 Refer to Table A.3b, Groundwater Standards, Criteria, and Risk-based Calculations, of this attachment.

2 Soil to Groundwater cleanup values are based on the MTCA fixed parameter three-phase partitioning model (WAC 173-340-747, equations 747-1 and 747-2), using partitioning factors presented in associated tables in this attachment.

3 The provisional toxicity factors for this chemical are semi-quantative and should be used for screening purposes only.

Abbreviations:

CAS Chemical abstract number
CLARC Cleanup Levels and Risk Calculation
Ecology Washington State Department of Ecology
EPA U.S. Environmental Protection Agency
MTCA Model Toxics Control Act
RSL Regional screening level

Table A.3d
Soil Equations and Parameters

Soil Cleanup Levels from Non-cancer Effects for Ingestion Only

Equation 740-1 Non-cancer

Soil Cleanup Level (mg/kg) = **EPA $SSL_{SOIL-NC-ING}$ =** $\frac{(RfD_o \times ABW \times UCF \times HQ \times AT)}{(SIR \times AB1 \times EF \times ED)}$

Terminology in MTCA:

RfD_o = Reference dose (mg/kg-day) as specified in WAC 173-340-708(7)
ABW = Average body weight (kg) over the exposure duration
UCF = 1,000,000 mg/kg
SIR = Soil ingestion rate (mg/kg)
AB1 = Gastrointestinal absorption fraction (unitless)
HQ = Hazard quotient (unitless)
AT = Averaging time (years)
ED = Exposure duration (years)
EF = Exposure frequency (fraction of time)

Terminology in EPA RSL Equation:

=	BW	Body weight (kg)
=	same	
=	IRS	Ingestion rate soil (mg/day)
=	not used	
=	THQ	Target hazard quotient (unitless)
=	AT	Averaging time (days)
=	ED	Exposure duration (years)
=	EF	Exposure frequency (days/year)

Exposure Scenarios	RfD_o (mg/kg-day)	ABW (kg)	HQ (unitless)	AT (years)	SIR (mg/day)	AB1 (unitless)	EF (unitless)	ED (years)	Assumptions for Unitless EF Term: Total Days (days)	hours/day (unitless)	days/week (unitless)	weeks/year (unitless)
MTCA Method B Residential Child	<table>	16	1	6	200	1	1.00	6	365	24	7	52
MTCA Method C Worker	<table>	70	1	20	50	1	0.40	20	350	10	7	50
EPA RSL Residental Child	<table>	15	1	6	200	1	0.96	6	350			
EPA RSL Residental Adult	<table>	70	1	24	100	1	0.96	25	350			
Modified EPA RSL Worker[1,2]	<table>	70	1	25	200	1	0.68	25	250			

EPA RSL **Soil Screening Levels from Non-cancer Effects**

Soil Screening Level (mg/kg)=

$$\frac{1}{\frac{1}{SSL_{SOIL-NC-ING}} + \frac{1}{SSL_{SOIL-NC-DER}} + \frac{1}{SSL_{SOIL-NC-INH}}}$$

< ---------- Ingestion of Soil Term ----------> < ------ Dermal Contact with Soil Term -------> < ---------- Inhalation of Dust ---------->

$SSL_{SOIL-NC-ING}$ = **Use the MTCA equation above for ingestion**

$$SSL_{SOIL-NC-DER} = \frac{THQ \times BW \times AT \times RfD_d \times UCF1}{EF \times ED \times SA \times AF \times ABS_d} = \frac{RfD_d}{ABS_d} \times \frac{THQ \times BW \times AT \times UCF1}{EF \times ED \times SA \times AF}$$

$$SSL_{SOIL-NC-INH} = \frac{THQ \times AT}{(1/RfC_i) \times EF \times ED \times ET \times UCF2 \times [(1/PEF) + (1/VF)]} = \frac{RfC_i}{[1/VF + 1/PEF]} \times \frac{THQ \times AT}{EF \times ED \times ET \times UCF2}$$

THQ = Target Hazard Quotient (or HQ Hazard Quotient), unitless
BW = Body Weight (kg)
AT = Averaging Time (total number of days in the averaging time: 6 yrs for children; 25 years for workers)
RfD_d = Dermal reference dose (mg/kg-day) = RfD_o * GI-abs
GI-abs = GI absorption conversion factor (unitless)
UCF1 = 1,000,000 mg/kg
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
ET = Exposure time (hours/day)
SA = Surface area exposed (cm^2/day)
AF = Adherence factor (mg/cm^2)
ABS_d = Skin absorption factor (unitless)
RfC_i = Reference concentration, inhalation (mg/m^3; chemical specific)
PEF = Particulate emission factor used for dusts (m^3/kg; 1.4 E+9 from EPA RSL User Manual)
VF = Volatilization factor used for volatile organic compounds (m^3/kg; chemical specific)
UCF2 = 1/24 day/hour

Source: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

Exposure Scenarios	THQ (unitless)	BW (kg)	AT (days)	RfD_d (mg/kg-day)	ED (years)	EF (days/year)	ET (hours/day)	IRS (mg/day)	SA (cm^2/day)	AF (mg/cm^2)	ABS (unitless)	RfC_i (mg/m^3)	VF (m^3/kg)	PEF (m3/kg)	1/VF + 1/PEF (m^3/kg)
EPA RSL Residential (Child)	1	15	2,190	<table>	6	350	24	200	2,800	0.2	<table>	<table>	<table>	1.36E+09	<table>
Modified EPA RSL Worker[1,2]	1	70	9,125	<table>	25	250	8	200	3,300	0.2	<table>	<table>	<table>	1.36E+09	<table>

Ecology **Soil Cleanup Levels from Cancer Risk for Ingestion Only**

Equation 740-2 Cancer

Soil Cleanup Level (mg/kg)= $\frac{(RISK \times ABW \times AT \times UCF)}{(CPF_o \times SIR \times AB1 \times ED \times EF)}$

RISK = Acceptable excess individual lifetime cancer risk level (unitless)
ABW = Average body weight (kg) over the exposure duration
AT = Averaging time (years)
UCF = 1,000,000 mg/kg
CPF_o = Carcinogenic potency factor (kg-day/mg)
SIR = Soil ingestion rate (mg/day)
AB1 = Gastrointestinal absorbtion fraction (unitless)
ED = Exposure duration (years)
EF = Exposure frequency (unitless)

Exposure Scenarios	RISK (unitless)	ABW (kg)	AT (years)	CPF_o (kg-day/mg)	SIR (mg/day)	AB1 (unitless)	ED (years)	EF (unitless)	Assumptions for Unitless EF Term: hours/day (unitless)	days/week (unitless)	weeks/year (unitless)
DEFAULT MTCA Method B	1.00E-06	16	75	<table>	200	1	6	1	24	7	52
DEFAULT MTCA Method C	1.00E-05	70	75	<table>	50	1	20	0.4	24	7	52

Table A.3d
Soil Equations and Parameters

EPA RSL — **Soil Screening Level from Cancer Risk for Residents (Childhood Corrected) and Workers**

< ---------- Ingestion of Soil Term ----------> < ------ Dermal Contact with Soil Term -------> < ---------- Inhalation of Dust ---------->

$$\text{Soil Screening Level (mg/kg)} = \frac{1}{\frac{1}{SSL_{SOIL\text{-}CA\text{-}ING}} + \frac{1}{SSL_{SOIL\text{-}CA\text{-}DER}} + \frac{1}{SSL_{SOIL\text{-}CA\text{-}INH}}}$$

$$SSL_{SOIL\text{-}CA\text{-}ING} = \frac{TR \times AT}{CSF_o \times EF \times IFS \times UCF1} \quad \text{where} \quad IFS = \frac{ED_c \times IRS_c}{BW_c} + \frac{ED_a \times IRS_a}{BW_a}$$

$$SSL_{SOIL\text{-}CA\text{-}DER} = \frac{TR \times AT}{CSF_d \times EF \times DFS \times ABS_d \times UCF1} \quad \text{where} \quad DFS = \frac{ED_c \times SA_c \times AF_c}{BW_c} + \frac{ED_a \times SA_a \times AF_a}{BW_a} \quad \text{and where} \quad CSFd = CSFo * GI\text{-}Abs$$

$$SSL_{SOIL\text{-}NC\text{-}INH} = \frac{TR \times AT}{IUR \times UCF2 \times EF \times ED \times ET \times UCF3 \times [(1/PEF) + (1/VF)]} = \frac{1}{IUR*[1/VF + 1/PEF]} \times \frac{TR \times AT}{UCF2 \times EF \times ED \times ET \times UCF3}$$

TR = Target excess individual lifetime cancer risk (unitless)
AT = Averaging time in days = 365 day/year * Lifetime (years)
CSF_o = Oral cancer slope factor (kg-day/mg)
EF = Exposure frequency (days/year)
IFS = Resident soil ingestion rate; age-adjusted (mg-year/kg-day)
UCF1 = 1/1,000,000 kg/mg
Ed_c = Exposure duration, child (years)
IRS_c = Resident soil ingestion rate, child; age-adjusted (mg-year/kg-day)
BW_c = Body weight, child (kg)
ED_a = Exposure duration, adult (years)
IRS_a = Resident soil ingestion rate, adult; age-adjusted (mg-year/kg-day)
BW_a = Body weight, adult (kg)
CSF_d = Cancer slope factor, dermal = CSFo*GI-abs
GI-abs = GI absorption conversion factor (unitless)
DFS = Resident soil dermal contact factor; age-adjusted (mg-year/kg-day)
ABS_d = Skin absorption factor (chemical specific)
SA_c = Surface area, child (cm^2/day)
AF_c = Adherence factor, child (mg/cm^2)
SA_a = Surface area, adult (cm^2/day)
AF_a = Adherence factor, adult (mg/cm^2)
IUR = Inhalation unit rate (m^3/µg)
UCF2 = 1000 µg/mg
UCF3 = 1/24 day/hr
ED = Exposure duration (years)
ET = Exposure time (hours/day)
PEF = Particulate emission factor used for dusts (m^3/kg)
VF = Volatilization factor used for volatile organic compounds (m^3/kg)

Source: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

Exposure Scenarios	TR (unitless)	AT (days)	LT (years)	SF_o (kg-day/mg)	EF (days/year)	ET (hours/day)	IFS (mg-year/kg-day)	IRS (mg-year/kg-day)	ED (years)	BW (kg)	DFS (mg-year/kg-da	SA (cm^2/day)	AF (mg/cm^2)	ABS (unitless)	IUR (m^3/µg)	PEF (m^3/kg)	VF (m3/kg)	(1/VF + 1/PEF) (m^3/kg)
EPA RSL Resident	1.00E-06	25,550	70	<table>	350	24	114		30		361			<table>	<table>	1.36E+09	<table>	<table>
contribution during childhood							80	200	6	15	224	2,800	0.2	<table>	<table>	1.36E+09	<table>	<table>
contribution during adult years							34	100	24	70	137	5,700	0.07	<table>	<table>	1.36E+09	<table>	<table>
Modified EPA RSL Worker[1,2]	1.00E-05	25,550	70	<table>	250	8	71	200	25	70	236	3,300	0.2	<table>	<table>	1.36E+09	<table>	<table>

Ecology — **Three-phase Partitioning Between Soil, Soil Vapor, and Groundwater Using MTCA Equation**

Equation 747-1

$$\text{Soil Concentration (mg/kg)} = C_s = C_w \times UCF \times DF \times \left(Kd + \frac{(\theta w + \theta a Hcc)}{\rho_b}\right) = C_w \times UCF \times DF \times K_d + \frac{C_w \times UCF \times DF \times \theta w}{\rho_b} + \frac{C_w \times UCF \times DF \times \theta a \times H_{cc}}{\rho_b} = C_w * (C1*K_d + C2 + C3*Hcc)$$

where

$$C1 = UCF \times DF$$
$$C2 = \frac{UCF \times DF \times \theta w}{\rho_b}$$
$$C3 = \frac{UCF \times DF \times \theta a}{\rho_b}$$

C_w = Ground water cleanup level established under WAC 173-340-720 (µg/L)
UCF = 1/1000 mg/µg
DF = Dilution factor (dimensionless)
Kd = Distribution coefficient (L/kg)
θ_w = Water-filled soil porosity (ml water/ml soil)
θa = Air-filled soil porosity (ml air/ml soil)
Hcc = Henry's law constant (dimensionless)
ρ_b = Dry soil bulk density (kg/L)

Exposure Scenarios	Cw (µg/L)	DF (unitless)	K_d (L/kg)	θw (ml water/ ml soil)	θa (ml air/ ml soil)	H_{cc} (unitless)	ρ_b (kg/L)	C1 (mg/µg)	C2 (L-ml water/ ml soil)	C3 (L-ml air/ ml soil)
Soil Concentration for Saturated Soil	<table>	20	<table>	0.3	0.13	<table>	1.5	0.02	0.004	0.002

Notes:

Indicates no value is required in calculations for the associated exposure scenario indicated.
<table> Indicates a chemical-specific factor is available in the associated tables of this attachment.
1 EPA RSL Worker scenario has been modified to a 1 in 100,000 excess individual lifetime cancer risk and a soil ingestion rate of 200 mg/kg-day by an EPA Region 10 risk management decision.
2 Exposure frequency taken to be 250 days/year. This value was selected based on Region 9 EPA RSL tables last updated November 2010, which uses parameters associated with an indoor worker to calculate risk.

Abbreviations:

EPA U.S. Environmental Protection Agency
MTCA Model Toxics Control Act
RSL Regional screening level
SSL Soil screening level

Subscripts:

CA Cancer
DER Dermal
ING Ingestion
INH Inhalation
NC Non-cancer

Table A.3e
Groundwater Calculations

		Surface Water to Fish Consumption Pathway														Drinking Water Pathways			
		EPA Tribal Calculations				Ecology MTCA Calculations						Proposed Water to Fish Consumption TMCLs				EPA		Ecology	
		Tribal Consumption Child Includes EPA BCFs and Toxicity Factors[1]		Tribal Consumption Adult Includes EPA BCFs and Toxicity Factors[1]		Default (Recreational) Includes EPA BCFs and Toxicity Factors[2]		Asian/Pacific Islander Consumption Child Includes EPA BCFs and Toxicity Factors[3]		Asian/Pacific Islander Consumption Adult Includes EPA BCFs and Toxicity Factors[3]		MTCA Default Consumption Rate Modified to Use EPA Toxicity and Partitioning Coefficients		Tribal and/or Asian/Pacific Islander Modified to Use EPA Toxicity and Partitioning Coefficients		EPA RSL Tap Water[4]		MTCA Method B Groundwater to Protect Drinking Water Use[5]	
CAS Number	Chemical	Cancer (µg/L)	Non-cancer (µg/L)	Cancer (µg/L)	Non-cancer (µg/L)	Cancer (µg/L)	Non-cancer (µg/L)	Cancer (µg/L)	Non-cancer (µg/L)	Cancer (µg/L)	Non-cancer (µg/L)	TMCL (µg/L)	Source (µg/L)	TMCL (µg/L)	Source (µg/L)	Cancer (µg/L)	Non-cancer (µg/L)	Cancer (µg/L)	Non-cancer (µg/L)
Semivolatile Organic Compounds (SVOCs)[6]																			
83-32-9	Acenaphthene	--	1.2E+02	--	2.5E+02	--	7.7E+02	--	1.9E+02	--	3.3E+02	7.7E+02	MTCA B	1.2E+02	Tribal Child	--	2.2E+03	--	9.6E+02
208-96-8	Acenaphthylene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
120-12-7	Anthracene	--	2.0E+02	--	4.3E+02	--	1.3E+03	--	3.4E+02	--	5.7E+02	1.3E+03	MTCA B	2.0E+02	Tribal Child	--	1.1E+04	--	4.8E+03
191-24-2	Benzo(g,h,i)perylene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
117-81-7	Bis(2-ethylhexyl)phthalate	6.0E+00	1.5E+02	1.2E+00	3.2E+02	8.7E+00	9.7E+02	1.0E+01	2.4E+02	4.3E+00	4.1E+02	8.7E+00	MTCA B	1.2E+00	Tribal Adult	4.8E+00	7.3E+02	6.3E+00	3.2E+02
85-68-7	Butylbenzyl phthalate	2.0E+00	6.5E+01	4.1E-01	1.4E+02	2.9E+00	4.4E+02	3.4E+00	1.1E+02	1.4E+00	1.9E+02	2.9E+00	MTCA B	4.1E-01	Tribal Adult	3.5E+01	7.3E+03	4.6E+01	3.2E+03
59-50-7	4-chloro-3-methylphenol	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3.7E+03	--	1.6E+03
132-64-9	*Dibenzofuran*[7]	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	*3.7E+01*	--	--
84-74-2	Di-n-butylphthalate	--	4.7E+01	--	1.0E+02	--	3.1E+02	--	7.9E+01	--	1.3E+02	3.1E+02	MTCA B	4.7E+01	Tribal Child	--	3.7E+03	--	1.6E+03
84-66-2	Diethylphthalate	--	1.8E+04	--	4.0E+04	--	1.2E+05	--	3.1E+04	--	5.3E+04	1.2E+05	MTCA B	1.8E+04	Tribal Child	--	2.9E+04	--	1.3E+04
105-67-9	2,4-Dimethylphenol	--	6.6E+02	--	1.4E+03	--	4.4E+03	--	1.1E+03	--	1.9E+03	4.4E+03	MTCA B	6.6E+02	Tribal Child	--	7.3E+02	--	3.2E+02
131-11-3	Dimethylphthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
117-84-0	Di-n-octyl phthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
206-44-0	Fluoranthene	--	1.1E+01	--	2.4E+01	--	7.4E+01	--	1.9E+01	--	3.1E+01	7.4E+01	MTCA B	1.1E+01	Tribal Child	--	1.5E+03	--	6.4E+02
86-73-7	Fluorene	--	4.5E+01	--	9.9E+01	--	3.0E+02	--	7.6E+01	--	1.3E+02	3.0E+02	MTCA B	4.5E+01	Tribal Child	--	1.5E+03	--	6.4E+02
7440-62-2	1-Methylnaphthalene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.3E+00	2.6E+03	3.0E+00	--
91-57-6	2-Methylnaphthalene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.5E+02	--	6.4E+01
95-48-7	2-Methylphenol (o-cresol)	--	3.1E+03	--	6.7E+03	--	2.0E+04	--	5.2E+03	--	8.7E+03	2.0E+04	MTCA B	3.1E+03	Tribal Child	--	1.8E+03	--	8.0E+02
106-44-5	4-Methylphenol (p-cresol)	--	3.3E+02	--	7.3E+02	--	2.2E+03	--	5.6E+02	--	9.5E+02	2.2E+03	MTCA B	3.3E+02	Tribal Child	--	1.8E+02	--	8.0E+01
91-20-3	Naphthalene[8]	--	2.6E+01	--	5.6E+01	--	1.7E+02	--	4.3E+01	--	7.4E+01	1.7E+02	MTCA B	2.6E+01	Tribal Child	1.4E-01	6.2E+00	--	1.6E+02
85-01-8	Phenanthrene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
108-95-2	Phenol	--	4.1E+04	--	8.9E+04	--	2.7E+05	--	6.9E+04	--	1.2E+05	2.7E+05	MTCA B	4.1E+04	Tribal Child	--	1.1E+04	--	4.8E+03
129-00-0	Pyrene	--	9.8E+00	--	2.1E+01	--	6.6E+01	--	1.7E+01	--	2.8E+01	6.6E+01	MTCA B	9.8E+00	Tribal Child	--	1.1E+03	--	4.8E+02
Polychlorinated Biphenyls (PCBs)																			
53469-21-9	Aroclor 1016/1242	1.1E-04	--	2.3E-05	--	1.6E-04	--	1.9E-04	--	8.0E-05	--	1.6E-04	MTCA B	2.3E-05	Tribal Adult	3.4E-02	--	4.4E-02	--
12672-29-6	Aroclor 1248	1.1E-04	--	2.3E-05	--	1.6E-04	--	1.9E-04	--	8.0E-05	--	1.6E-04	MTCA B	2.3E-05	Tribal Adult	3.4E-02	--	4.4E-02	--
11097-69-1	Aroclor 1254	2.7E-05	9.2E-05	5.5E-06	2.0E-04	3.9E-05	6.2E-04	4.5E-05	1.6E-04	1.9E-05	2.6E-04	3.9E-05	MTCA B	5.5E-06	Tribal Adult	3.4E-02	7.3E-01	4.4E-02	3.2E-01
37324-23-2	Aroclor 1260	1.1E-04	--	2.3E-05	--	1.6E-04	--	1.9E-04	--	8.0E-05	--	1.6E-04	MTCA B	2.3E-05	Tribal Adult	3.4E-02	--	4.4E-02	--
1336-36-3	Total PCBs	1.1E-04	--	2.3E-05	--	1.6E-04	--	1.9E-04	--	8.0E-05	--	1.6E-04	MTCA B	2.3E-05	Tribal Adult	3.4E-02	--	4.4E-02	--

Notes:

1 MTCA Method B Equations 730-1 and 730-2 modified to apply Tribal fish ingestion rates, body weights, and exposure duration (Ecology 2007). Refer to associated tables in this attachment for toxicity factors, bioconcentration factors, and exposure parameters.
2 MTCA Method B Equations 730-1 and 730-2 using default exposure assumptions. Refer to associated tables in this attachment for toxicity factors, bioconcentration factors, and exposure parameters.
3 MTCA Method B Equations 730-1 and 730-2 modified to apply Asian/Pacific Islander fish ingestion rates, body weights, and exposure duration (Ecology 2007). Refer to associated tables in this attachment for toxicity factors, bioconcentration factors, and exposure parameters.
4 EPA RSL, Residential Tapwaters; http://www.epa.gov/region9/superfund/prg/.
5 MTCA Method B Equations 720-1 and 720-2 groundwater cleanup levels to protect drinking water uses.
6 Includes all SVOCS except mutagenic/carcinogenic polycyclic aromatic hydrocarbons (cPAHs).
7 The provisional toxicity factors for this chemical are semi-quantative and should be used for screening purposes only.
8 Naphthalene is treated as a volatile organic compound (VOC) for MTCA Groundwater calculations and therefore uses an Inhalation Correction Factor of 2 instead of 1.

Abbreviations:

BCF Bioconcentration factor
CAS Chemical abstract number
Ecology Washington State Department of Ecology
EPA U.S. Environmental Protection Agency
MTCA Model Toxics Control Act
RSL Regional screening level

Table A.3f
Groundwater Equations and Parameters

Surface Water to Fish Consumption by Humans: Non-cancer Effects

$$\text{Surface Water Cleanup of Screening Level (µg/L)} = \frac{(RfD_o \times ABW \times UCF1 \times UCF2 \times HQ \times AT)}{(BCF \times FCR \times FDF \times ED)}$$

RfD_o = Oral reference dose (mg/kg-day)
ABW = Average body weight (kg)
UCF1 = 1,000 g/mg
UCF2 = 1,000 g/L
HQ = Hazard quotient (unitless)
AT = Averaging time (years)
BCF = Bioconcentration factor (L/kg)
FCR = Fish consumption rate (g/day)
FDF = Fish diet fraction (unitless)
ED = Exposure duration (years)

Exposure Scenarios	RfD_o (mg/kg-day)	ABW (kg)	HQ (unitless)	AT (years)	BCF (L/kg)	FCR (g/day)	FDF (unitless)	ED (years)
MTCA Default[1]	<table>	70	1	30	<table>	54	0.5	30
MTCA Asian/Pacific Islander Child2,3	<table>	15	1	6	<table>	23	1	6
MTCA Asian/Pacific Islander Adult2,3	<table>	63	1	24	<table>	57.1	1	24
EPA Tribal Child[3,4]	<table>	15	1	6	<table>	38.8	1	6
EPA Tribal Adult[3,4]	<table>	81.8	1	64	<table>	97.1	1	64

Surface Water to Fish Consumption by Humans: Cancer

$$\text{Surface Water Cleanup or Screening Level (µg/L)} = \frac{(RISK \times ABW \times UCF1 \times UCF2 \times AT)}{(CPF_o \times BCF \times FCR \times FDF \times ED)}$$

Risk = Target excess individual lifetime cancer risk level (unitless)
ABW = Average body weight (kg)
UCF1 = 1,000 µg/mg
UCF2 = 1,000 g/L
AT = Averaging time (years)
CPF_o = Cancer potency factor (kg-day/mg)
BCF = Bioconcentration factor (L/kg)
FCR = Fish consumption rate (g/day)
FDF = Fish diet fraction (unitless)
ED = Exposure duration (years)

Exposure Scenarios	Risk (unitless)	ABW (kg)	AT (years)	CPF_o (kg-day/mg)	BCF (L/kg)	FCR (g/day)	FDF (unitless)	ED (years)
MTCA Default[1]	1.00E-06	70	75	<table>	<table>	54	0.5	30
MTCA Asian/Pacific Islander Child2,3	1.00E-06	15	70	<table>	<table>	23	1	6
MTCA Asian/Pacific Islander Adult2,3	1.00E-06	63	70	<table>	<table>	57.1	1	24
EPA Tribal Child[3,4]	1.00E-06	15	70	<table>	<table>	38.8	1	6
EPA Tribal Adult[3,4]	1.00E-06	81.8	70	<table>	<table>	97.1	1	64

Groundwater (as Drinking Water) Cleanup Levels: Non-cancer Effects

$$\text{Surface Water Cleanup or Screening Level (µg/L)} = \frac{(RfD_o \times ABW \times UCF \times HQ \times AT)}{(DWIR \times INH \times DWF \times ED)}$$

RfD_o = Oral reference dose (mg/kg-day)
ABW = Average body weight (kg)
UCF = 1,000 µg/mg
HQ = Hazard quotient (unitless)
AT = Averaging time (years)
DWIR = Drinking water ingestion rate (L/day)
INH = Inhalation correction factor (unitless)
DWF = Drinking water fraction (unitless)
ED = Exposure duration (years)

Exposure Scenarios	RfD_o (mg/kg-day)	ABW (kg)	HQ (unitless)	AT (years)	DWIR (L/day)	INH (unitless)	DWF (unitless)	ED (years)
MTCA Default[1]	<table>	16	1	6	1	1	1	6

Groundwater (as Drinking Water) Cleanup Levels: Cancer

$$\text{Surface Water Cleanup Screening Level (µg/L)} = \frac{(RISK \times ABW \times UCF \times AT)}{(CPF_o \times DWIR \times INH \times DWF \times ED)}$$

Risk = Target excess individual lifetime cancer risk level (unitless)
ABW = Average body weight (kg)
UCF = 1,000 µg/mg
AT = Averaging time (years)
CPF_o = Cancer potency factor (kg-day/mg)
DWIR = Drinking water ingestion rate (L/day)
INH = Inhalation correction factor (unitless)
DWF = Drinking water fraction (unitless)
ED = Exposure duration (years)

Exposure Scenarios	Risk (unitless)	ABW (kg)	AT (years)	CPF_o (kg-day/mg)	DWIR (L/day)	INH (unitless)	DWF (unitless)	ED (years)
MTCA Default[1]	1.00E-06	70	75	<table>	2	1	1	30

Notes:

<table> Indicates a chemical-specific factor is available in the associated tables of this attachment.

1 All parameters derived from Model Toxics Control Act (MTCA) WAC 173-340-730, equations 730-1 and 730-2. The inhalation parameter is equivalent to 1 for all Semivolatile organic compounds (SVOCs) and is equivalent to 2 for naphthalene, which is treated as a volatile organic compound (VOC).

2 Fish consumption rates derived from Washington State Department of Ecology (Ecology) 2009: MTCA Regulation Update Summary, Fish Consumption Rates for High Exposure Populations.

3 Fish consumption rates include both finfish and shellfish, and exclude salmon.

4 All parameters derived from U.S. Environmental Protection Agency (EPA) Region: Framework for Selecting and Using Tribal Fish and Shellfish Consumption Rates for Risk-based Decision Making (2007).

Table A.3g
Cross-Media Factors

		Other Chemical Factors					Bioconcentration Factors							
		EPA R10					EPA R10		Ecology MTCA/CLARC		Others		Selected for Use[4]	
CAS Number	Chemical	GI Absorption Conversion Factor (unitless)	Dermal Absorption Fraction (unitless)	Volatilization Factor (m^3/kg)	Source for Preceding Factors	(1/VF + 1/PEF)[1] kg/m^3	Water to Fish BCF[2] (L/kg)	Source	Water to Fish BCF[3] (L/kg)	Source	Water to Fish BCF (L/kg)	Source	Water to Fish BCF (L/kg)	Source
Semivolatile Organic Compounds (SVOCs)														
83-32-9	Acenaphthene	1	0.13	1.5E+05	EPA RSL 2010	6.7E-06	2.0E+02	HHRAP	2.4E+02	AWQC Gold Book	--	--	2.0E+02	AWQC Gold Book
208-96-8	Acenaphthylene	1	0.13	--	EPA RSL 2010	7.4E-10	--	--	--	AWQC Gold Book	--	--	--	--
120-12-7	Anthracene	1	0.13	5.6E+05	EPA RSL 2010	1.8E-06	5.8E+02	HHRAP	3.0E+01	AWQC Gold Book	--	--	5.8E+02	HHRAP
191-24-2	Benzo(g,h,i)perylene	1	0.13	--	EPA RSL 2010	7.4E-10	--	--	--	--	--	--	--	--
117-81-7	Bis(2-ethylhexyl)phthalate	1	0.1	--	EPA RSL 2010	7.4E-10	5.3E+01	HHRAP	1.3E+02	AWQC Gold Book	--	--	5.3E+01	HHRAP
85-68-7	Butylbenzyl phthalate	1	0.1	--	EPA RSL 2010	7.4E-10	1.2E+03	HHRAP	4.1E+02	AWQC Gold Book	--	--	1.2E+03	HHRAP
59-50-7	4-chloro-3-methylphenol	1	0.1	--	EPA RSL 2010	7.4E-10	--	--	--	--	--	--	--	--
132-64-9	*Dibenzofuran*[6]	*1*	--	*2.1E+05*	EPA RSL 2010	*4.8E-06*	--	--	--	--	--	--	--	--
84-74-2	Di-n-butylphthalate	1	0.1	--	EPA RSL 2010	7.4E-10	8.3E+02	HHRAP	8.9E+01	AWQC Gold Book	--	--	8.3E+02	AWQC Gold Book
84-66-2	Diethylphthalate	1	0.1	--	EPA RSL 2010	7.4E-10	1.7E+01	HHRAP	7.3E+01	AWQC Gold Book	--	--	1.7E+01	HHRAP
105-67-9	2,4-Dimethylphenol	1	0.1	--	EPA RSL 2010	7.4E-10	1.2E+01	HHRAP	9.4E+01	AWQC Gold Book	--	--	1.2E+01	AWQC Gold Book
131-11-3	Dimethylphthalate	1	0.1	--	EPA RSL 2010	7.4E-10	3.2E+00	HHRAP	3.6E+01	AWQC Gold Book	--	--	3.2E+00	AWQC Gold Book
117-84-0	Di-n-octyl phthalate	1	0.1	--	EPA RSL 2010	7.4E-10	6.4E+01	HHRAP	--	--	--	--	6.4E+01	HHRAP
206-44-0	Fluoranthene	1	0.13	--	EPA RSL 2010	7.4E-10	1.4E+03	HHRAP	1.2E+03	AWQC Gold Book	--	--	1.4E+03	AWQC Gold Book
86-73-7	Fluorene	1	0.13	3.0E+05	EPA RSL 2010	3.3E-06	3.4E+02	HHRAP	3.0E+01	AWQC Gold Book	--	--	3.4E+02	AWQC Gold Book
7440-62-2	1-Methylnaphthalene	1	0.13	6.3E+04	EPA RSL 2010	1.6E-05	--	--	--	--	--	--	--	--
91-57-6	2-Methylnaphthalene	1	0.13	6.2E+04	EPA RSL 2010	1.6E-05	--	--	--	--	--	--	--	--
95-48-7	2-Methylphenol (o-cresol)	1	0.1	--	EPA RSL 2010	7.4E-10	6.3E+00	HHRAP	--	--	--	--	6.3E+00	HHRAP
106-44-5	4-Methylphenol (p-cresol)	1	0.1	--	EPA RSL 2010	7.4E-10	5.8E+00	HHRAP	--	--	--	--	5.8E+00	HHRAP
91-20-3	Naphthalene	1	0.13	5.0E+04	EPA RSL 2010	2.0E-05	6.9E+01	HHRAP	1.1E+01	AWQC Gold Book	3.0E+02	McCarthy 1985[7]	3.0E+02	McCarthy 1985[7]
85-01-8	Phenanthrene	1	0.13	--	EPA RSL 2010	7.4E-10	5.8E+02	HHRAP	--	--	--	--	5.8E+02	HHRAP
108-95-2	Phenol	1	0.1	--	EPA RSL 2010	7.4E-10	2.9E+00	HHRAP	1.4E+00	AWQC Gold Book	--	--	2.9E+00	HHRAP
129-00-0	Pyrene	1	0.13	2.6E+06	EPA RSL 2010	3.9E-07	1.2E+03	HHRAP	3.0E+01	AWQC Gold Book	--	--	1.2E+03	AWQC Gold Book
Polychlorinated Biphenyls (PCBs)														
53469-21-9	Aroclor 1016/1242	1	0.14	--	EPA RSL 2010	7.4E-10	2.0E+04	HHRAP	--	--	--	--	2.0E+04	HHRAP
12672-29-6	Aroclor 1248	1	0.14	--	EPA RSL 2010	7.4E-10	2.0E+04	HHRAP	--	--	--	--	2.0E+04	HHRAP
11097-69-1	Aroclor 1254	1	0.14	--	EPA RSL 2010	7.4E-10	8.4E+04	HHRAP	3.1E+04	AWQC Gold Book	--	--	8.4E+04	HHRAP
37324-23-2	Aroclor 1260	1	0.14	--	EPA RSL 2010	7.4E-10	2.0E+04	HHRAP	--	--	--	--	2.0E+04	HHRAP
1336-36-3	Total PCBs	1	0.14	--	EPA RSL 2010	7.4E-10	2.0E+04	HHRAP	3.1E+04	AWQC Gold Book	--	--	2.0E+04	HHRAP

Table A.3g
Cross-Media Factors

		Soil Organic Carbon to Water Partitioning Coefficient (K_{oc})								Soil to Water Partitioning Coefficient ($K_d = K_{oc} \times f_{oc}$)						Water to Air Partitioning					
		EPA R10		Ecology MTCA/CLARC		Others		Selected for Use		EPA R10		Ecology MTCA/CLARC		Selected for Use[5]		EPA R10		Ecology MTCA/CLARC		Selected for Use	
CAS Number	Chemical	K_{oc} (L/kg)	Source	K_{oc} (L/kg)	Source	K_{oc} (L/kg)	Source	K_{oc} (L/kg)	Source	K_d (L/kg)	Source	K_d (L/kg)	Source	K_d (L/kg)	Source	Henry's Law Constant (H_{cc}) (unitless)	Source	Henry's Law Constant (H_{cc}) (unitless)	Source	Henry's Law Constant (H_{cc}) (unitless)	Source
Semivolatile Organic Compounds (SVOCs)																					
83-32-9	Acenaphthene	5.0E+03	EPI Suite 2010	4.9E+03	EPA SSL 1996	--	--	5.0E+03	Average	5.0E+00	RSL K_{oc}*0.001	4.9E+00	SSL K_{oc}*0.001	9.9E+01	Average K_{oc}*f_{oc}	7.5E-03	EPA RSL 2010	6.4E-03	EPA SSL 1996	6.9E-03	Average
208-96-8	Acenaphthylene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
120-12-7	Anthracene	1.6E+04	EPI Suite 2010	2.3E+04	EPA SSL 1996	--	--	2.0E+04	Average	1.6E+01	RSL K_{oc}*0.001	2.3E+01	SSL K_{oc}*0.001	3.9E+02	Average K_{oc}*f_{oc}	2.3E-03	EPA RSL 2010	2.7E-03	EPA SSL 1996	2.5E-03	Average
191-24-2	Benzo(g,h,i)perylene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
117-81-7	Bis(2-ethylhexyl)phthalate	1.2E+05	EPI Suite 2010	1.1E+05	EPA SSL 1996	--	--	1.1E+05	Average	1.2E+02	RSL K_{oc}*0.001	1.1E+02	SSL K_{oc}*0.001	2.3E+03	Average K_{oc}*f_{oc}	1.1E-05	EPA RSL 2010	4.2E-06	EPA SSL 1996	7.6E-06	Average
85-68-7	Butylbenzyl phthalate	7.2E+03	EPI Suite 2010	1.4E+04	EPA SSL 1996	--	--	1.1E+04	Average	7.2E+00	RSL K_{oc}*0.001	1.4E+01	SSL K_{oc}*0.001	2.1E+02	Average K_{oc}*f_{oc}	5.2E-05	EPA RSL 2010	5.2E-05	EPA SSL 1996	5.2E-05	Average
59-50-7	4-chloro-3-methylphenol	4.9E+02	EPI Suite 2010	--	--	--	--	4.9E+02	Average	4.9E-01	RSL K_{oc}*0.001	--	--	9.8E+00	Average K_{oc}*f_{oc}	1.0E-04	EPA RSL 2010	--	--	1.0E-04	Average
132-64-9	*Dibenzofuran* [6]	*9.2E+03*	*EPI Suite 2010*	--	--	--	--	*9.2E+03*	*Average*	*9.2E+00*	*RSL K_{oc}*0.001*	--	--	*1.8E+02*	*Average K_{oc}*f_{oc}*	*8.7E-03*	*EPA RSL 2010*	--	--	8.7E-03	Average
84-74-2	Di-n-butylphthalate	1.2E+03	EPI Suite 2010	1.6E+03	EPA SSL 1996	--	--	1.4E+03	Average	1.2E+00	RSL K_{oc}*0.001	1.6E+00	SSL K_{oc}*0.001	2.8E+01	Average K_{oc}*f_{oc}	7.4E-05	EPA RSL 2010	3.9E-08	EPA SSL 1996	3.7E-05	Average
84-66-2	Diethylphthalate	1.0E+02	EPI Suite 2010	8.2E+01	EPA SSL 1996	--	--	9.3E+01	Average	1.0E-01	RSL K_{oc}*0.001	8.2E-02	SSL K_{oc}*0.001	1.9E+00	Average K_{oc}*f_{oc}	2.5E-05	EPA RSL 2010	1.9E-05	EPA SSL 1996	2.2E-05	Average
105-67-9	2,4-Dimethylphenol	4.9E+02	EPI Suite 2010	2.1E+02	EPA SSL 1996	--	--	3.5E+02	Average	4.9E-01	RSL K_{oc}*0.001	2.1E-01	SSL K_{oc}*0.001	7.0E+00	Average K_{oc}*f_{oc}	3.9E-05	EPA RSL 2010	8.2E-05	EPA SSL 1996	6.0E-05	Average
131-11-3	Dimethylphthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
117-84-0	Di-n-octyl phthalate	--	--	8.3E+07	EPA SSL 1996	--	--	8.3E+07	Average	--	--	8.3E+04	SSL K_{oc}*0.001	--	--	--	--	2.7E-03	EPA SSL 1996	2.7E-03	Average
206-44-0	Fluoranthene	5.5E+04	EPI Suite 2010	4.9E+04	EPA SSL 1996	--	--	5.2E+04	Average	5.5E+01	RSL K_{oc}*0.001	4.9E+01	SSL K_{oc}*0.001	1.0E+03	Average K_{oc}*f_{oc}	3.6E-04	EPA RSL 2010	6.6E-04	EPA SSL 1996	5.1E-04	Average
86-73-7	Fluorene	9.2E+03	EPI Suite 2010	7.7E+03	EPA SSL 1996	--	--	8.4E+03	Average	9.2E+00	RSL K_{oc}*0.001	7.7E+00	SSL K_{oc}*0.001	1.7E+02	Average K_{oc}*f_{oc}	3.9E-03	EPA RSL 2010	2.6E-03	EPA SSL 1996	3.3E-03	Average
7440-62-2	1-Methylnaphthalene	2.5E+03	EPI Suite 2010	--	--	--	--	2.5E+03	Average	2.5E+00	RSL K_{oc}*0.002	--	--	--	--	2.1E-02	EPA RSL 2011	--	--	2.1E-02	Average
91-57-6	2-Methylnaphthalene	2.5E+03	EPI Suite 2010	--	--	--	--	2.5E+03	Average	2.5E+00	RSL K_{oc}*0.003	--	--	--	--	2.1E-02	EPA RSL 2012	--	--	2.1E-02	Average
95-48-7	2-Methylphenol (o-cresol)	3.1E+02	EPI Suite 2010	9.1E+01	EPA SSL 1996	--	--	2.0E+02	Average	3.1E-01	RSL K_{oc}*0.001	9.1E-02	SSL K_{oc}*0.001	4.0E+00	Average K_{oc}*f_{oc}	4.9E-05	EPA RSL 2010	4.9E-05	EPA SSL 1996	4.9E-05	Average
106-44-5	4-Methylphenol (p-cresol)	3.0E+02	EPI Suite 2010	--	--	--	--	3.0E+02	Average	3.0E-01	RSL K_{oc}*0.001	--	--	6.0E+00	Average K_{oc}*f_{oc}	4.1E-05	EPA RSL 2010	--	--	4.1E-05	Average
91-20-3	Naphthalene	1.5E+03	EPI Suite 2010	1.2E+03	EPA SSL 1996	2.0E+03	Cal/EPA	1.6E+03	Average	1.5E+00	RSL K_{oc}*0.001	1.2E+00	SSL K_{oc}*0.001	3.2E+01	Average K_{oc}*f_{oc}	1.8E-02	EPA RSL 2010	2.0E-02	EPA SSL 1996	1.9E-02	Average
85-01-8	Phenanthrene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
108-95-2	Phenol	1.9E+02	EPI Suite 2010	2.9E+01	EPA SSL 1996	--	--	1.1E+02	Average	1.9E-01	RSL K_{oc}*0.001	2.9E-02	SSL K_{oc}*0.001	2.2E+00	Average K_{oc}*f_{oc}	1.4E-05	EPA RSL 2010	1.6E-05	EPA SSL 1996	1.5E-05	Average
129-00-0	Pyrene	5.4E+04	EPI Suite 2010	6.8E+04	EPA SSL 1996	--	--	6.1E+04	Average	5.4E+01	RSL K_{oc}*0.001	6.8E+01	SSL K_{oc}*0.001	1.2E+03	Average K_{oc}*f_{oc}	4.9E-04	EPA RSL 2010	4.5E-04	EPA SSL 1996	4.7E-04	Average
Polychlorinated Biphenyls (PCBs)																					
53469-21-9	Aroclor 1016/1242	7.8E+04	EPI Suite 2010	--	--	--	--	7.8E+04	Average	7.8E+01	RSL K_{oc}*0.001	--	--	1.6E+03	Average K_{oc}*f_{oc}	7.8E-03	EPA RSL 2010	--	--	7.8E-03	Average
12672-29-6	Aroclor 1248	7.7E+04	EPI Suite 2010	--	--	--	--	7.7E+04	Average	7.7E+01	RSL K_{oc}*0.002	--	--	--	--	1.8E-02	EPA RSL 2010	--	--	1.8E-02	Average
11097-69-1	Aroclor 1254	1.3E+05	EPI Suite 2010	--	--	--	--	1.3E+05	Average	1.3E+02	RSL K_{oc}*0.001	--	--	2.6E+03	Average K_{oc}*f_{oc}	1.2E-02	EPA RSL 2010	--	--	1.2E-02	Average
37324-23-2	Aroclor 1260	3.5E+05	EPI Suite 2010	8.2E+05	EPA SSL 1996	--	--	5.8E+05	Average	3.5E+02	RSL K_{oc}*0.001	8.2E+02	SSL K_{oc}*0.001	1.2E+04	Average K_{oc}*f_{oc}	1.4E-02	EPA RSL 2010	--	--	1.4E-02	Average
1336-36-3	Total PCBs	7.8E+04	EPI Suite 2010	3.1E+05	EPA SSL 1996	--	--	1.9E+05	Average	7.8E+01	RSL K_{oc}*0.001	3.1E+02	SSL K_{oc}*0.001	3.9E+03	Average K_{oc}*f_{oc}	7.8E-03	EPA RSL 2010	--	--	7.8E-03	Average

Notes:

1 If VF is not available (i.e., is presented as "--" in table), this term simplifies to one divided by the particulate emission factor (1/PEF).
2 BCFs derived from Meylan, et al., 1999 (in EPA Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities [HHRAP] Guidance, 2005, EPA520-R-05-006).
3 BCFs derived from CLARC database, originally sourced from EPA Ambient Water Quality Criteria (AWQC Gold Book, 1986). EPA 440/5-86-001.
4 In general, EPA BCFs are from the HHRAP summary; most of these were calculated using the method of Meylan, et al., 1999 (refer to Note 1); emperical values from other studies may be more appropirate for specific sites.
5 A site-specific f_{oc} was developed for Boeing Plant 2 using areas with no or limited organic contamination to represent the actual fraction of organic carbon present in the alluvial soils; this value is 0.02.
6 The provisional toxicity factors for this chemical are semi-quantative and should be used for screening purposes only.
7 McCarthy, John F. and Braulio D. Jimenez. 1985. Reduction in Bioavailibility to Bluegills of Polycylic Aromatic Hydrocarbons Bound to Dissolved Humic Material. Environmental Toxicology and Chemistry Vol. 4: 511-521.

Abbreviations:

AWQC Ambient Water Quality Criteria
BCF Bioconcentration factor
CAS Chemical abstract number
CLARC Cleanup Levels and Risk Calculation
EPA U.S. Environmental Protection Agency
EPA RSL 2010 Regional Screening Levels, November 2010; http://www.epa.gov/region9/superfund/prg/.
EPA SSL 1996 Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, EPA540/R-96/018, June 1996
EPI Suite EPA Estimation Program Interface Suite located online at http://www.epa.gov/oppt/exposure/pubs/episuite.htm
f_{oc} Soil fraction of organic carbon
GI Gastrointestinal
HHRAP Human Health Risk Assessment Protocol
K_d Distribution coeffiecient
K_{oc} Soil organic carbon-water partitioning coefficient
MTCA Model Toxics Control Act
PEF Particulate emission factor; specific factors are presented in associated tables in this attachment.
R10 Region 10
RSL Regional screening level
SSL Soil screening level
VF Volatilization factor

Table A.3h
Toxicological Factors

		EPA R10[1]												Ecology[2]											
		Oral/Ingestion Toxicity Factors				Dermal Toxicity Factors[3]				Inhalation Toxicity Factors				Oral/Ingestion Toxicity Factors				Dermal Toxicity Factors[4]				Inhalation Toxicity Factors			
CAS Number	Chemical	Cancer Slope Factor (CSF_o) (kg-day/mg)	Source	Reference Dose (RfD_o) (mg/kg-day)	Source	Cancer Slope Factor (CSF_d) (kg-day/mg)	Source	Reference Dose (RfD_d) (mg/kg-day)	Source	Inhalation Unit Risk (IUR) ($\mu g/m^3$)	Source	Reference Concentration (RfC_i) (mg/m^3)	Source	Cancer Potency Factor (CPF_o) (kg-day/mg)	Source	Reference Dose (RfD_o) (mg/kg-day)	Source	Cancer Potency Factor (CPF_d) (kg-day/mg)	Source	Reference Dose (RfD_d) (mg/kg-day)	Source	Cancer Potency Factor (CPF_i) (kg-day/mg)	Source	Reference Dose (RfD_i) (mg/kg-day)	Source
Semivolatile Organic Compounds (SVOCs)																									
83-32-9	Acenaphthene	--	--	6.0E-02	IRIS	--	--	6.0E-02	RfD_o*GI-abs	--	--	--	--	--	--	6.0E-02	IRIS	--	--	3.0E-02	RfD_o*GI-abs	--	--	--	--
208-96-8	Acenaphthylene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
120-12-7	Anthracene	--	--	3.0E-01	IRIS	--	--	3.0E-01	RfD_o*GI-abs	--	--	--	--	--	--	3.0E-01	IRIS	--	--	1.5E-01	RfD_o*GI-abs	--	--	--	--
191-24-2	Benzo(g,h,i)perylene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
117-81-7	Bis(2-ethylhexyl)phthalate	1.4E-02	IRIS	2.0E-02	IRIS	1.4E-02	CPF_o/GI-abs	2.0E-02	RfD_o*GI-abs	2.4E-06	--	--	--	1.4E-02	IRIS	2.0E-02	IRIS	2.8E-02	CPF_o/GI-abs	1.0E-02	RfD_o*GI-abs	--	--	--	--
85-68-7	Butylbenzyl phthalate	1.9E-03	PPRTV	2.0E-01	IRIS	1.9E-03	CPF_o/GI-abs	2.0E-01	RfD_o*GI-abs	--	--	--	--	1.9E-03	PPRTV	2.0E-01	IRIS	3.8E-03	CPF_o/GI-abs	1.0E-01	RfD_o*GI-abs	--	--	2.0E-01	HEAST
59-50-7	4-chloro-3-methylphenol	--	--	1.0E-01	PPRTV	--	--	1.0E-01	RfD_o*GI-abs	--	--	--	--	--	--	1.0E-01	PPRTV	--	--	5.0E-02	RfD_o*GI-abs	--	--	--	--
132-64-9	*Dibenzofuran*[5]	--	--	*1.0E-03*	*PPRTV-x*	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
84-74-2	Di-n-butylphthalate	--	--	1.0E-01	IRIS	--	--	1.0E-01	RfD_o*GI-abs	--	--	--	--	--	--	1.0E-01	IRIS	--	--	5.0E-02	RfD_o*GI-abs	--	--	--	--
84-66-2	Diethylphthalate	--	--	8.0E-01	IRIS	--	--	8.0E-01	RfD_o*GI-abs	--	--	--	--	--	--	8.0E-01	IRIS	--	--	4.0E-01	RfD_o*GI-abs	--	--	--	--
105-67-9	2,4-Dimethylphenol	--	--	2.0E-02	IRIS	--	--	2.0E-02	RfD_o*GI-abs	--	--	--	--	--	--	2.0E-02	IRIS	--	--	1.0E-02	RfD_o*GI-abs	--	--	--	--
131-11-3	Dimethylphthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
117-84-0	Di-n-octyl phthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
206-44-0	Fluoranthene	--	--	4.0E-02	IRIS	--	--	4.0E-02	RfD_o*GI-abs	--	--	--	--	--	--	4.0E-02	IRIS	--	--	2.0E-02	RfD_o*GI-abs	--	--	--	--
86-73-7	Fluorene	--	--	4.0E-02	IRIS	--	--	4.0E-02	RfD_o*GI-abs	--	--	--	--	--	--	4.0E-02	IRIS	--	--	2.0E-02	RfD_o*GI-abs	--	--	--	--
7440-62-2	1-Methylnaphthalene	2.9E-02	PPRTV	7.0E-02	ATDSR	2.9E-02	CPF_o/GI-abs	7.0E-02	RfD_o*GI-abs	--	--	--	--	2.9E-02	PPRTV	--	--	5.8E-02	CPF_o/GI-abs	--	--	--	--	--	--
91-57-6	2-Methylnaphthalene	--	--	4.0E-03	IRIS	--	--	4.0E-03	RfD_o*GI-abs	--	--	--	--	--	--	4.0E-03	IRIS	--	--	2.0E-03	RfD_o*GI-abs	--	--	--	--
95-48-7	2-Methylphenol (o-cresol)	--	--	5.0E-02	IRIS	--	--	5.0E-02	RfD_o*GI-abs	--	--	--	--	--	--	5.0E-02	IRIS	--	--	2.5E-02	RfD_o*GI-abs	--	--	--	--
106-44-5	4-Methylphenol (p-cresol)	--	--	5.0E-03	IRIS	--	--	5.0E-03	RfD_o*GI-abs	--	--	--	--	--	--	5.0E-03	IRIS	--	--	2.5E-03	RfD_o*GI-abs	--	--	--	--
91-20-3	Naphthalene	--	--	2.0E-02	IRIS	--	--	2.0E-02	RfD_o*GI-abs	3.4E-05	Cal/EPA	3.0E-03	IRIS	--	--	2.0E-02	IRIS	--	--	1.0E-02	RfD_o*GI-abs	--	--	8.6E-04	IRIS
85-01-8	Phenanthrene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
108-95-2	Phenol	--	--	3.0E-01	IRIS	--	--	3.0E-01	RfD_o*GI-abs	--	--	--	--	--	--	3.0E-01	IRIS	--	--	1.5E-01	RfD_o*GI-abs	--	--	--	--
129-00-0	Pyrene	--	--	3.0E-02	IRIS	--	--	3.0E-02	RfD_o*GI-abs	--	--	--	--	--	--	3.0E-02	IRIS	--	--	1.5E-02	RfD_o*GI-abs	--	--	--	--
Polychlorinated Biphenyls (PCBs)																									
53469-21-9	Aroclor 1016/1242	2.0E+00	IRIS	--	--	2.0E+00	CPF_o/GI-abs	--	--	--	--	--	--	2.0E+00	IRIS	--	--	4.0E+00	CPF_o/GI-abs	--	--	--	--	--	--
12672-29-6	Aroclor 1248	2.0E+00	IRIS	--	--	2.0E+00	CPF_o/GI-abs	--	--	--	--	--	--	2.0E+00	IRIS	--	--	4.0E+00	CPF_o/GI-abs	--	--	--	--	--	--
11097-69-1	Aroclor 1254	2.0E+00	IRIS	2.0E-05	IRIS	2.0E+00	CPF_o/GI-abs	2.0E-05	RfD_o*GI-abs	--	--	--	--	2.0E+00	IRIS	2.0E-05	IRIS	4.0E+00	CPF_o/GI-abs	1.0E-05	RfD_o*GI-abs	--	--	--	--
37324-23-2	Aroclor 1260	2.0E+00	IRIS	--	--	2.0E+00	CPF_o/GI-abs	--	--	--	--	--	--	2.0E+00	IRIS	--	--	4.0E+00	CPF_o/GI-abs	--	--	--	--	--	--
1336-36-3	Total PCBs	2.0E+00	IRIS	--	--	2.0E+00	CPF_o/GI-abs	--	--	--	--	--	--	2.0E+00	IRIS	--	--	4.0E+00	CPF_o/GI-abs	--	--	2.0E+00	HEAST	--	--

Notes:

1 Toxicity factors are from the November 2010 EPA RSL Tables unless otherwise noted.

2 Toxicity factors from Ecology were taken from CLARC on January 30, 2011; then updated to include all IRIS changes. PPRTV were also incorporated where it was clear what value would be used. Values from ATSDR, Cal/EPA, and NJDEP were not used.

3 EPA dermal toxicity factors are calculated based on the oral toxicity factors as follows: $CSF_d = CSF_o$/GI-abs; $RfD_d = RfD_o$ x GI-abs. GI-abs is the gastrointestinal absorption conversion factor, which is equal to 1.0 except where otherwise specified (usually only for metals).

4 MTCA dermal toxicity factors are calculated based on the oral toxicity factors as follows: $CSF_d = CSF_o$/GI-abs; $RfD_d = RfD_o$ x GI-abs. GI-abs is the gastrointestinal absorption conversion factor, which is equal to 0.5 for SVOCs (see Equations 740-4 and 740-5).

5 The provisional toxicity factors for this chemical are semi-quantative and should be used for screening purposes only.

Abbreviations:

ATSDR Agency for Toxic Substances and Disease Registry.
Cal/EPA California Environmental Protection Agency.
CLARC Cleanup Levels and Risk Calculation.
CSF and CPF The terms "cancer slope factor" and "cancer potency factor" are interchangeable.
Ecology Washington State Department of Ecology.
EPA U.S. Environmental Protection Agency.
HEAST Health Effects Assessment Summary Tables.
IRIS Integrated Risk Information System.
NJDEP New Jersey Department of Environmental Protection.
PPRTV Provisional Peer Reviewed Toxicity Value.
PPRTV-x Semi-quantitative value; see note 5 above.
R10 Region 10.
Rfd and RfC The terms "Reference factor Dose" and "Reference factor Concentration" are not interchangeable. The former is expressed as a dose (mg/kg-day) while the later is a concentrations (mg/unit volume of media).
VOC Volatile organic compound.

Table A.4a
Soil Standards, Criteria, and Risk-based Calculations

		Residential		Industrial		Sediment Protection	Groundwater Protection	EPA Proposed Soil TMCL to Protect All Pathways	
		EPA	Ecology	EPA Modified	Ecology	Ecology	Ecology		
CAS Number	Chemical[1]	EPA RSL Residential Includes Ingestion, Dermal, and Inhalation[2] (mg/kg)	MTCA Method B Unrestricted Land Use Includes CLARC Toxicity Factors[3] (mg/kg)	EPA RSL Industrial Includes Ingestion, Dermal, and Inhalation[4] (mg/kg)	MTCA Method C Industrial Land Use Includes CLARC Toxicity Factors[3] (mg/kg)	SMS Sediment Quality Standards[5] (mg/kg dry weight)	Soil Level to Protect Groundwater Using Three-phase Model[6] (mg/kg)	(mg/kg)	Exposure Pathway Basis of TMCL
56-55-3	Benzo(a) anthracene					1.1E+02			
50-32-8	Benzo(a) pyrene					9.9E+01			
205-99-2	Benzo (b) fluoranthene[7]					2.3E+02			
207-08-9	Benzo(k) fluoranthene[7]					2.3E+02			
218-01-9	Chrysene					1.1E+02			
53-70-3	Dibenz(a,h)anthracene					1.2E+01			
193-39-5	Indeno(1,2,3-cd)pyrene					3.4E+01			
--	Benzo(a)pyrene TEQ[8]	1.5E-02	1.4E-01	1.4E+00	1.8E+01	--	5.7E-02	1.5E-02	EPA RSL Residential with Early Life Correction.

Notes:

Washington state regulates carcinogenic polycyclic aromatic hydrocarbons using the benzo(a)pyrene Toxic Equivalent; therefore, no individual soil cleanup levels have been developed, and the cells are "grayed out." Refer to https://fortress.wa.gov/ecy/clarc/FocusSheets/tef.pdf. This is consistent with EPA's philosophy of using relative potency factors. EPA has approved the use of Ecology's TEFs for this site.

1 Not all chemicals are constituents needing TMCLs at Boeing Plant 2.
2 EPA RSL calculations with early life correction were calculated using EPA toxicity factors and exposure parameters as presented in associated tables in this attachment.
3 MTCA Method B uses WAC 173-340-740, equations 740-1 and 740-2; MTCA Method C uses WAC-173-340-745, equations 745-1 and 745-2 (Ecology 2007); specific parameters are presented in associated tables in this attachment.
4 EPA RSL calculations using EPA toxicity factors and exposure parameters as presented in associated tables in this attachment. EPA RSL Worker scenario has been modified to a 1 in 100,000 excess individual lifetime cancer risk and a soil ingestion rate of 200 mg/kg-day by an EPA Region 10 risk management decision.
5 Sediment Management Standards Sediment Quality Standards Chemical Criteria (dry weight) (WAC-173-204-320[a]).
6 Soil to Groundwater cleanup values are based on the MTCA fixed parameter three-phase partitioning model (WAC 173-340-747, equation 747-1), using partitioning factors presented in associated tables in this attachment.
7 SMS SQS of 2.3E+02 is for the sum of all benzofluoranthene congeners, including benzo(b)fluoranthene, benzo(k)fluoranthene, and benzo(j)fluoranthene.
8 Because the cPAHs in this table are considered mutagenic by EPA, EPA RSL calculations included an early life correction.

Abbreviations:

CAS Chemical abstract number
CLARC Cleanup Levels and Risk Calculation
cPAH Carcinogenic polycyclic aromatic hydrocarbon
Ecology Washington State Department of Ecology
EPA U.S. Environmental Protection Agency
MTCA Model Toxics Control Act
RSL Regional screening level
SMS Sediment Management Standards
SQS Sediment Quality Standards
TEQ Toxic Equivalent

Table A.4b
Groundwater Standards, Criteria, and Risk-based Calculations

		Protection of Drinking Water[2]				Protection of Aquatic Species						Protection of Human Health for Consumption of Fish and Shellfish in Marine Waters				EPA Proposed TMCL for Surface Water and Groundwater Discharging to Surface Water in the Lower Duwamish Waterway	
		Drinking Water Standard/Criteria[3]				Freshwater Standards			Marine Standards								
		Federal Primary Drinking Water Standards[4]	EPA RSL Tap Water Criteria[5]	State Primary Drinking Water Standards[6]	MTCA B Groundwater Cleanup Level[7]	Federal National Toxics Rule[8]	Federal Ambient Water Quality Criteria[9, 10]	Washington Surface Water Quality Standards[10, 11]	Federal National Toxics Rule[8]	Federal Ambient Water Quality Criteria[9]	Washington Surface Water Quality Standards[10, 11]	Federal National Toxics Rule[8]	Federal Ambient Water Quality Criteria[9]	Lowest of Tribal and Asian/Pacific Islander Exposure Scenarios[11, 12]	MTCA Method B Surface Water[11, 13]		
		EPA MCLs		Washington MCLs		Chronic	Chronic	Chronic	Chronic	Chronic	Chronic	Organism Only			Fish/Shellfish		
CAS Number	Chemical[1]	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)			(µg/L)	(µg/L)	Exposure Pathway Basis of TMCL
56-55-3	Benzo(a) anthracene	--	2.9E-02			--	--	--	--	--	--	3.1E-02	1.8E-02	1.8E-03	2.9E-02	1.8E-03	EPA R10 Tribal Consumption of Seafood.
50-32-8	Benzo(a) pyrene	2.0E-01	2.9E-03			--	--	--	--	--	--	3.1E-02	1.8E-02	1.8E-04	2.9E-03	1.8E-04	EPA R10 Tribal Consumption of Seafood.
205-99-2	Benzo (b) fluoranthene	--	2.9E-02			--	--	--	--	--	--	3.1E-02	1.8E-02	1.8E-03	2.9E-02	1.8E-03	EPA R10 Tribal Consumption of Seafood.
207-08-9	Benzo(k) fluoranthene	--	2.9E-01			--	--	--	--	--	--	3.1E-02	1.8E-02	1.8E-03	2.9E-02	1.8E-03	EPA R10 Tribal Consumption of Seafood.
218-01-9	Chrysene	--	2.9E+00			--	--	--	--	--	--	3.1E-02	1.8E-02	1.8E-02	2.9E-01	1.8E-02	EPA R10 Tribal Consumption of Seafood.
53-70-3	Dibenz(a,h)anthracene	--	2.9E-03			--	--	--	--	--	--	3.1E-02	1.8E-02	1.8E-03	2.9E-02	1.8E-03	EPA R10 Tribal Consumption of Seafood.
193-39-5	Indeno(1,2,3-cd)pyrene	--	2.9E-02			--	--	--	--	--	--	3.1E-02	1.8E-02	1.8E-03	2.9E-02	1.8E-03	EPA R10 Tribal Consumption of Seafood.
--	Benzo(a)pyrene TEQ	2.0E-01	2.9E-03	2.0E-01	1.2E-02	--	--	--	--	--	--	3.1E-02	1.8E-02	1.8E-04	2.9E-03	1.8E-04	EPA R10 Tribal Consumption of Seafood.

Notes:

Washington state regulates carcinogenic polycyclic aromatic hydrocarbons using the benzo(a)pyrene Toxic Equivalent; therefore, no individual soil cleanup levels have been developed, and the cells are "grayed out." Refer to https://fortress.wa.gov/ecy/clarc/FocusSheets/tef.pdf. This is consistent with EPA's philosophy of using relative potency factors. EPA has approved the use of Ecology's TEFs for this site.

1 Not all chemicals are constituents needing TMCLs at Boeing Plant 2.
2 Drinking water standards/criteria are not applicable to Boeing Plant 2 unless no other applicable standard exists for a constituent needing a TMCL in groundwater
3 The standards are potentially applicable to groundwater that may be used for drinking water supplies. Ecology determines the maximum beneficial use of groundwater, which may or may not include drinking
4 National Primary Drinking Water Regulations, Maximum Contaminant Levels (MCLs); http://water.epa.gov/drink/contaminants/index.cfm
5 EPA RSL, Residential Tapwaters; http://www.epa.gov/region9/superfund/prg/.
6 Washington Primary Drinking Water Standards WAC 246-290-130, Maximum Contaminant Levels (MCLs).
7 Standard MTCA Method B uses WAC 173-340-740; equations 730-1 and 730-2 (Ecology 2007). Parameters and toxicity factors can be found in associated tables in this attachment.
8 National Toxics Rule (NTR), 40 CFR 131.36.
9 EPA Ambient Water Quality Criteria (AWQCs), Clean Water Action Section 304.
10 Washington Surface Water Quality Standards; WAC 173-201A, Surface Water Quality Criteria
11 EPA and Ecology fish consumption scenarios are based on MTCA Method B Surface Water Equations (equations 730-1 and 730-2); however, they use different exposure assumptions. Details are given in associated tables in this attachment
12 This column uses the approach described in note 8, but selects the lower concentrations that are protective of special populations including Tribal and Asian/Pacific Islander; the lowest concentration is always associated with Tribal exposure
13 This column is included for comparison only and is based on the default exposure scenario in MTCA 173-340-730.

Abbreviations:

CAS Chemcial abstract number
cPAH Carcinogenic polycyclic aromatic hydrocarbon
Ecology Washington State Department of Ecology
EPA U.S. Environmental Protection Agency
MTCA Model Toxics Control Act
R10 Region 10
RSL Regional screening level
TEQ Toxic Equivalent

Table A.4c
Soil Calculations

		Direct Contact Exposures										Protection of Groundwater	
		Ecology Default Calculations		EPA RSL Calculations with Site-specific Factors				EPA RSL Calculations with Site-specific Factors				MTCA Three-phase Model for Unsaturated Soils	
		Residential	Industrial	Residential Exposure[1]				Worker Exposure[2]					
		MTCA Method B with CLARC Values	MTCA Method C with CLARC Values	Cancer Risk with EPA RSL Calculations, Parameters, and Toxicity Factors				Cancer Risk with EPA RSL Calculations, Parameters, and Toxicity Factors				Groundwater Target to be Protected[3]	Three-phase Partitioning Between Soil, Soil Vapor, and Groundwater using MTCA Equation[4]
CAS Number	Chemical	Cancer (mg/kg)	Cancer (mg/kg)	Ingestion (mg/kg)	Dermal (mg/kg)	Inhalation (mg/kg)	TOTAL (mg/kg)	Ingestion (mg/kg)	Dermal (mg/kg)	Inhalation (mg/kg)	TOTAL (mg/kg)	(µg/L)	(mg/kg)
56-55-3	Benzo(a)anthracene	1.4E+00	1.8E+02	2.0E-01	5.3E-01	1.2E+04	1.5E-01	2.0E+01	4.6E+01	1.6E+06	1.4E+01	1.8E-03	2.0E-01
50-32-8	Benzo(a)pyrene	1.4E-01	1.8E+01	2.0E-02	5.3E-02	1.2E+03	1.5E-02	2.0E+00	4.6E+00	1.6E+05	1.4E+00	1.8E-04	5.7E-02
205-99-2	Benzo(b)fluoranthene	1.4E+00	1.8E+02	2.0E-01	5.3E-01	1.2E+04	1.5E-01	2.0E+01	4.6E+01	1.6E+06	1.4E+01	1.8E-03	6.6E-01
207-08-9	Benzo(k)fluoranthene[5]	1.4E+00	1.8E+02	2.0E-01	5.3E-01	1.2E+04	1.5E-01	2.0E+01	4.6E+01	1.6E+06	1.4E+01	1.8E-03	6.5E-01
218-01-9	Chrysene[5]	1.4E+01	1.8E+03	2.0E+00	5.3E+00	1.2E+05	1.5E+00	2.0E+02	4.6E+02	1.6E+07	1.4E+02	1.8E-02	2.1E+00
53-70-3	Dibenz(a,h)anthracene[5]	1.4E+00	1.8E+02	2.0E-01	5.3E-01	1.2E+04	1.5E-01	2.0E+01	4.6E+01	1.6E+06	1.4E+01	1.8E-03	1.4E+00
193-39-5	Indeno(1,2,3-cd)pyrene	1.4E+00	1.8E+02	2.0E-01	5.3E-01	1.2E+04	1.5E-01	2.0E+01	4.6E+01	1.6E+06	1.4E+01	1.8E-03	2.0E+00
--	Benzo(a)pyrene TEQ	1.4E-01	1.8E+01	2.0E-02	5.3E-02	1.2E+03	1.5E-02	2.0E+00	4.6E+00	1.6E+05	1.4E+00	1.8E-04	5.7E-02

Notes:

1 Because cPAHs in this table are considered mutagenic by EPA, EPA RSL calculations include an early life exposure correction.

2 EPA RSL Worker scenario has been modified to a 1 in 100,000 excess individual lifetime cancer risk and a soil ingestion rate of 200 mg/kg-day by an EPA Region 10 risk management decision.

3 Refer to Table A.4b, Groundwater Standards, Criteria, and Risk-based Calculations, of this attachment.

4 Soil to Groundwater cleanup values are based on the MTCA fixed parameter three-phase partitioning model (WAC 173-340-747, equation 747-1), using partitioning factors presented in associated tables in this attachment.

5 Ecology Toxic Equivalent Factor (TEF) multipliers were used for all calculations, including both EPA and Ecology equations. This decision is the source of the difference in calculated values between published EPA RSL cleanup levels and EPA RSL cleanup levels in this workbook for benzo(k)fluoranthene, chrysene, and dibenz(a,h)anthracene.

Abbreviations:

CAS Chemical abstract number
CLARC Cleanup Levels and Risk Calculation
Ecology Washington State Department of Ecology
EPA U.S. Environmental Protection Agency
MTCA Model Toxics Control Act
RSL Regional screening level
TEQ Toxic Equivalent

Table A.4d
Soil Equations and Parameters

Ecology — **Soil Cleanup Levels from Cancer Risk for Ingestion Only**

Equation 740-2 Cancer

$$\text{Soil Cleanup Level (mg/kg)} = \frac{(RISK \times ABW \times AT \times UCF)}{(CPF_o \times SIR \times AB1 \times ED \times EF)}$$

RISK = Acceptable excess individual lifetime cancer risk level (unitless)
ABW = Average body weight (kg) over the exposure duration
AT = Averaging time (years)
UCF = Unit conversion factor (mg/kg)
CPF_o = Carcinogenic potency factor (kg-day/mg)
SIR = Soil ingestion rate (mg/day)
AB1 = Gastrointestinal absorbtion fraction (unitless)
ED = Exposure duration (years)
EF = Exposure frequency (fraction of time)

Exposure Scenarios	RISK (unitless)	ABW (kg)	AT (years)	CPF_o (kg-day/mg)	SIR (mg/day)	AB1 (unitless)	ED (years)	EF (unitless)	Assumptions for Unitless EF Term: hours/day (unitless)	days/week (unitless)	weeks/year (unitless)
DEFAULT MTCA Method B	1.00E-06	16	75	<table>	200	1	6	1.00	24	7	52
DEFAULT MTCA Method C	1.00E-05	70	75	<table>	50	1	20	0.40	24	7	52

EPA RSL — **Soil Screening level from Cancer Risk for Residents and Workers (Mutagenic Compound)**

$$\text{Soil Screening Level (mg/kg)} = \frac{1}{\frac{1}{SSL_{SOIL\text{-}MU\text{-}ING}} + \frac{1}{SSL_{SOIL\text{-}MU\text{-}DER}} + \frac{1}{SSL_{SOIL\text{-}MU\text{-}INH}}}$$

< ---------- Ingestion of Soil Term ----------> < ------ Dermal Contact with Soil Term -------> < ---------- Inhalation of Dust ----------->

$$SSL_{SOIL\text{-}MU\text{-}ING} = \frac{TR \times AT}{CSF_o \times EF \times IFSM \times UCF1} \quad \text{where} \quad IFSM = \frac{ED_{0\text{-}2} \times IRS_c \times 10}{BW_c} + \frac{ED_{2\text{-}6} \times IRS_c \times 3}{BW_a} + \frac{ED_{6\text{-}16} \times IRS_a \times 3}{BW_a} + \frac{ED_{16\text{-}30} \times IRS_a \times 1}{BW_a}$$

$$= \Sigma \frac{ED \times IRS \times ADAF}{BW}$$

$$SSL_{SOIL\text{-}MU\text{-}DER} = \frac{TR \times AT}{CSF_d \times EF \times DFSM \times ABS_d \times UCF1} \quad \text{where} \quad DFSMadj = \frac{ED_{0\text{-}2} \times SA_c \times AF_c \times 10}{BW_c} + \frac{ED_{2\text{-}6} \times SA_c \times AF_c \times 3}{BW_c} + \frac{ED_{6\text{-}16} \times SA_a \times AF_a \times 3}{BW_a} + \frac{ED_{16\text{-}30} \times SA_a \times AF_a \times 1}{BW_a}$$

$$= \Sigma \frac{ED \times SA \times AF \times ADAF}{BW}$$

$$SSL_{SOIL\text{-}MU\text{-}INH} = \frac{TR \times AT}{UCF2 \times EF \times ET \times UCF3 \times \Sigma (ED \times IUR \times ADAF) \times [(1/PEF) + (1/VF)]} \quad \text{where} \quad \Sigma (ED \times IUR \times ADAF) = IUR \times (ED_{0\text{-}2} \times 10 + ED_{2\text{-}6} \times 3 + ED_{6\text{-}16} \times 3 + ED_{16\text{-}70} \times 1)$$

$$= \frac{1}{\Sigma (ED \times IUR \times ADAF) \times [1/VF + 1/PEF]} \times \frac{TR \times AT}{UCF2 \times EF \times ET \times UCF3}$$

$$= \frac{1}{\Sigma (IUR) \times [1/VF + 1/PEF]} \times \frac{TR \times AT}{UCF2 \times EF \times ET \times UCF3 \times \Sigma (ED \times ADAF)}$$

TR = Target excess individual lifetime cancer risk (unitless)
AT = Averaging Time in days = 365 day/year * Lifetime (years)
LT = Lifetime (years)
CSF_o = Oral cancer slope factor (kg-day/mg)
CSF_d = Dermal cancer slope factor (kg-day/mg)
EF = Exposure frequency (days/year)
ET = Exposure time (hours/day)
IFSM = Resident soil ingestion rate - age-adjusted for mutanegic compounds (mg-year/kg-day)
IRS = Ingestion rate soil (mg/day)
ED = Exposure duration (years)
BW = Body weight (age dependent) (kg; age dependent)
ADAF = Age dependent adjustment factor (unitless)
UCF1 = 1.0E-6 kg/mg
DFSM = Resident soil dermal contact factor: age-adjusted for mutagenic compounds(mg-year/kg-day)
SA = Skin surface area (cm^2/day; age dependent)
AF = Adherence factor (mg/cm^2)
ABS = Skin absorption factor (0.13 for cPAHs)
UCF2 = 1,000 (µg/mg)
UCF3 = 1/24 (day/hours)
IUR = Inhalation unit risk
PEF = Particulate emission factor used for dusts
VF = Volatilization factor used for volatile organic chemicals

Source: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

Exposure Scenarios	TR (unitless)	AT (days)	LT (years)	CSF_o (kg-day/mg)	CSF_d (kg-day/mg)	EF (days/year)	ET (hours/day)	IFSM (mg-year/kg-day)	IRS (mg-year/kg-day)	ED (years)	∑ ED x ADAF (years)	BW (kg)	ADAF (unitless)	DFSM (mg-year/kg-day)	SA (cm^2/day)	AF (mg/cm^2)	ABS (unitless)	IUR (m^3/µg)	PEF (m^3/kg)	VF (m^3/kg)	1/VF+1/PEF (kg/m^3)
EPA RSL Resident	1.00E-06	25,550	70	<table>	<table>	350	24	4.9E+02			76			1.4E+03			<table>	<table>	1.40E+09	<table>	<table>
Contribution between ages 0 - 2								2.7E+02	200	2	20	15	10	7.5E+02	2,800	0.2					
Contribution between ages 2 - 6								1.6E+02	200	4	12	15	3	4.5E+02	2,800	0.2					
Contribution between ages 6 - 16								4.3E+01	100	10	30	70	3	1.7E+02	5,700	0.07					
Contribution between ages 16 - 30								2.0E+01	100	14	14	70	1	8.0E+01	5,700	0.07					
Modified EPA RSL Worker[1,2]	1.00E-05	25,550	70	<table>	<table>	250	8	7.1E+01	200	25	25	70	1	2.4E+02	3,300	0.2	<table>	<table>	1.40E+09	<table>	<table>

Table A.4d
Soil Equations and Parameters

Ecology — **Three-phase Partitioning Between Soil, Soil Vapor, and Groundwater Using MTCA Equation**

Equation 747-1

$$\text{Soil Concentration (mg/kg)} = C_s = C_W \times UCF \times DF \times \left(K_d + \frac{(\theta_w + \theta_a H_{cc})}{\rho_b} \right) = C_W \times UCF \times DI + \frac{C_W \times UCF \times DF \times \theta_w}{\rho_b} + \frac{C_W \times UCF \times DF \times \theta_a \times H_{cc}}{\rho_b} = C_W * (C1*K_d + C2 + C3*H_{cc})$$

where $C1 = UCF \times DF$

$C2 = \frac{UCF \times DF \times \theta_w}{\rho_b}$

$C3 = \frac{UCF \times DF \times \theta_a}{\rho_b}$

C_W = Ground water cleanup level established under WAC 173-340-720 (µg/L)
UCF = 1/1,000 (mg/µg)
DF = Dilution factor (dimensionless)
K_d = Distribution coefficient (L/kg)
θ_W = Water-filled soil porosity (ml water/ml soil)
θ_a = Air-filled soil porosity (ml air/ml soil)
H_{cc} = Henry's Law Constant (dimensionless)
ρ_b = Dry soil bulk density (kg/L)

Exposure Scenarios	C_w (µg/L)	DF (unitless)	K_d (L/kg)	θ_w (ml water/ ml soil)	θ_a (ml air/ ml soil)	H_{cc} (unitless)	ρ_b (kg/L)	C1 (mg/µg)	C2 (L-ml water/ ml soil)	C3 (L-ml air/ ml soil)
Soil Concentration for Saturated Soil	<table>	20	<table>	0.3	0.13	<table>	1.5	2.0E-02	4.0E-03	1.7E-03

Notes:

Indicates no value is required in calculations for the associated exposure scenario indicated.
<table> Indicates a chemical-specific factor is available in the associated tables of this attachment.
1 EPA RSL Worker scenario has been modified to a 1 in 100,000 excess individual lifetime cancer risk and a soil ingestion rate of 200 mg/kg-day by an EPA Region 10 risk management decision.
2 Exposure frequency taken to be 250 days/year. This value was selected based on Region 9 EPA RSL tables last updated November 2010, which uses parameters associated with an indoor worker to calculate risk.

Abbreviations:

EPA U.S. Environmental Protection Agency
MTCA Model Toxics Control Act
RSL Regional screening level
SSL Soil screening level

Subscripts:

CA Cancer
DER Dermal
ING Ingestion
INH Inhalation
MU Mutagenic

Table A.4e
Groundwater Calculations

		Surface Water to Fish Consumption Pathway							Drinking Water Pathways	
		EPA Calculations	Ecology MTCA Calculations		Proposed Water to Fish Consumption TMCLs				EPA	MTCA
		Tribal Consumption Includes EPA BCFs and Toxicity Factors[1]	Default Without Early Life Adjustment Includes EPA BCFs and Toxicity Factors[2]	Asian/Pacific Islander Consumption with Early Life Includes EPA BCFs and Toxicity Factors[3]	MTCA Default Adult Exposure Using EPA and Toxicity Factor[2]		Tribal and/or Asian/Pacific Islander Modified to Use EPA Toxicity and Partitioning Coefficients		EPA RSL Tap Water[4]	MTCA Method B Groundwater to Protect Drinking Water Use[5]
CAS Number	Chemical	(µg/L)	(µg/L)	(µg/L)	TMCL (µg/L)	Source (µg/L)	TMCL (µg/L)	Source (µg/L)	(µg/L)	(µg/L)
56-55-3	Benzo(a) anthracene	1.8E-03	2.9E-02	3.7E-03	2.9E-02	MTCA B	1.8E-03	Tribal	2.9E-02	1.2E-01
50-32-8	Benzo(a) pyrene	1.8E-04	2.9E-03	3.7E-04	2.9E-03	MTCA B	1.8E-04	Tribal	2.9E-03	1.2E-02
205-99-2	Benzo (b) fluoranthene	1.8E-03	2.9E-02	3.7E-03	2.9E-02	MTCA B	1.8E-03	Tribal	2.9E-02	1.2E-01
207-08-9	Benzo(k) fluoranthene	1.8E-03	2.9E-02	3.7E-03	2.9E-02	MTCA B	1.8E-03	Tribal	2.9E-01	1.2E-01
218-01-9	Chrysene	1.8E-02	2.9E-01	3.7E-02	2.9E-01	MTCA B	1.8E-02	Tribal	2.9E+00	1.2E+00
53-70-3	Dibenz(a,h)anthracene	1.8E-03	2.9E-02	3.7E-03	2.9E-02	MTCA B	1.8E-03	Tribal	2.9E-03	1.2E-01
193-39-5	Indeno(1,2,3-cd)pyrene	1.8E-03	2.9E-02	3.7E-03	2.9E-02	MTCA B	1.8E-03	Tribal	2.9E-02	1.2E-01
--	Benzo(a)pyrene TEQ	1.8E-04	2.9E-03	3.7E-04	2.9E-03	MTCA B	1.8E-04	Tribal	2.9E-03	1.2E-02

Notes:

1 MTCA Method B, equations 730-1 and 730-2 modified to apply Tribal fish ingestion rates, body weights, and exposure duration (Ecology 2007). Refer to associated tables in this attachment for toxicity factors, bioconcentration factors, and exposure parameters. Modified to include early life exposure.

2 MTCA Method B equations 730-1 and 730-2 modified to apply Asian/Pacific Islander fish ingestion rates, body weights, and exposure duration (Ecology 2007). Refer to associated tables in this attachment for toxicity factors, bioconcentration factors, and exposure parameters. Does not include early life exposure.

3 MTCA Method B equations 730-1 and 730-2 modified to apply Asian/Pacific Islander fish ingestion rates, body weights, and exposure duration (Ecology 2007). Refer to associated tables in this attachment for toxicity factors, bioconcentration factors, and exposure parameters. Modified to include early life exposure.

4 EPA RSL, Residential Tapwaters; http://www.epa.gov/region9/superfund/prg/.

5 MTCA Method B equations 720-1 and 720-2; groundwater cleanup levels to protect drinking water use.

Abbreviations:

BCF Bioconcentration factor
CAS Chemical abstract number
Ecology Washington State Department of Ecology
EPA U.S. Environmental Protection Agency
MTCA Model Toxics Control Act
RSL Regional screening level
TEQ Toxic Equivalent

Table A.4f
Groundwater Equations and Parameters

Surface Water to Fish Consumption by Humans: Cancer

$$\text{Surface Water Cleanup or Screening Level (µg/L)} = \frac{(RISK \times BW \times UCF1 \times UCF2 \times AT)}{(CPF_o \times BCF \times FCR \times FDF \times ED)}$$

Risk = Target excess individual lifetime cancer risk level (unitless)
BW = Average body weight (kg)
UCF1 = 1,000 g/mg
UCF2 = 1,000 g/L
AT = Averaging time (years)
CPF_o = Cancer potency factor (kg-day/mg)
BCF = Bioconcentration factor (L/kg)
FCR = Fish consumption rate (g/day)
FDF = Fish diet fraction (unitless)
ED = Exposure duration (years)

Exposure Scenarios	Risk (unitless)	BW (kg)	AT (years)	CPF_o (kg-day/mg)	BCF (L/kg)	FCR (g/day)	FDF (unitless)	ED (years)
MTCA Default[1]	1.00E-06	70	75	<table>	<table>	54	0.50	30

Surface Water to Fish Consumption by Humans: Cancer Adjusted for Early-life Exposure[2]

$$\text{Surface Water Cleanup or Screening Level (µg/L)} = \frac{(RISK \times UCF1 \times UCF2 \times AT)}{CPF_o \times [BCF \times \sum(FCR/ABW \times EF \times ED \times ADAF)]}$$

where

$$\sum \frac{FCR \times EF \times ED \times ADAF}{BW} = \frac{FCR_{0\text{-}2} \times EF \times ED_c \times 10}{BW_c} + \frac{FCR_{2\text{-}6} \times EF \times ED_c \times 3}{BW_c} + \frac{FCR_{6\text{-}16} \times EF \times ED_a \times 3}{BW_a} + \frac{FCR_{16\text{-}70} \times EF \times ED_a \times 1}{BW_a}$$

Risk = Target excess individual lifetime cancer risk level (unitless)
BW = Average body weight (kg)
UCF1 = 1,000 µg/mg
UCF2 = 1,000 g/kg
AT = Averaging Time in days = 365 day/year * Lifetime (years)
CPF_o = Cancer potency factor (kg-day/mg)
BCF = Bioconcentration factor (L/kg)
FCR = Fish consumption rate (g/day)
FDF = Fish diet fraction (unitless)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
ADAF = Age-dependent adjustment factor (unitless)

Exposure Scenarios	Risk (unitless)	BW (kg)	AT (days)	LT (years)	CPF_o (kg-day/mg)	BCF (L/kg)	FCR (g/day)	EF (days/year)	ED (years)	ADAF (unitless)
Tribal Consumption[3,4]	1.00E-06		25,550	70	<table>	<table>		350		
Contribution from ages 0 -2		15					38.8		2	10
Contribution from ages 2 -6		15					38.8		4	3
Contribution from ages 6 - 16		81.8					97.1		10	3
Contribution from ages 16 - 70		81.8					97.1		54	1
API Consumption[4,5]	1.00E-06		25,550	70	<table>	<table>		350		
API Exposure 0-2 years		15					23		2	10
API Exposure 2 - < 6 years		15					23		4	3
API Exposure 6 - < 16 years		63					57.1		10	3
API Exposure 16 - < 70 years		63					57.1		14	1

Groundwater (as Drinking Water) Cleanup Levels: Cancer

$$\text{Groundwater Cleanup or Screening Level (µg/L)} = \frac{(RISK \times BW \times UCF \times AT)}{(CPF_o \times DWIR \times INH \times DWF \times ED)}$$

Risk = Target excess individual lifetime cancer risk level (unitless)
BW = Average body weight (kg)
UCF = 1,000 µg/mg
AT = Averaging time (years)
CPF_o = Cancer potency factor (kg-day/mg)
DWIR = Drinking water ingestion rate (L/day)
INH = Inhalation correction factor (unitless)
DWF = Drinking water fraction (unitless)
ED = Exposure duration (years)

Exposure Scenarios	Risk (unitless)	BW (kg)	AT (years)	CPF_o (kg-day/mg)	DWIR (L/day)	INH (unitless)	DWF (unitless)	ED (years)
MTCA Default[1]	1.00E-06	70	75	<table>	2	1	1.00	30

Notes:

Indicates no value is required in calculations for the associated exposure scenario indicated.
<table> Indicates a chemical-specific factor is available in the associated tables of this attachment.
1 All parameters derived from Model Toxics Control Act (MTCA) WAC 173-340-730, equations 730-1 and 730-2.
2 Supplemental Guidance for Assessing Susceptibility from Early-life Exposure to Carcinogens. U.S. Environmental Protection Agency (EPA), Washington, DC, EPA/630/R-03/003F (2005).
3 All parameters derived from EPA Region 10 Framework for Selecting and Using Tribal Fish and Shellfish Consumption Rates for Risk-based Decision Making (2007).
4 Fish consumption rates include both finfish and shellfish, and exclude salmon.
5 Fish consumption rates derived from Washington State Department of Ecology (Ecology). MTCA Regulation Update Summary, Fish Consumption Rates for High Exposure Populations (2009).

Abbreviations:

API Asian/Pacific Islander
MTCA Model Toxics Control Act

Table A.4g
Cross-media Factors

		Other Chemical Factors					Bioconcentration Factors							
		EPA R10					EPA R10		Ecology MTCA/CLARC		Others		Selected for Use[4]	
CAS Number	Chemical	GI Absorption Conversion Factor (GI) (unitless)	Dermal Absorption Fraction (ABS_d) (unitless)	Volatilization Factor (VF) (m^3/kg)	Source For Preceeding Factors	(1/VF + 1/PEF)[1] (kg/m^3)	Water to Fish BCF[2] (L/kg)	Source	Water to Fish BCF[3] (L/kg)	Source	Water to Fish BCF (L/kg)	Source	Water to Fish BCF (L/kg)	Source
56-55-3	Benzo(a) anthracene	1	0.13	--	EPA RSL 2010	7.1E-10	4.9E+03	HHRAP	30	AWQC Gold Book	3.0E+02	Use B(a)P	3.0E+02	Use B(a)P
50-32-8	Benzo(a) pyrene (B(a)P)	1	0.13	--	EPA RSL 2010	7.1E-10	8.3E+03	HHRAP	30	AWQC Gold Book	3.0E+02	McCarthy 1985[6]	3.0E+02	McCarthy 1985[6]
205-99-2	Benzo (b) fluoranthene	1	0.13	--	EPA RSL 2010	7.1E-10	1.0E+04	HHRAP	30	AWQC Gold Book	3.0E+02	Use B(a)P	3.0E+02	Use B(a)P
207-08-9	Benzo(k) fluoranthene	1	0.13	--	EPA RSL 2010	7.1E-10	9.9E+03	HHRAP	30	AWQC Gold Book	3.0E+02	Use B(a)P	3.0E+02	Use B(a)P
218-01-9	Chrysene	1	0.13	--	EPA RSL 2010	7.1E-10	4.9E+03	HHRAP	30	AWQC Gold Book	3.0E+02	Use B(a)P	3.0E+02	Use B(a)P
53-70-3	Dibenz(a,h)anthracene	1	0.13	--	EPA RSL 2010	7.1E-10	2.0E+04	HHRAP	30	AWQC Gold Book	3.0E+02	Use B(a)P	3.0E+02	Use B(a)P
193-39-5	Indeno(1,2,3-cd)pyrene	1	0.13	--	EPA RSL 2010	7.1E-10	2.4E+04	HHRAP	30	AWQC Gold Book	3.0E+02	Use B(a)P	3.0E+02	Use B(a)P
--	Total Benzo(a)pyrene TEQ	1	0.13	--	Use B(a)P	7.1E-10	8.3E+03	Use B(a)P	30	Use B(a)P	3.0E+02	Use B(a)P	3.0E+02	Use B(a)P

Table A.4g
Cross-media Factors

		Soil Organic Carbon to Water Partitioning Coefficient (K_{oc})						Soil to Water Partitioning Coefficient ($K_d = K_{oc} \times f_{oc}$)						Water to Air Partitioning					
		EPA R10		Ecology MTCA/CLARC		Selected for Use		EPA R10		Ecology MTCA/CLARC		Selected for Use[5]		EPA R10		Ecology MTCA/CLARC		Selected for Use	
CAS Number	Chemical	K_{oc} (L/kg)	Source	K_{oc} (L/kg)	Source	K_{oc} (L/kg)	Source	K_d (L/kg)	Source	K_d (L/kg)	Source	K_d (L/kg)	Source	Henry's Law Constant (H_{cc}) (unitless)	Source	Henry's Law Constant (H_{cc}) (unitless)	Source	Henry's Law Constant (H_{cc}) (unitless)	Source
56-55-3	Benzo(a) anthracene	1.8E+05	EPA RSL 2010	3.6E+05	EPA SSL 1996	2.7E+05	Average	1.8E+02	RSL K_{oc}*0.001	3.6E+02	SSL K_{oc}*0.001	5.4E+03	Average K_{oc}*0.02	4.9E-04	EPA RSL 2010	1.4E-04	EPA SSL 1996	3.2E-04	Average
50-32-8	Benzo(a) pyrene (B(a)P)	5.9E+05	EPA RSL 2010	9.7E+05	EPA SSL 1996	7.8E+05	Average	5.9E+02	RSL K_{oc}*0.001	9.7E+02	SSL K_{oc}*0.001	1.6E+04	Average K_{oc}*0.02	1.9E-05	EPA RSL 2010	4.6E-05	EPA SSL 1996	3.2E-05	Average
205-99-2	Benzo (b) fluoranthene	6.0E+05	EPA RSL 2010	1.2E+06	EPA SSL 1996	9.0E+05	Average	6.0E+02	RSL K_{oc}*0.001	1.2E+03	SSL K_{oc}*0.001	1.8E+04	Average K_{oc}*0.02	2.7E-05	EPA RSL 2010	4.6E-03	EPA SSL 1996	2.3E-03	Average
207-08-9	Benzo(k) fluoranthene	5.9E+05	EPA RSL 2010	1.2E+06	EPA SSL 1996	8.9E+05	Average	5.9E+02	RSL K_{oc}*0.001	1.2E+03	SSL K_{oc}*0.001	1.8E+04	Average K_{oc}*0.02	2.4E-05	EPA RSL 2010	3.4E-05	EPA SSL 1996	2.9E-05	Average
218-01-9	Chrysene	1.8E+05	EPA RSL 2010	4.0E+05	EPA SSL 1996	2.9E+05	Average	1.8E+02	RSL K_{oc}*0.001	4.0E+02	SSL K_{oc}*0.001	5.8E+03	Average K_{oc}*0.02	2.1E-04	EPA RSL 2010	3.9E-03	EPA SSL 1996	2.1E-03	Average
53-70-3	Dibenz(a,h)anthracene	1.9E+06	EPA RSL 2010	1.8E+06	EPA SSL 1996	1.9E+06	Average	1.9E+03	RSL K_{oc}*0.001	1.8E+03	SSL K_{oc}*0.001	3.7E+04	Average K_{oc}*0.02	5.8E-06	EPA RSL 2010	6.0E-07	EPA SSL 1996	3.2E-06	Average
193-39-5	Indeno(1,2,3-cd)pyrene	2.0E+06	EPA RSL 2010	3.5E+06	EPA SSL 1996	2.7E+06	Average	2.0E+03	RSL K_{oc}*0.001	3.5E+03	SSL K_{oc}*0.001	5.5E+04	Average K_{oc}*0.02	1.4E-05	EPA RSL 2010	6.6E-05	EPA SSL 1996	4.0E-05	Average
--	Total Benzo(a)pyrene TEQ	5.9E+05	Use B(a)P	9.7E+05	Use B(a)P	7.8E+05	Use B(a)P					1.6E+04	Use B(a)P					3.2E-05	Use B(a)P

Notes:

EPA and Ecology have not selected final values for either the distribution coefficient (Kd) or Henry's Law Constant for benzo(a)pyrene TEQ.

1 If VF is not available (i.e., is presented as "--" in table), this term simplifies to one divided by the particulate emission factor (1/PEF).

2 BCFs derived from Meylan, et al. (1999) (in EPA Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities [HHRAP] Guidance, 2005, EPA520-R-05-006).

3 BCFs derived from CLARC database, originally sourced from EPA Quality Criteria for Water (AWQC Gold Book 1986), EPA 440/5-86-001.

4 In general, the EPA BCFs are from the HHRAP summary; most of these are calculated using the method of Meylan, et al. 1999 (refer to Note 1); emperical values from other studies may be more appropirate for specific sites.

5 A site-specific f_{oc} was developed for Boeing Plant 2 using areas with no or limited organic contamination to represent the actual fraction of organic carbon present in the alluvial soils; this value is 0.02.

6 McCarthy, John F. and Braulio D. Jimenez. 1985. Reduction in Bioavailibility to Bluegills of Polycylic Aromatic Hydrocarbons Bound to Dissolved Humic Material. Environmental Toxicology and Chemistry Vol. 4: 511-521.

Abbreviations:

BCF Bioconcentration factor
CAS Chemical abstract number
CLARC Cleanup Levels and Risk Calculation
cPAH Carcinogenic polycyclic aromatic hydrocarbon
Ecology Washington State Department of Ecology
EPA U.S. Environmental Protection Agency
EPA RSL 2010 Regional Screeining Levels, November 2010; http://www.epa.gov/region9/superfund/prg/
EPA SSL 1996 Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, EPA540/R-96/018, July 1996
f_{oc} Soil fraction of organic carbon
MTCA Model Toxics Control Act
R10 Region 10
RSL Regional screening level
TEQ Toxic Equivalent Quantity
VF Volitilization Factor

Table A.4h
Toxicological Factors

CAS Number	Chemical	Toxicity Equivalent Factor (TEF)[1]		EPA R10[2]						Ecology[3]					
				Oral/Ingestion Toxicity Factors		Dermal Toxicity Factors[4]		Inhalation Toxicity Factors		Oral/Ingestion Toxicity Factors		Dermal Toxicity Factors[5]		Inhalation Toxicity Factors	
		(unitless)	Source	Cancer Slope Factor (CSF_o) (kg-day/mg)	Source	Cancer Slope Factor (CSF_d) (kg-day/mg)	Source	Inhalation Unit Risk (IUR) ($m^3/\mu g$)	Source	Cancer Potency Factor (CPF_o) (kg-day/mg)	Source	Cancer Potency Factor (CPF_d) (kg-day/mg)	Source	Cancer Potency Factor (CPF_i) (kg-day/mg)	Source
56-55-3	Benzo(a) anthracene	0.1	WAC 173-340-900	7.3E-01	B(a)P IRIS * TEQ	7.3E-01	CPF_o/GI-abs	1.1E-04	B(a)P IRIS * TEQ	7.3E-01	B(a)P IRIS * TEQ	1.5E+00	CPF_o/GI-abs	6.1E-01	--
50-32-8	Benzo(a) pyrene (B(a)P)	1	WAC 173-340-901	7.3E+00	IRIS	7.3E+00	CPF_o/GI-abs	1.1E-03	IRIS	7.3E+00	IRIS	1.5E+01	CPF_o/GI-abs	6.1E+00	HEAST
205-99-2	Benzo (b) fluoranthene	0.1	WAC 173-340-902	7.3E-01	B(a)P IRIS * TEQ	7.3E-01	CPF_o/GI-abs	1.1E-04	B(a)P IRIS * TEQ	7.3E-01	B(a)P IRIS * TEQ	1.5E+00	CPF_o/GI-abs	6.1E-01	--
207-08-9	Benzo(k) fluoranthene	0.1	WAC 173-340-903	7.3E-01	B(a)P IRIS * TEQ	7.3E-01	CPF_o/GI-abs	1.1E-04	B(a)P IRIS * TEQ	7.3E-01	B(a)P IRIS * TEQ	1.5E+00	CPF_o/GI-abs	6.1E-01	--
218-01-9	Chrysene	0.01	WAC 173-340-904	7.3E-02	B(a)P IRIS * TEQ	7.3E-02	CPF_o/GI-abs	1.1E-05	B(a)P IRIS * TEQ	7.3E-02	B(a)P IRIS * TEQ	1.5E-01	CPF_o/GI-abs	6.1E-02	--
53-70-3	Dibenz(a,h)anthracene	0.1	WAC 173-340-905	7.3E-01	B(a)P IRIS * TEQ	7.3E-01	CPF_o/GI-abs	1.1E-04	B(a)P IRIS * TEQ	7.3E-01	B(a)P IRIS * TEQ	1.5E+00	CPF_o/GI-abs	6.1E-01	--
193-39-5	Indeno(1,2,3-cd)pyrene	0.1	WAC 173-340-906	7.3E-01	B(a)P IRIS * TEQ	7.3E-01	CPF_o/GI-abs	1.1E-04	B(a)P IRIS * TEQ	7.3E-01	B(a)P IRIS * TEQ	1.5E+00	CPF_o/GI-abs	6.1E-01	--
--	Total Benzo(a)pyrene TEQ	--	--	7.3E+00	Use B(a)P	7.3E+00	Use B(a)P	1.1E-03	Use B(a)P	7.3E+00	Use B(a)P	1.5E+01	Use B(a)P	6.1E+00	--

Notes:

1 Ecology Toxic Equivalency Factors (TEF) multipliers, as shown below, were used for all calculations, including both EPA and Ecology equations. This decision is the source of the difference in calculated values between published EPA RSL clean up levels and EPA RSL cleanup levels in this workbook for benzo(k)fluoranthene, chrysene, and dibenz(a,h)anthracene.

2 Toxicity factors are from the November 2010 EPA RSL Tables unless otherwise noted.

3 Toxicity factors from Ecology were taken from CLARC on January 30, 2011; then updated to include all IRIS changes. PPRTV were also incorporated where it was clear what value would be used. Values from ATSDR, Cal/EPA, and NJEPA were not used.

4 EPA dermal toxicity factors are calculated based on the oral toxicity factors as follows: $CSF_d = CSf_o$/GI-abs; $RfD_d = RfD_d$ x GI-abs. GI-abs is the gastrointestinal absorption conversion factor, which is equal to 1.0 except where otherwise specified (usually only for metals).

5 MTCA dermal toxicity factors are calculated based on the oral toxicity factors as follows: $CSF_d = CSf_o$/GI-abs; $RfD_d = RfD_d$ x GI-abs. GI-abs is the gastrointestinal absorption conversion factor, which is equal to 0.5 for Semivolatile organic compounds (see Equations 740-4 and 740-5).

Abbreviations:

ATSDR Agency for Toxic Substances and Disease Registry.
Cal/EPA California Environmental Protection Agency.
CLARC Cleanup Levels and Risk Calculation
CSF and CPF The terms "cancer slope factor" and "cancer potency factor" are interchangeable.
Ecology Washington State Department of Ecology.
EPA U.S. Environmental Protection Agency.
HEAST Health Effects Assessment Summary Tables.
IRIS Integrated Risk Information System.
NJDEP New Jersey Department of Environmental Protection.
PPRTV Provisional Peer Reviewed Toxicity Value.
R10 Region 10.
Rf_o and Rf_c The terms "Reference factor Dose" and "Reference factor Concentration" are not interchangeable. The former is expressed as a dose (mg/kg-day) while the later is a concentrations (mg/unit volume of media).
TEQ Toxic Equivalent Factor

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Attachment B
Frequency of Exceedance Tables and Scatter Plots

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Seattle, WA

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Attachment B
Frequency of Exceedance Tables and Scatter Plots

Tables

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Table B.1a
Frequency of Exceedance of TMCLs by Metals in Soil

CAS	Constituent	EPA Proposed Soil TMCL	Units	Number of Results	Number of Detected Results	Percent Detected	Number of Detected Results that Exceed Criteria[1]	Percent of Detected Results that Exceed Criteria[1]	Maximum Detected Value	Exceedance Factor[1]	Retained as COC[2]
Metals											
7429-90-5	Aluminum	7.7E+04	mg/kg	1,763	1,763	100%	10	0.6%	1.8E+05	2.3	No; detected exceedance < 10%, exceedance factor ≈ 2.0
7440-36-0	**Antimony**	3.1E+01	mg/kg	2,059	58	3%	15	0.7%	8.2E+02	26	**Yes**
7440-38-2	**Arsenic**	2.0E+01	mg/kg	2,341	822	35%	13	0.6%	2.9E+02	14	**Yes**
7440-39-3	**Barium**	1.0E+02	mg/kg	1,910	1,910	100%	71	3.7%	4.8E+03	48	**Yes**
7440-41-7	Beryllium	1.6E+02	mg/kg	2,203	1,713	78%			1.5E+00		No
18540-29-9	**Chromium (VI)**	1.2E+00	mg/kg	170	18	11%	5	2.9%	1.3E+03	1051	**Yes**
7440-48-4	**Cobalt[3]**	1.2E+01	mg/kg	1,718	1,717	100%	43	2.5%	1.9E+02	16	**Yes; Small localized hotspot within OA-1/OA-2**
7440-43-9	**Cadmium**	4.0E+00	mg/kg	2,383	557	23%	74	3.1%	3.7E+03	932	**Yes**
7440-50-8	**Copper**	8.0E+01	mg/kg	2,331	2,331	100%	54	2.3%	2.8E+04	350	**Yes**
7439-89-6	**Iron[4]**	5.9E+04	mg/kg	1,836	1,836	100%	13	0.7%	1.8E+05	3.0	**Yes; Small localized hotspot within OA-1/OA-2**
7439-92-1	**Lead**	2.5E+02	mg/kg	2,389	1,872	78%	43	1.8%	1.8E+04	72	**Yes**
7439-96-5	**Manganese[4]**	1.8E+03	mg/kg	1,889	1,889	100%	8	0.4%	6.9E+03	3.8	**Yes; Small localized hotspot within OA-1/OA-2**
7439-97-6	**Mercury as Elemental Mercury**	1.5E+00	mg/kg	2,320	707	30%	14	0.6%	3.8E+01	25	**Yes; Mercury retained. Specific form in soil not specified**
7487-94-7	**Mercury as Inorganic Mercury Salts**	2.3E+01	mg/kg	2,320	707	30%	2	0.1%	3.8E+01	1.6	
7439-98-7	**Molybdenum[3]**	2.0E+01	mg/kg	1,195	503	42%	8	0.7%	1.7E+02	8.2	**Yes; Small localized hotspot within OA-1/OA-2**
7440-02-0	**Nickel**	2.1E+02	mg/kg	2,242	2,241	100%	23	1.0%	2.1E+03	10	**Yes**
7782-49-2	**Selenium**	1.0E+00	mg/kg	2,247	58	3%	33	1.5%	9.0E+00	8.8	**Yes**
7440-22-4	Silver	1.7E+02	mg/kg	2,279	130	6%	4	0.2%	2.7E+02	1.6	No; detected exceedance < 10%, exceedance factor < 2.0
7440-31-5	Tin	4.7E+04	mg/kg	1,195	94	8%			7.6E+02		No
1314-62-1	Vanadium	7.0E+02	mg/kg	1,769	1,769	100%			1.1E+02		No
7440-66-6	**Zinc**	1.4E+03	mg/kg	2,338	2,338	100%	26	1.1%	2.6E+04	18	**Yes**
Other Inorganics											
57-12-5	**Cyanide (free)**	2.0E+01	mg/kg	972	222	23%	5	0.5%	4.6E+03	230	**Yes**

Notes:

Dark red text with dark background Indicates that constituent was retained as a constituent of concern.

1 Blank indicates that the no detected result exceeds the criteria.
2 EPA has approved the use of MTCA soil compliance rules for screening constituents in soil. Specifically, constituents with a frequency of detected exceedance less than ten percent and an exceedance factor less than 2.0 have not been carried forward in accordance with WAC 173-340-740(7)(e)(i-ii).
3 Scatter plots of cobalt and molybdenum data are presented to illustrate the occurance of localized exceedences.
4 For information on background concentrations of iron and manganese in Washington State and at Boeing Plant 2, please see associated scatter plots presented in this attachment.

Abbreviations:

CAS Chemical abstract number
COC Constituent of Concern
EPA U. S. Environmental Protection Agency

Table B.1b
Frequency of Exceedance of TMCLs by Semivolatile Organic Compounds in Soil

CAS	Constituent	EPA Proposed Soil TMCL[1]	Units	Number of Results	Number of Detected Results	Percent Detected	Number of Detected Results that Exceed Criteria[2]	Percent of Detected Results that Exceed Criteria[2]	Maximum Detected Value	Exceedance Factor[1]	Retained as COC[3]
Semivolatile Organic Compounds (SVOCs)											
83-32-9	Acenaphthene	2.3E+02	mg/kg	1,105	85	8%			5.3E+01		No
208-96-8	Acenaphthylene		mg/kg	1,104	55	5%			2.4E+02		No
120-12-7	Anthracene	1.6E+03	mg/kg	1,104	129	12%			2.4E+02		No
191-24-2	Benzo(g,h,i)perylene		mg/kg	1,104	227	21%			1.0E+02		No
117-81-7	**Bis(2-ethylhexyl)phthalate**	3.5E+01	mg/kg	1,020	171	17%	1	0.1%	3.3E+02	9.4	**Yes**
85-68-7	Butylbenzyl phthalate	1.7E+00	mg/kg	1,004	6	0.6%			1.6E-01		No
86-74-8	Carbazole	5.0E+01	mg/kg	964	13	1%			1.6E+01		No
59-50-7	4-chloro-3-methylphenol	7.4E+02	mg/kg	982	2	0.2%			1.3E+00		No
132-64-9	Dibenzofuran	1.2E+02	mg/kg	1,066	105	10%			5.8E+01		No
84-74-2	Di-n-butylphthalate	2.6E+01	mg/kg	1,004	60	6%			1.1E+00		No
84-66-2	Diethylphthalate	7.6E+02	mg/kg	1,004	38	4%			2.3E-01		No
105-67-9	2,4-Dimethylphenol	9.5E+01	mg/kg	1,004	2	0.2%			6.8E-02		No
131-11-3	Dimethylphthalate		mg/kg	1,004	2	0.2%			9.9E+00		No
117-84-0	Di-n-octyl phthalate		mg/kg	1,011	15	1%			7.7E+01		No
206-44-0	Fluoranthene	2.3E+02	mg/kg	1,105	379	34%	1	0.1%	4.1E+02	1.8	No; detected exceedance < 10%, exceedance factor < 2.0
86-73-7	Fluorene	1.5E+02	mg/kg	1,104	97	9%	1	0.1%	1.8E+02	1.2	No; detected exceedance < 10%, exceedance factor < 2.0
7440-62-2	**1-Methylnaphthalene**	1.6E+01	mg/kg	439	89	20%	5	1.1%	1.8E+02	11	**Yes**
91-57-6	2-Methylnaphthalene	2.3E+02	mg/kg	1,089	176	16%	1	0.1%	2.9E+02	1.3	No; detected exceedance < 10%, exceedance factor < 2.0
95-48-7	2-Methylphenol (o-cresol)	2.5E+02	mg/kg	1,004	2	0.2%			1.1E-01		No
106-44-5	4-Methylphenol (p-cresol)	4.1E+01	mg/kg	1,004	5	0.5%			3.6E-01		No
85-01-8	Phenanthrene		mg/kg	1,105	407	37%			9.4E+02		No
108-95-2	Phenol	1.9E+03	mg/kg	1,001	24	2%			5.5E+00		No
129-00-0	**Pyrene**	2.4E+02	mg/kg	1,105	405	37%	1	0.1%	5.5E+02	2.3	**Yes**

Notes:

Dark red text with dark background Indicates that constituent was retained as a constituent of concern.

1 Blank indicates that no TMCL was developed for the associated constituent.
2 Blank indicates that the no detected result exceeds the criteria.
3 EPA has approved the use of MTCA soil compliance rules for screening constituents in soil. Specifically, constituents with a frequency of detected exceedance less than ten percent and an exceedance factor less than 2.0 have not been carried forward in accordance with WAC 173-340-740(7)(e)(i-ii).

Abbreviations:

CAS Chemical abstract number
COC Constituent of Concern
EPA U. S. Environmental Protection Agency

Table B.1c
Frequency of Exceedance of TMCLs by Carcinogenic Polycyclic Aromatic Hydrocarbons and Polychlorinate Biphenyls in Soil

CAS	Constituent	EPA Proposed Soil TMCL[1]	Units	Number of Results	Number of Detected Results	Percent Detected	Number of Detected Results that Exceed Criteria[2]	Percent of Detected Results that Exceed Criteria[2]	Maximum Detected Value	Exceedance Factor[2]	Retained as COC[1]
Mutagenic Carcinogenic Polycyclic Aromatic Hydrocarbons (cPAHs)											
56-55-3	Benzo(a) anthracene		mg/kg	1,104	267	24%			2.0E+02		
50-32-8	Benzo(a) pyrene		mg/kg	1,104	247	22%			2.1E+02		
205-99-2	Benzo (b) fluoranthene		mg/kg	1,104	256	23%			1.0E+02		
207-08-9	Benzo(k) fluoranthene		mg/kg	1,104	233	21%			1.6E+02		
218-01-9	Chrysene		mg/kg	1,105	358	32%			2.4E+02		
53-70-3	Dibenz(a,h)anthracene		mg/kg	1,104	67	6%			3.3E+01		
193-39-5	Indeno(1,2,3-cd)pyrene		mg/kg	1,104	185	17%			8.3E+01		
	Benzo(a)pyrene TEQ[3,4]	1.5E-02	mg/kg	1,098	365	33%	194	18%	2.7E+02	18,000	**Yes**
Polychlorinated Biphenyls (PCBs)											
53469-21-9	**Aroclor 1016/1242**	7.2E-04	mg/kg	278	2	0.7%	2	0.7%	9.0E-01	1,250	**Yes**
12672-29-6	**Aroclor 1248**	2.2E-01	mg/kg	1,585	16	1.0%	7	0.4%	1.3E+02	591	**Yes**
11097-69-1	**Aroclor 1254**	2.9E-04	mg/kg	1,585	124	8%	124	7.8%	8.1E+01	279,310	**Yes**
37324-23-2	**Aroclor 1260**	5.4E-03	mg/kg	1,585	225	14%	225	14%	6.6E+02	122,222	**Yes**
1336-36-3	**Total PCBs**	1.8E-03	mg/kg	1,590	316	20%	316	20%	6.6E+02	366,667	**Yes**

Notes:

Dark red text with dark background Indicates that constituent was retained as a constituent of concern.

1 Blank indicates that no individual soil cleanup level has been developed for the associated constituent; therefore, the associated constituent was not retained as a contaminant of concern at Boeing Plant 2. This is because Washington state regulates carcinogenic polycyclic aromatic hydrocarbons using the benzo(a)pyrene Toxic Equivalent. Refer to https://fortress.wa.gov/ecy/clarc/FocusSheets/tef.pdf. This is consistent with EPA's philosophy of using relative potency factors.

2 Blank indicates that the no detected result exceeds the criteria.

3 Benzo(a)pyrene TEQ calculated using 1/2 the reporting limit as a surrogate for non-detected constituents when at least one constituent contributing to the TEQ was detected.

4 EPA has approved the use of Ecology's TEFs for this site.

Abbreviations:

CAS Chemical abstract number
COC Constituent of Concern
EPA U. S. Environmental Protection Agency
Ecology Washington State Department of Ecology
TEQ Toxic Equivalent
TEF Toxic Equivalency Factor

Table B.1d
Frequency of Exceedance of TMCLs by Volatile Organic Compounds in Soil

CAS	Constituent	EPA Proposed Soil TMCL	Units	Number of Results	Number of Detected Results[1]	Percent Detected[1]	Number of Detected Results that Exceed Criteria[2]	Percent of Detected Results that Exceed Criteria[2]	Maximum Detected Value[1]	Exceedance Factor[2]	Retained as COC[3]
Volatile Organic Constituents (VOCs) including pre-2005 data											
67-64-1	Acetone	5.1E+02	mg/kg	2,302	1,142	50%			5.8E+00		No
71-43-2	**Benzene**	9.3E-02	mg/kg	2,341	244	10%	10	0.4%	4.9E+01	526	**Yes**
78-93-3	2-Butanone (MEK)	4.3E+02	mg/kg	2,269	400	18%			3.4E+02		No
75-15-0	Carbon Disulfide	7.5E+01	mg/kg	2,305	402	17%			3.1E-01		No
56-23-5	Carbon Tetrachloride	2.1E-02	mg/kg	2,314	8	0.3%			1.5E-02		No
108-90-7	Chlorobenzene	2.6E+01	mg/kg	2,316	9	0.4%			1.9E+00		No
75-00-3	Chloroethane	2.8E+02	mg/kg	2,314	3	0.1%			4.1E-03		No
67-66-3	**Chloroform**	2.0E-01	mg/kg	2,316	55	2%	1	0.04%	2.0E-01	1.0	No; detected exceedance < 10%, exceedance factor < 2.0
74-87-3	Chloromethane	1.6E+00	mg/kg	2,314	5	0.2%			2.3E-02		No
106-43-4	4-Chlorotoluene	4.0E+02	mg/kg	1,520	1	0.1%			1.2E-03		No
95-50-1	1,2-Dichlorobenzene	6.8E+01	mg/kg	1,832	4	0.2%			5.5E-02		No
106-46-7	1,4-Dichlorobenzene	3.5E-01	mg/kg	1,832	7	0.4%			2.2E-01		No
75-34-3	**1,1-Dichloroethane**	7.1E-01	mg/kg	2,314	55	2%	1	0.04%	2.5E+00	3.5	**Yes**
107-06-2	1,2-Dichloroethane	7.0E-02	mg/kg	2,313	1	0.04%			3.5E-02		No
75-35-4	**1,1-Dichloroethene**	8.1E-02	mg/kg	2,316	17	1%	3	0.1%	1.7E+00	21	**Yes**
156-59-2	**cis-1,2-Dichloroethene**	2.6E+00	mg/kg	2,254	276	12%	13	0.6%	4.1E+02	159	**Yes**
156-60-5	trans-1,2-Dichloroethene	1.9E+01	mg/kg	2,260	73	3%			7.1E+00		No
78-87-5	1,2-Dichloropropane	9.2E-02	mg/kg	2,316							No
100-41-4	**Ethylbenzene**	2.3E-01	mg/kg	2,346	69	3%	25	1.1%	2.6E+02	1,121	**Yes**
98-82-8	Isopropylbenzene(cumene)	7.8E+01	mg/kg	1,520	11	0.7%			1.8E+01		No
591-78-6	2-Hexanone	3.2E+01	mg/kg	2,307	2	0.1%			1.1E-02		No
75-09-2	**Methylene Chloride**	6.5E-01	mg/kg	2,305	348	15%	3	0.1%	8.8E+00	14	**Yes**
108-10-1	Methyl Isobutyl Ketone	1.7E+02	mg/kg	2,309	14	0.6%			4.3E-02		No
91-20-3	**Naphthalene**	3.6E+00	mg/kg	3,844	360	9%	46	1.2%	5.2E+02	146	**Yes**
100-42-5	Styrene	6.3E+03	mg/kg	2,314	4	0.2%			4.0E-01		No
79-34-5	**1,1,2,2-Tetrachloroethane**	1.3E-02	mg/kg	2,316	1	0.04%	1	0.04%	1.7E-01	13	**Yes**
127-18-4	**Tetrachloroethene (PCE)**	1.6E-03	mg/kg	2,314	176	8%	137	5.9%	2.0E+01	12,560	**Yes**
108-88-3	**Toluene**	1.0E+02	mg/kg	2,346	408	17%	1	0.0%	6.5E+02	6.3	**Yes**
71-55-6	1,1,1-Trichloroethane	1.9E+03	mg/kg	2,314	87	4%			1.1E+02		No
79-00-5	**1,1,2-Trichloroethane**	7.3E-02	mg/kg	2,314	17	0.7%	1	0.04%	3.3E+00	45	**Yes**
79-01-6	**Trichloroethene (TCE)**	1.8E-02	mg/kg	2,324	780	34%	353	15%	1.1E+04	609,389	**Yes**
120-82-1	**1,2,4-trichlorobenzene**	8.0E-02	mg/kg	1,825	10	0.5%	5	0.3%	1.2E+00	15	**Yes**
75-69-4	Trichlorofluoromethane	2.0E+02	mg/kg	2,273	9	0.4%			2.4E-02		No
76-13-1	1,1,2-Trichlorotrifluoroethane	4.3E+02	mg/kg	2,270	36	2%			1.4E+02		No
75-01-4	**Vinyl chloride**	8.1E-05	mg/kg	2,323	58	2%	58	2.5%	1.8E+00	22,268	**Yes**
95-47-6	o-Xylene[4]	2.0E+02	mg/kg	1,674	26	2%			1.4E+01		No
179601-23-1	m,p-Xylene[4]	1.6E+02	mg/kg	1,662	58	3%	1	0.1%	2.2E+02	1.4	No; detected exceedance < 10%, exceedance factor < 2.0
10330-20-7	**Xylenes (total)[4]**	2.0E+02	mg/kg	678	89	13%	4	0.6%	1.4E+03	7.1	**Yes**

Notes:

Dark red text with dark background Indicates that constituent was retained as a constituent of concern at the point of compliance.

1 Blank indicates that constituent was not detected at Boeing Plant 2.
2 Blank indicates that the no detected result exceeds the criteria.
3 EPA has approved the use of MTCA soil compliance rules for screening constituents in soil. Specifically, constituents with a frequency of detected exceedance less than ten percent and an exceedance factor less than 2.0 have not been carried forward in accordance with WAC 173-340-740(7)(e)(i-ii).
4 Older data is reported as total xylenes, whereas newer data is reported as o-xylene and m,p-xylene. Some areas with total data do not have more recent isomer-specific data.

Abbreviations:

CAS Chemical abstract number
COC Constituent of Concern
EPA U. S. Environmental Protection Agency

Table B.1e
Frequency of Exceedance of TMCLs by Total Petroleum Hydrocarbons in Soil

CAS	Constituent[1]	EPA Proposed Soil TMCL	Units	Number of Results	Number of Detected Results	Percent Detected	Number of Detected Results that Exceed Criteria[2]	Percent of Detected Results that Exceed Criteria[2]	Maximum Detected Value	Exceedance Factor[2]	Retained as COC
Total Petroleum Hydrocarbons (TPH)											
86290-81-5	TPH - Gasoline (Benzene Present)	3.0E+01	mg/kg	838	98	12%	47	5.6%	2.5E+04	833	**Yes**
8008-20-6	TPH - Aged Gasoline & Mineral Spirits	1.0E+02	mg/kg	62	3	4.8%	2	3.2%	4.1E+03	41	**Yes**
64475-85-0	TPH - Diesel #2	1.0E+02	mg/kg	1,584	588	37%	59	3.7%	1.1E+05	1,100	**Yes**
68334-30-5	TPH - Heavy Oil	2.0E+03	mg/kg	1,234	493	40%	19	1.5%	6.2E+04	31	**Yes**

Notes:

Dark red text with dark background Indicates that constituent was retained as a constituent of concern at the point of compliance.

1 Petroleum hydrocarbons have been measured at Plant 2 over the years using a variety of methods and standards. Please see the table below to understand how each of the measurements of TPH have been compared to the TPH TMCLs.

2 Blank indicates that the no detected result exceeds the criteria.

Abbreviations:

CAS Chemical abstract number
COC Constituent of Concern
EPA U. S. Environmental Protection Agency

TPH Map Between Constituent and TMCL

Constituent	Regulatory Standard
TPH - Gasoline (Benzene Present)	TPH - Gasoline (Benzene Present)
TPH - Kerosene Range	TPH - Aged Gasoline & Mineral Spirits
TPH - Mineral Spirits Range	TPH - Aged Gasoline & Mineral Spirits
TPH - Diesel Range	TPH - Diesel #2
TPH - Bunker C	TPH - Heavy Oil
TPH - Motor Oil Range	TPH - Heavy Oil
TPH - Oil and Grease	TPH - Heavy Oil
TPH - Diesel + Oil Range	TPH - Diesel #2

Table B.2a
Frequency of Exceedance of TMCLs by Metals in Groundwater

CAS	Constituent	Units	EPA Proposed Groundwater TMCL[1]	Data from Shoreline Monitoring Wells: 2005-Present (Point of Compliance Wells)								Data from Upland Groundwater Wells: 2005-Present (All Uplands Wells)							
				Number of Results[2]	Number of Detected Results[3]	Percent Detected[3]	Number of Detected Results that Exceed Criteria[4]	Percent of Detected Results that Exceed Criteria[4]	Maximum Detected Value[3]	Exceedance Factor[4]	*COC in Groundwater* COCs at the Point of Compliance[5]	Number of Results	Number of Detected Results[3]	Percent Detected[3]	Number of Detected Results that Exceed Criteria[4]	Percent of Detected Results that Exceed Criteria[4]	Maximum Detected Value[3]	Exceedance Factor[4]	*Upgradient Potential COC* Constituents Present Upgradient of the Point of Compliance[5]
Dissolved Metals																			
7429-90-5	Aluminum	µg/L	8.7E+01	13	1	7.7%	1	7.7%	1.0E+02	1.1	No, 1 hit with minimal exceedance	610	248	41%	165	27%	2.5E+05	2,920	Yes
7440-36-0	Antimony	µg/L	1.5E+02	420	58	14%			1.1E+01		No	1,245	64	5.1%			6.0E+01		No
7440-38-2	Arsenic	µg/L	8.0E+00	420	345	82%	41	9.8%	2.6E+01	3.2	Yes	1,355	1,107	82%	211	16%	1.1E+03	139	Yes
7440-39-3	Barium	µg/L	1.2E+02	13	13	100%	4	31%	4.7E+02	3.8	Yes	598	566	95%	53	8.9%	6.2E+02	5	Yes
7440-41-7	Beryllium	µg/L	1.2E+01	420	3	0.7%			3.0E-01		No	1,246	6	0.5%			1.0E+01		No
18540-29-9	Chromium (VI)	µg/L	5.8E-01								No	12	1	8.3%	1	8.3%	1.2E+01	21	Yes
7440-48-4	Cobalt	µg/L	4.8E+00	13							No	601	53	8.8%	22	3.7%	9.5E+01	20	Yes
7440-50-8	Copper	µg/L	8.0E+00	420	220	52%	35	8.3%	4.3E+01	5.4	Yes	1,246	42	3.4%	41	3.3%	1.6E+02	21	Yes
7440-43-9	Cadmium	µg/L	2.5E-01	420	26	6.2%	26	6.2%	1.6E+02	656	Yes	1,243	691	56%	102	8.2%	1.4E+02	540	Yes
7439-89-6	Iron	µg/L	1.0E+03	290	218	75%	193	67%	2.2E+05	215	Yes[6]	1,132	1,013	89%	871	77%	1.2E+06	1210	Yes[6]
7439-92-1	Lead	µg/L	2.5E+00	420	3	0.7%	1	0.2%	4.0E+00	1.6	No; exceedance factor < 2.0; detected exceedence < 0.5%	1,246	19	1.5%	5	0.4%	1.2E+01	4.8	Yes
7439-96-5	Manganese	µg/L	2.0E+03	377	300	80%	40	10.6%	7.6E+03	3.8	Yes[6]	1,389	1,309	94%	196	14%	1.6E+04	8.1	Yes[6]
7439-97-6	Mercury as Elemental Mercury	µg/L	1.2E-02	420	3	0.7%	3	0.7%	4.7E-02	3.9	No[7]	1,242	25	2.0%	25	2.0%	7.0E+00	583	No[7]
7487-94-7	Mercury as Inorganic Mercury Salts	µg/L	4.8E+00	420	3	0.7%			4.7E-02		No	1,242	25	2.0%	1	0.1%	7.0E+00	1.5	No; exceedance factor < 2.0; detected exceedence < 0.5%
7439-98-7	Molybdenum	µg/L	8.0E+01	13	5	38%			3.0E+01		No	598	279	47%	1	0.2%	8.6E+01	1.1	No[8]
7440-02-0	Nickel	µg/L	8.2E+00	420	384	91%	62	15%	2.6E+02	31	Yes	1,251	1,106	88%	175	14%	2.6E+02	31	Yes
7782-49-2	Selenium	µg/L	5.0E+00	421	28	6.7%	10	2.4%	3.2E+02	64	Yes; may need background	1,247	101	8.1%	14	1.1%	3.2E+02	64	Yes; may need background
7440-22-4	Silver	µg/L	2.2E+01	420	20	4.8%	10	2.4%	7.3E+01	3.3	Yes	1,246	42	3.4%	10	0.8%	7.3E+01	3.3	Yes
7440-31-5	Tin	µg/L	9.6E+03	13	1	7.7%			1.0E+01		No	598	7	1.2%			2.0E+01		No
1314-62-1	Vanadium	µg/L	1.4E+02	420	232	55%			2.6E+01		No	1,240	793	64%	10	0.8%	6.7E+02	4.6	Yes
7440-66-6	Zinc	µg/L	5.6E+01	420	85	20%	41	9.8%	2.6E+03	46	Yes	1,246	288	23%	89	7.1%	1.2E+04	215	Yes
Metals, fraction not specified																			
18540-29-9	Chromium (VI)	µg/L	5.8E-01								No	13	2	15%	2	15%	1.5E+01	26	Yes
Other Inorganics																			
57-12-5	Cyanide (free) - total	µg/L	1.0E+00	7							No	284	51	18%	51	18%	5.0E+02	500	Yes
57-12-5	Cyanide (free) - no fraction specified	µg/L	1.0E+00	7							No	234	9	3.8%	9	3.8%	2.5E+02	248	Yes

Notes:

Dark red text with pale background Indicates that constituent was retained as an upgradient potential constituent of concern but not as a constituent of concern at the point of compliance.

Dark red text with dark background Indicates that constituent was retained as a constituent of concern at the point of compliance.

1 Blank indicates that no individual groundwater cleanup level has been developed for the associated constituent.
2 Blank indicates that no results are available for the associated constituent.
3 Blank indicates that constituent was not detected in this data set.
4 Blank indicates that the no detected result exceeds the criteria.
5 COCs may be added in the future depending on future sampling results.
6 May be dissolving from natural soils due to anaerobic groundwater conditions present on site.
7 Elemental mercury is not stable in groundwater; mercury in groundwater occurs as a soluble mercury salt.
8 In addition to being a minor exceedance, the TMCL for molybdenum is based on a surrogate value to protect drinking water (MTCA B groundwater standard to protect drinking water).

Abbreviations:

CAS Chemical abstract number
COC Constituent of Concern
EPA U. S. Environmental Protection Agency

Table B.2b
Frequency of Exceedance of TMCLs by Semivolatile Organic Compounds in Groundwater

				Data from Shoreline Monitoring Wells: 2005-Present (Point of Compliance Wells)								Data from Upland Groundwater Wells: 2005-Present (All Uplands Wells)							
CAS	Constituent	Units	EPA Proposed Groundwater TMCL[1]	Number of Results	Number of Detected Results[2]	Percent Detected[2]	Number of Detected Results that Exceed Criteria[3]	Percent of Detected Results that Exceed Criteria[3]	Maximum Detected Value[2]	Exceedance Factor[3]	*COC in Groundwater* COCs at the Point of Compliance[4]	Number of Results	Number of Detected Results[2]	Percent Detected[2]	Number of Detected Results that Exceed Criteria[3]	Percent of Detected Results that Exceed Criteria[3]	Maximum Detected Value[2]	Exceedance Factor[3]	*Upgradient Potential COC* Constituents Present Upgradient of the Point of Compliance[4]
Semivolatile Organic Compounds (SVOCs)																			
83-32-9	Acenaphthene	µg/L	1.2E+02	38	11	29%			2.6E+00		No	338	29	8.6%			1.0E+01		No
208-96-8	Acenaphthylene	µg/L		38							No	339	3	0.9%			1.3E+00		No
120-12-7	Anthracene	µg/L	2.0E+02	38	1	2.6%			1.2E-01		No	338	5	1.5%			1.7E+00		No
191-24-2	Benzo(g,h,i)perylene	µg/L		38							No	338	1	0.3%			1.4E+00		No
117-81-7	**Bis(2-ethylhexyl)phthalate**	µg/L	1.2E+00	38	2	5.3%	2	5.3%	2.4E+00	1.9	No[5]	338	35	10%	29	8.6%	3.5E+01	28	**Yes**
85-68-7	Butylbenzyl phthalate	µg/L	4.1E-01	38							No	338							No
86-74-8	Carbazole	µg/L	4.4E+00	38							No	338	3	0.9%	1	0.3%	4.7E+00	1.1	No; exceedance factor < 2.0; detected exceedence < 0.5%
59-50-7	4-chloro-3-methylphenol	µg/L	3.7E+03	38							No	338	2	0.6%			2.5E+03		No
132-64-9	Dibenzofuran	µg/L	3.2E+01	38	2	5.3%			1.5E-01		No	338	7	2.1%			5.0E+00		No
84-74-2	Di-n-butylphthalate	µg/L	4.7E+01	38							No	338	7	2.1%			1.2E+01		No
84-66-2	Diethylphthalate	µg/L	1.8E+04	38							No	338							No
105-67-9	2,4-Dimethylphenol	µg/L	6.6E+02	38							No	338	3	0.9%			9.7E+01		No
131-11-3	Dimethylphthalate	µg/L	1.1E+06	38							No	338							No
117-84-0	Di-n-octyl phthalate	µg/L		38							No	338	1	0.3%			1.5E+00		No
206-44-0	Fluoranthene	µg/L	1.1E+01	38	2	5.3%			3.3E-01		No	338	6	1.8%			3.3E-01		No
86-73-7	Fluorene	µg/L	4.5E+01	38	3	7.9%			1.2E+00		No	338	10	3.0%			1.9E+01		No
7440-62-2	1-Methylnaphthalene	µg/L	2.3E+00	33	2	6.1%			1.4E-01		No	253	11	4.3%	1	0.4%	3.7E+00	1.6	No; exceedance factor < 2.0; detected exceedence < 0.5%
91-57-6	2-Methylnaphthalene	µg/L	6.4E+01	38							No	336	8	2.4%			4.8E+01		No
95-48-7	2-Methylphenol (o-cresol)	µg/L	3.1E+03	38							No	338	2	0.6%			4.2E+00		No
106-44-5	4-Methylphenol (p-cresol)	µg/L	3.3E+02	38							No	338	3	0.9%			3.5E+01		No
85-01-8	Phenanthrene	µg/L		38	1	2.6%			3.1E-01		No	338	14	4.1%			1.6E+01		No
108-95-2	Phenol	µg/L	4.1E+04	38							No	338	1	0.3%			3.2E+00		No
129-00-0	Pyrene	µg/L	9.8E+00	38	2	5.3%			1.5E-01		No	338	6	1.8%			2.8E-01		No

Notes:

Dark red text with pale background — Indicates that constituent was retained as an upgradient potential constituent of concern but not as a constituent of concern at the point of compliance.

Dark red text with dark background — Indicates that constituent was retained as a constituent of concern at the point of compliance.

1 Blank indicates that no individual groundwater cleanup level has been developed for the associated constituent.
2 Blank indicates that constituent was not detected in this data set.
3 Blank indicates that the no detected result exceeds the criteria.
4 COCs may be added in the future depending on future sampling results.
5 Constituent was not carried forward as a constituent of concern because bis(2-ethylhexyl)phthalate is a common lab contaminant and the exceedence factor is less than 2.

Abbreviations:

CAS Chemical abstract number
COC Constituent of Concern
EPA U. S. Environmental Protection Agency

Table B.2c

Frequency of Exceedance of TMCLs by Carcinogenic Polycyclic Aromatic Hydrocarbons and Polychlorinated Biphenyls in Groundwater

				Data from Shoreline Monitoring Wells: 2005-Present (Point of Compliance Wells)								Data from Upland Groundwater Wells: 2005-Present (All Uplands Wells)							
CAS	Constituent	Units	EPA Proposed Groundwater TMCL[1]	Number of Results	Number of Detected Results[1]	Percent Detected[1]	Number of Detected Results that Exceed Criteria[1]	Percent of Detected Results that Exceed Criteria[1]	Maximum Detected Value[1]	Exceedance Factor[1]	*COC in Groundwater* COCs at the Point of Compliance[1]	Number of Results	Number of Detected Results[1]	Percent Detected[1]	Number of Detected Results that Exceed Criteria[1]	Percent of Detected Results that Exceed Criteria[1]	Maximum Detected Value[1]	Exceedance Factor[1]	*Upgradient Potential COC* Constituents Present Upgradient of the Point of Compliance[1]
Mutagenic Cancerous Polycyclic Aromatic Hydrocarbons (cPAHs)																			
56-55-3	Benzo(a)anthracene	µg/L		38								338							
50-32-8	Benzo(a)pyrene	µg/L		38								338							
205-99-2	Benzo(b)fluoranthene	µg/L		38								338							
207-08-9	Benzo(k)fluoranthene	µg/L		38								338							
218-01-9	Chrysene	µg/L		38								338							
53-70-3	Dibenz(a,h)anthracene	µg/L		38								338							
193-39-5	Indeno(1,2,3-cd)pyrene	µg/L		38								338							
	Benzo(a)pyrene TEQ[2,3]	µg/L	1.8E-04	39	0	0.0%	0	0.0%	ND	ND	No[4]	348	0	0.0%	0	0.0%	ND	ND	No
Polychlorinated Biphenyls (PCBs)																			
12672-29-6	**Aroclor 1248**	µg/L	2.3E-05	63	0	0.0%	0	0.0%	ND	ND	No[4]	304	1	0.3%	1	0.3%	1.3E-01	5,644	**Yes**
11097-69-1	**Aroclor 1254**	µg/L	5.5E-06	63	0	0.0%	0	0.0%	ND	ND	No[4]	304	8	2.6%	8	2.6%	3.7E-02	6,746	**Yes**
37324-23-2	**Aroclor 1260**	µg/L	2.3E-05	63	19	30%	19	30%	1.2E-01	5,209	**Yes**	304	36	11.8%	36	11.8%	8.0E-01	34,729	**Yes**
1336-36-3	**Total PCBs**	µg/L	2.3E-05	63	19	30%	19	30%	1.2E-01	5,209	**Yes**	304	41	13.5%	41	13.5%	8.0E-01	34,729	**Yes**

Notes:

Dark red text with pale background Indicates that constituent was retained as an upgradient potential constituent of concern but not as a constituent of concern at the point of compliance.

Dark red text with dark background Indicates that constituent was retained as a constituent of concern at the point of compliance.

1 Blank indicates that no individual soil cleanup level has been developed for the associated constituent; therefore, the associated constituent was not retained as a contaminant of concern at Boeing Plant 2. This is because Washington state regulates carcinogenic polycyclic aromatic hydrocarbons using the benzo(a)pyrene Toxic Equivalent. Refer to https://fortress.wa.gov/ecy/clarc/FocusSheets/tef.pdf. This is consistent with EPA's philosophy of using relative potency factors.

2 Benzo(a)pyrene TEQ calculated using 1/2 the reporting limit as a surrogate for non-detected constituents when at least one constituent contributing to the TEQ was detected.

3 EPA has approved the use of Ecology's TEFs for this site.

4 These constituents may be added back as COCs in the future if they are detected in Shoreline Monitoring Wells.

Abbreviations:

CAS Chemical abstract number
COC Constituent of Concern
Ecology Washington State Department of Ecology
EPA U. S. Environmental Protection Agency
PAH Polycyclic Aromatic Hydrocarbons
TEF Toxic Equivalency Factor
TEQ Toxic Equivalent

Table B.2d
Frequency of Exceedance of TMCLs by Volatile Organic Compounds in Groundwater

				Data from Shoreline Monitoring Wells: 2005-Present (Point of Compliance Wells)								Data from Upland Groundwater Wells: 2005-Present (All Uplands Wells)							
CAS	Constituent	Units	EPA Proposed Groundwater TMCL[1]	Number of Results	Number of Detected Results[2]	Percent Detected[2]	Number of Detected Results that Exceed Criteria[3]	Percent of Detected Results that Exceed Criteria[3]	Maximum Detected Value[2]	Exceedance Factor[3]	COC in Groundwater COCs at the Point of Compliance[4]	Number of Results	Number of Detected Results[2]	Percent Detected[2]	Number of Detected Results that Exceed Criteria[3]	Percent of Detected Results that Exceed Criteria[3]	Maximum Detected Value[2]	Exceedance Factor[3]	Upgradient Potential COC Constituents Present Upgradient of the Point of Compliance
Volatile Organic Constituents (VOCs)																			
67-64-1	Acetone	µg/L	1.1E+05	415	20	4.8%			1.5E+01		No	1,926	344	18%			2.7E+03		No
71-43-2	**Benzene**	µg/L	2.0E+00	416	18	4.3%	6	1.4%	1.7E+01	8.4	**Yes**	2,124	143	6.7%	38	1.8%	4.4E+02	217	**Yes**
78-93-3	2-Butanone (MEK)	µg/L	7.3E+04	400							No	1,851	121	6.5%			1.3E+04		No
75-15-0	Carbon Disulfide	µg/L	3.9E+03	416							No	2,124	180	8.5%			1.7E+01		No
56-23-5	**Carbon Tetrachloride**	µg/L	4.6E-01	416	8	1.9%	7	1.7%	1.6E+00	3.5	**Yes**	2,124	9	0.4%	8	0.4%	1.6E+00	3.5	**Yes**
108-90-7	Chlorobenzene	µg/L	2.7E+02	416							No	2,124	40	1.9%			3.4E+00		No
75-00-3	Chloroethane	µg/L	2.1E+04	416							No	2,124	33	1.6%			6.2E+02		No
67-66-3	Chloroform	µg/L	9.4E+00	416	23	5.5%			4.6E+00		No	2,124	89	4.2%	2	0.1%	1.5E+01	1.6	No; exceedance factor < 2.0; detected exceedence < 0.5%
74-87-3	Chloromethane	µg/L	1.9E+02	416	1	0.2%			3.0E-01		No	2,124	35	1.6%			2.9E+01		No
106-43-4	4-Chlorotoluene	µg/L	2.6E+03	20							No	864							No
95-50-1	1,2-Dichlorobenzene	µg/L	4.4E+02	54							No	951	2	0.2%			1.0E+00		No
106-46-7	1,4-Dichlorobenzene	µg/L	1.7E+00	54							No	951	1	0.1%			3.0E-01		No
75-34-3	1,1-Dichloroethane	µg/L	3.3E+01	416	17	4.1%			1.7E+00		No	2,124	204	9.6%	1	0.05%	6.7E+01	2.0	No; exceedance factor < 2.0; detected exceedence < 0.5%
107-06-2	1,2-Dichloroethane	µg/L	3.6E+00	416							No	2,123	19	0.9%			7.0E-01		No
75-35-4	**1,1-Dichloroethene**	µg/L	3.2E+00	416							No	2,124	59	2.8%	16	0.8%	2.7E+02	84	**Yes**
156-59-2	**cis-1,2-Dichloroethene**	µg/L	1.3E+02	416	97	23%	18	4.3%	1.8E+03	13	**Yes**	2,186	1,147	52%	252	11.5%	1.5E+05	1,123	**Yes**
156-60-5	**trans-1,2-Dichloroethene**	µg/L	9.4E+02	416	26	6.3%			1.4E+02		No	2,186	445	20%	1	0.05%	4.8E+03	5.1	**Yes**
78-87-5	1,2-Dichloropropane	µg/L	3.7E+00	416							No	2,124	3	0.1%			6.0E-01		No
100-41-4	**Ethylbenzene**	µg/L	1.7E+00	416	1	0.2%			1.1E+00		No	2,124	106	5.0%	38	1.8%	9.0E+02	522	**Yes**
98-82-8	Isopropylbenzene (cumene)	µg/L	2.7E+02	20							No	864	18	2.1%			9.4E+01		No
591-78-6	2-Hexanone	µg/L	3.2E+03	416							No	2,002	1	0.0%			1.2E+01		No
75-09-2	Methylene Chloride	µg/L	6.1E+01	416							No	2,123	32	1.5%			4.6E+01		No
108-10-1	Methyl Isobutyl Ketone	µg/L	1.9E+04	391							No	1,740	1	0.1%			1.3E+00		No
91-20-3	**Naphthalene**	µg/L	2.6E+01	108	4	3.7%			2.1E-01		No	1,898	114	6.0%	18	0.9%	6.3E+02	24	**Yes**
100-42-5	Styrene	µg/L	7.7E+04	416							No	2,124	31	1.5%			6.9E+01		No
79-34-5	1,1,2,2-Tetrachloroethane	µg/L	3.3E-01	416							No	2,124							No
127-18-4	**Tetrachloroethene (PCE)**	µg/L	2.1E-02	416	4	1.0%	4	1.0%	1.0E+00	49	**Yes**	2,124	76	3.6%	76	3.6%	7.8E+00	379	**Yes**
108-88-3	**Toluene**	µg/L	1.3E+03	416	9	2.2%			1.4E+00		No	2,124	186	8.8%	6	0.3%	5.1E+03	3.9	**Yes**
71-55-6	1,1,1-Trichloroethane	µg/L	4.6E+04	416							No	2,124	38	1.8%			7.3E+00		No
79-00-5	1,1,2-Trichloroethane	µg/L	2.3E+00	416							No	2,124	23	1.1%			2.3E+00		No
79-01-6	**Trichloroethene (TCE)**	µg/L	5.1E-01	416	86	21%	82	20%	2.9E+01	57	**Yes**	2,186	730	33%	637	29%	6.2E+04	122,465	**Yes**
120-82-1	**1,2,4-trichlorobenzene**	µg/L	1.3E-01	54							No	951	2	0.2%	2	0.2%	2.8E+00	21	**Yes**
75-69-4	Trichlorofluoromethane	µg/L	6.9E+03	416							No	2,108	4	0.2%			6.0E-01		No
76-13-1	1,1,2-Trichlorotrifluoroethane	µg/L	5.9E+04	416							No	2,124	2	0.1%			2.3E+00		No
75-01-4	**Vinyl chloride**	µg/L	2.4E+00	416	74	18%	37	8.9%	1.5E+03	625	**Yes**	2,186	992	45%	539	25%	2.8E+04	11,667	**Yes**
95-47-6	o-Xylene[5]	µg/L	1.6E+03	416	3	0.7%			1.1E+00		No	2,124	55	2.6%			6.4E+02		No
179601-23-1	m,p-Xylene[5]	µg/L	1.3E+03	416	7	1.7%			1.7E+00		No	2,124	74	3.5%	2	0.1%	2.0E+03	1.5	No; exceedance factor < 2.0; detected exceedence < 0.5%

Notes:

Dark red text with pale background Indicates that constituent was retained as an upgradient potential constituent of concern but not as a constituent of concern at the point of compliance.

Dark red text with pale background Indicates that constituent was retained as a constituent of concern at the point of compliance.

1 Blank indicates that no individual groundwater cleanup level has been developed for the associated constituent.
2 Blank indicates that constituent was not detected in this data set.
3 Blank indicates that the no detected result exceeds the criteria.
4 COCs may be added in the future depending on future sampling results.
5 Older data is reported as total xylenes, whereas newer data is reported as o-xylene and m,p-xylene. Some areas with more recent isomer-specific data do not have older total xylene data.

Abbreviations:

CAS Chemical abstract number
COC Constituent of Concern
EPA U. S. Environmental Protection Agency

Table B.2e
Frequency of Exceedance of TMCLs by Total Petroleum Hydrocarbons in Groundwater

				Data from Shoreline Monitoring Wells: 2005-Present (Point of Compliance Wells)								Data from Upland Groundwater Wells: 2005-Present (All Uplands Wells)							
CAS	Constituent[1]	Units	EPA Proposed Groundwater TMCL	Number of Results	Number of Detected Results	Percent Detected	Number of Detected Results that Exceed Criteria	Percent of Detected Results that Exceed Criteria	Maximum Detected Value	Exceedance Factor	*COC in Groundwater* COCs at the Point of Compliance[2]	Number of Results	Number of Detected Results	Percent Detected	Number of Detected Results that Exceed Criteria[3]	Percent of Detected Results that Exceed Criteria[3]	Maximum Detected Value	Exceedance Factor	*Upgradient Potential COC* Constituents Present Upgradient of the Point of Compliance
Total Petroleum Hydrocarbons (TPH)[5]																			
--	**TPH - Gasoline (Benzene Present)**	µg/L	1.0E+03	9	0	0.0%	0	0.0%	ND	ND	No	254	38	15%	21	8.3%	2.3E+04	23	**Yes**
--	**TPH - Aged Gasoline & Mineral Spirits**	µg/L	8.0E+02	1	0	0.0%	0	0.0%	ND	ND	No	6	1	17%	1	17%	2.7E+03	3.4	**Yes**
--	**TPH - Diesel #2**	µg/L	5.0E+02	9	0	0.0%	0	0.0%	ND	ND	No	259	23	8.9%	10	3.9%	1.1E+04	22	**Yes**
--	**TPH - Heavy Oil**	µg/L	5.0E+02	13	0	0.0%	0	0.0%	ND	ND	No	294	5	1.7%	4	1.4%	3.4E+03	6.8	**Yes**

Notes:

Dark red text with pale background — Indicates that constituent was retained as an upgradient potential constituent of concern but not as a constituent of concern at the point of compliance.

Dark red text with dark background — Indicates that constituent was retained as a constituent of concern at the point of compliance.

1 Petroleum hydrocarbons have been measured at Plant 2 over the years using a variety of methods and standards. Please see the table below to understand how each of the measurements of TPH have been compared to the TPH TMCLs.
2 COCs may be added in the future depending on future sampling results.

Abbreviations:

CAS Chemical abstract number
COC Constituent of Concern
EPA U. S. Environmental Protection Agency

TPH Map Between Constituent and TMCL

Constituent	Regulatory Standard
TPH - Gasoline (Benzene Present)	TPH - Gasoline (Benzene Present)
TPH - Mineral Spirits Range	TPH - Aged Gasoline & Mineral Spirits
TPH - Diesel Range	TPH - Diesel #2
TPH - Bunker C	TPH - Heavy Oil
TPH - Motor Oil Range	TPH - Heavy Oil

Table B.3a
Frequency of Exceedance of TMCL by Constituents in Sediments

CAS	Constituent	Sediment TMCL[1]	Units	Number of Results	Number of Detected Results[2]	Percent Detected[2]	Number of Detected Results that Exceed Criteria[3]	Percent of Detected Results that Exceed Criteria[3]	Maximum Detected Value[2]	Exceedance Factor[3]	Retained as COC
Metals											
7429-90-5	Aluminum		mg/kg	95	95	100%			3.1E+04		No
7440-36-0	Antimony		mg/kg	42	12	29%			1.1E+02		No
7440-38-2	Arsenic	5.7E+01	mg/kg	100	54	54%			3.1E+01		No
7440-39-3	Barium		mg/kg	95	95	100%			4.2E+02		No
7440-41-7	Beryllium		mg/kg	95	88	93%			6.0E-01		No
7447-47-3	**Chromium**	2.6E+02	mg/kg	199	199	100%	3	2%	3.4E+02	1.3	**Yes**
18540-29-9	Chromium (VI)		mg/kg	2							No
7440-48-4	Cobalt		mg/kg	96	96	100%			1.4E+02		No
7440-43-9	**Cadmium**	5.1E+00	mg/kg	198	122	62%	10	5%	2.1E+01	4.1	**Yes**
7440-50-8	**Copper**	3.9E+02	mg/kg	199	199	100%	4	2%	2.5E+03	6.4	**Yes**
7439-89-6	Iron		mg/kg	95	95	100%			8.1E+04		No
7439-92-1	**Lead**	4.5E+02	mg/kg	198	153	77%	3	2%	3.9E+03	8.7	**Yes**
7439-96-5	Manganese		mg/kg	95	95	100%			1.7E+03		No
7439-97-6	**Mercury**	4.1E-01	mg/kg	195	119	61%	14	7%	4.6E+00	11	**Yes**
7487-94-7	Mercury (inorganic salts and elemental)		mg/kg	195	119	61%			4.6E+00		No
7439-98-7	Molybdenum		mg/kg	4	4	100%			8.0E+00		No
7440-02-0	Nickel		mg/kg	100	100	100%			2.2E+02		No
7782-49-2	Selenium		mg/kg	96	12	13%			1.1E+01		No
7440-22-4	**Silver**	6.1E+00	mg/kg	198	78	39%	3	2%	7.9E+00	1.3	**Yes**
7440-31-5	Tin		mg/kg	7	5	71%			5.0E+00		No
1314-62-1	Vanadium		mg/kg	96	96	100%			1.5E+02		No
7440-66-6	**Zinc**	4.1E+02	mg/kg	198	198	100%	21	11%	4.2E+03	10	**Yes**
Other Inorganics											
57-12-5	Cyanide (free)		mg/kg	14	1	7%			3.5E-01		No
Volatile Organic Constituents (VOCs)											
67-64-1	Acetone		mg/kg	37	11	30%			5.3E-01		No
71-43-2	Benzene		mg/kg	37							No
78-93-3	2-Butanone (MEK)		mg/kg	34	12	35%			1.1E-01		No
75-15-0	Carbon Disulfide		mg/kg	37	17	46%			1.8E-02		No
56-23-5	Carbon Tetrachloride		mg/kg	37							No
108-90-7	Chlorobenzene		mg/kg	37	1	3%			1.4E+00		No
75-00-3	Chloroethane		mg/kg	37							No
67-66-3	Chloroform		mg/kg	37							No
74-87-3	Chloromethane		mg/kg	37							No
106-43-4	4-Chlorotoluene		mg/kg	4							No
95-50-1	1,2-Dichlorobenzene		mg/kg	105	1	1%			2.2E-02		No
106-46-7	1,4-Dichlorobenzene		mg/kg	105	2	2%			2.7E-02		No
106-46-7	1,4-Dichlorobenzene		mg/kg	105	2	2%			2.7E-02		No
75-34-3	1,1-Dichloroethane		mg/kg	37							No
107-06-2	1,2-Dichloroethane		mg/kg	37							No
75-35-4	1,1-Dichloroethene		mg/kg	37							No
156-59-2	cis-1,2-Dichloroethene		mg/kg	37	4	11%			4.3E-03		No
156-60-5	trans-1,2-Dichloroethene		mg/kg	37							No
78-87-5	1,2-Dichloropropane		mg/kg	37							No
100-41-4	Ethylbenzene		mg/kg	37	1	3%			4.7E-01		No
98-82-8	Isopropylbenzene(cumene)		mg/kg	4							No
591-78-6	2-Hexanone		mg/kg	37							No
75-09-2	Methylene Chloride		mg/kg	37							No
108-10-1	Methyl Isobutyl Ketone		mg/kg	37							No
100-42-5	Styrene		mg/kg	37							No
79-34-5	1,1,2,2-Tetrachloroethane		mg/kg	37							No
127-18-4	Tetrachloroethene (PCE)		mg/kg	37							No
108-88-3	Toluene		mg/kg	37	1	3%			1.8E-03		No
71-55-6	1,1,1-Trichloroethane		mg/kg	37							No
79-00-5	1,1,2-Trichloroethane		mg/kg	37							No
79-01-6	Trichloroethene (TCE)		mg/kg	37	8	22%			2.3E-02		No
120-82-1	1,2,4-trichlorobenzene		mg/kg	105							No
75-69-4	Trichlorofluoromethane		mg/kg	37							No
76-13-1	1,1,2-Trichlorotrifluoroethane		mg/kg	37							No
75-01-4	Vinyl chloride		mg/kg	37	1	3%			2.0E-03		No
95-47-6	o-Xylene[5]		mg/kg	30	2	7%			4.8E-01		No
179601-23-1	m,p-Xylene[5]		mg/kg	26	2	8%			1.2E+00		No
10330-20-7	Xylenes (total)[5]		mg/kg	11							No
Semivolatile Organic Compounds (SVOCs)[4]											
83-32-9	**Acenaphthene**	5.0E-01	mg/kg	102	14	14%	3	3%	7.6E-01	1.5	**Yes**
208-96-8	Acenaphthylene	1.3E+00	mg/kg	102	2	2%			5.7E-02		No
120-12-7	**Anthracene**	9.6E-01	mg/kg	102	28	27%	1	1%	4.4E+00	4.6	**Yes**
191-24-2	Benzo(g,h,i)perylene		mg/kg	102	43	42%			7.0E-01		No
191-24-2	Benzo(g,h,i)perylene		mg/kg	102	43	42%			7.0E-01		No
117-81-7	**Bis(2-ethylhexyl)phthalate**	1.3E+00	mg/kg	107	71	66%	6	6%	8.6E+00	6.6	**Yes**
85-68-7	**Butylbenzyl phthalate**	6.3E-02	mg/kg	107	20	19%	13	12%	7.1E+00	113	**Yes**
86-74-8	Carbazole		mg/kg	70	8	11%			2.9E-01		No
59-50-7	4-chloro-3-methylphenol		mg/kg	70							No
132-64-9	Dibenzofuran	5.4E-01	mg/kg	70	7	10%			3.6E-01		No
84-74-2	**Di-n-butylphthalate**	1.4E+00	mg/kg	107	29	27%	2	2%	3.8E+00	2.7	**Yes**
84-66-2	Diethylphthalate	2.0E-01	mg/kg	107	6	6%			3.4E-02		No
105-67-9	2,4-Dimethylphenol	2.9E-02	mg/kg	102							No
131-11-3	Dimethylphthalate	7.1E-02	mg/kg	107	4	4%			2.2E-02		No
117-84-0	Di-n-octyl phthalate	6.2E+00	mg/kg	107	3	3%			2.9E-01		No
206-44-0	**Fluoranthene**	1.7E+00	mg/kg	102	77	75%	8	8%	1.0E+01	5.9	**Yes**
86-73-7	**Fluorene**	5.4E-01	mg/kg	102	12	12%	1	1%	1.5E+00	2.8	**Yes**
91-57-6	2-Methylnaphthalene	6.7E-01	mg/kg	102	3	3%			2.2E-01		No
95-48-7	2-Methylphenol (o-cresol)	6.3E-02	mg/kg	102							No
106-44-5	4-Methylphenol (p-cresol)	6.7E-01	mg/kg	98	1	1%			5.2E-02		No
91-20-3	Naphthalene	2.1E+00	mg/kg	210	12	6%			3.8E-01		No
85-01-8	**Phenanthrene**	1.5E+00	mg/kg	102	53	52%	1	1%	4.9E+00	3.3	**Yes**
108-95-2	Phenol	4.2E-01	mg/kg	102	7	7%	1	1%	4.4E-01	1.0	No
129-00-0	**Pyrene**	2.6E+00	mg/kg	102	79	77%	4	4%	5.2E+00	2.0	**Yes**
Mutagenic Cancerous Polycyclic Aromatic Hydrocarbons (cPAHs)											
56-55-3	Benzo(a)anthracene	1.1E+02	mg/kg	102	49	48%			4.7E+00		No
50-32-8	Benzo(a)pyrene	9.9E+01	mg/kg	102	56	55%			2.0E+00		No
205-99-2	Benzo(b)fluoranthene	2.3E+02	mg/kg	102	59	58%			4.5E+00		No
207-08-9	Benzo(k)fluoranthene	2.3E+02	mg/kg	102	53	52%			2.5E+00		No
218-01-9	Chrysene	1.1E+02	mg/kg	102	66	65%			6.6E+00		No
53-70-3	Dibenz(a,h)anthracene	1.2E+01	mg/kg	102	13	13%			3.3E-01		No
193-39-5	Indeno(1,2,3-cd)pyrene	3.4E+01	mg/kg	102	42	41%			8.3E-01		No
Polychlorinated Biphenyls (PCBs)											
12672-29-6	Aroclor 1248		mg/kg	825	110	13%			2.0E+01		No
11097-69-1	Aroclor 1254		mg/kg	825	433	52%			1.1E+02		No
37324-23-2	Aroclor 1260		mg/kg	825	541	66%			5.1E+01		No
1336-36-3	**Total PCBs**	1.3E-01	mg/kg	547	425	78%	376	69%	1.1E+02	846	**Yes**

Notes:

Dark red text with dark background Indicates that constituent was retained as a constituent of concern.

1 Blank indicates that no TMCL was developed for the associated constituent.
2 Blank indicates that constituent was not detected at Boeing Plant 2.
3 Blank indicates that the no detected result exceeds the criteria.
4 SVOCs are detected infrequently in the sediments and fall within the footprint of contamination defined by total PCBs. EPA has made the risk management decision to treat the metals and PCBs as the COCs used to define the corrective measures for the sediments, since the Corrective Measures for sediments defined by metals and PCBs will remediate contamination for the SVOCs.
5 Older data is reported as total xylenes, whereas newer data is reported as o-xylene and m,p-xylene. Some areas with more recent isomer-specific data do not have older total xylene data; similarly, some areas with older total xylene data do not have newer isomer-specific data.

Abbreviations:

CAS Chemical abstract number
COC Constituent of Concern
EPA U. S. Environmental Protection Agency

Table B.4a
Frequency of Exceedance of TMCLs by Volatile Organic Compounds in Ambient Air

CAS	Constituent[1]	EPA Proposed Residential Air TMCL[2]	Units	Number of Results	Number of Detected Results[3]	Percent Detected[3]	Number of Detected Results that Exceed Criteria[4]	Percent of Detected Results that Exceed Criteria[4]	Maximum Detected Value[3]	Exceedance Factor[4]	Retained as COC	EPA Proposed Modified Industrial Worker Air TMCL[2]	Units	Number of Results	Number of Detected Results[3]	Percent Detected[3]	Number of Detected Results that Exceed Criteria[4]	Percent of Detected Results that Exceed Criteria[4]	Maximum Detected Value[3]	Exceedance Factor[4]	Retained as COC
56-23-5	**Carbon Tetrachloride**	4.1E-01	µg/m^3	18	18	100%	14	78%	0.43	1.1	**Yes**	2.0E+01	µg/m^3	18	18	100%			0.43		No
75-35-4	1,1-Dichloroethene	2.1E+02	µg/m^3	18							No	8.8E+02	µg/m^3	18							No
156-59-2	*cis*-1,2-Dichloroethene		µg/m^3	18							No		µg/m^3	18							No
127-18-4	Tetrachloroethene (PCE)	4.1E-01	µg/m^3	18	3	17%			0.25		No	2.1E+01	µg/m^3	18	3	17%			0.25		No
79-01-6	**Trichloroethene (TCE)**	1.2E-01	µg/m^3	18	16	89%	16	89%	1.9	16	**Yes**	6.1E+00	µg/m^3	18	16	89%			1.9		No
75-01-4	Vinyl chloride	2.8E-01	µg/m^3	18	14	78%			0.12		No	1.4E+01	µg/m^3	18	14	78%			0.12		No

Notes:

Dark red text with dark background Indicates that constituent was retained as a constituent of concern.

1 Only a limited number of constituents were analyzed for in indoor air at Plant 2; the list was developed based on existing groundwater, soil, and soil vapor data.
2 Blank indicates that no TMCL was developed for the associated constituent.
3 Blank indicates that constituent was not detected in this data set.
4 Blank indicates that the no detected result exceeds the criteria.

Abbreviations:

CAS Chemical abstract number
COC Constituent of Concern
EPA U. S. Environmental Protection Agency

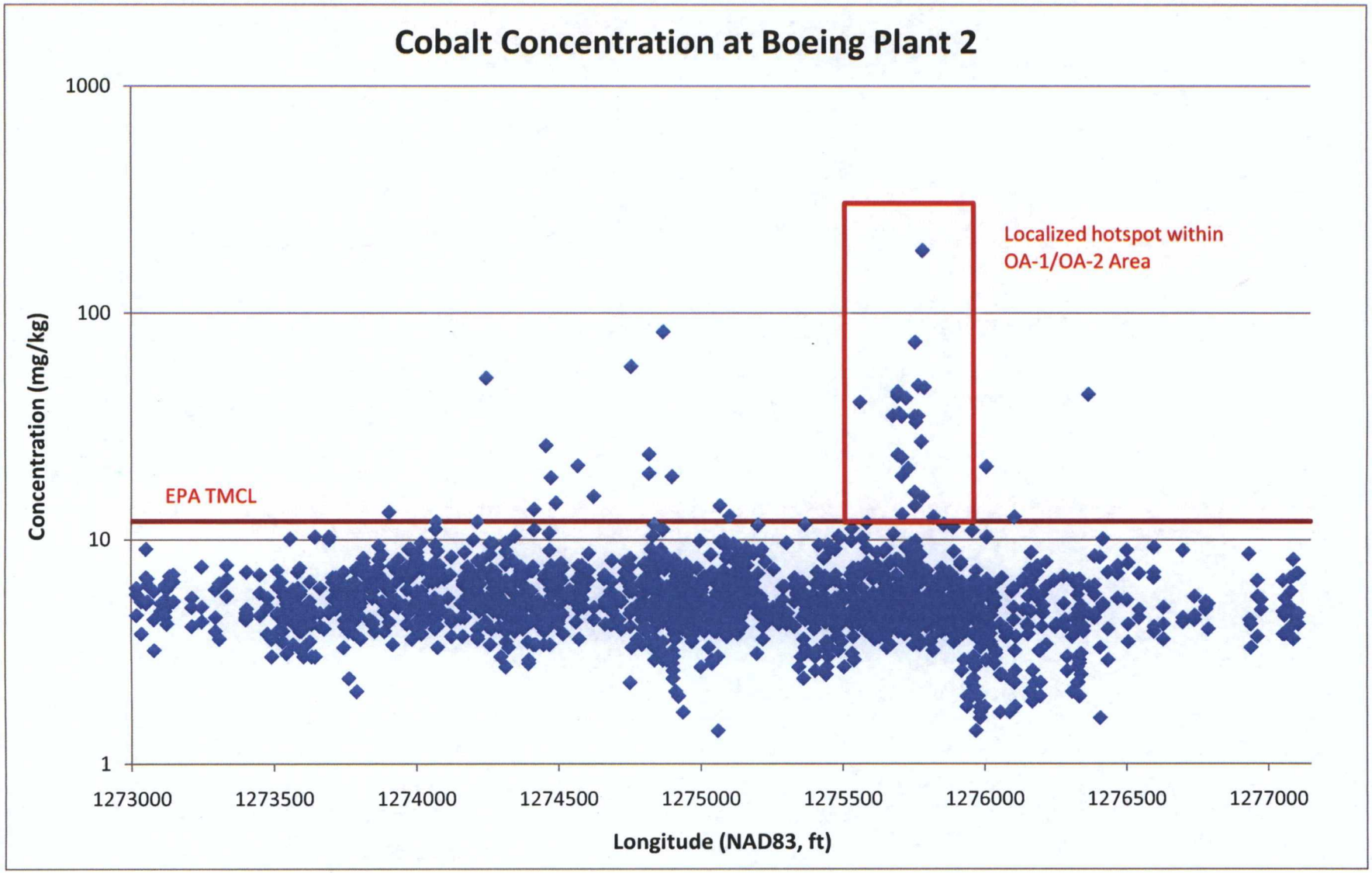
Boeing Plant 2
Seattle, WA

Target Media Cleanup Levels Technical Memorandum

Attachment B
Frequency of Exceedance Tables and Scatter Plots

Figures

FINAL



	TMCL Technical Memorandum **Boeing Plant 2**	Figure B.1 Cobalt Concentration at Boeing Plant 2

FIGURE 35: IRON X,Y SCATTER PLOT

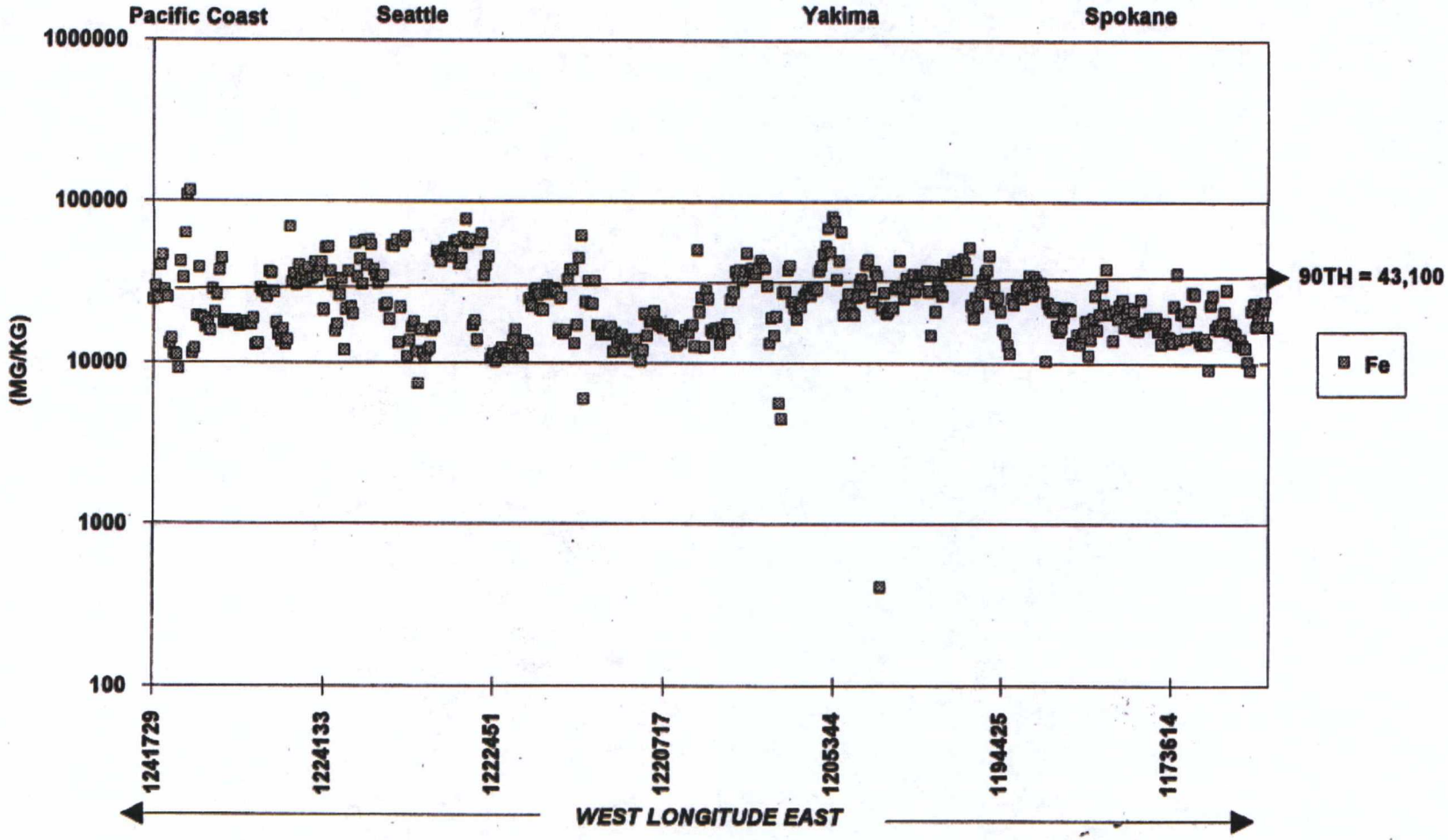
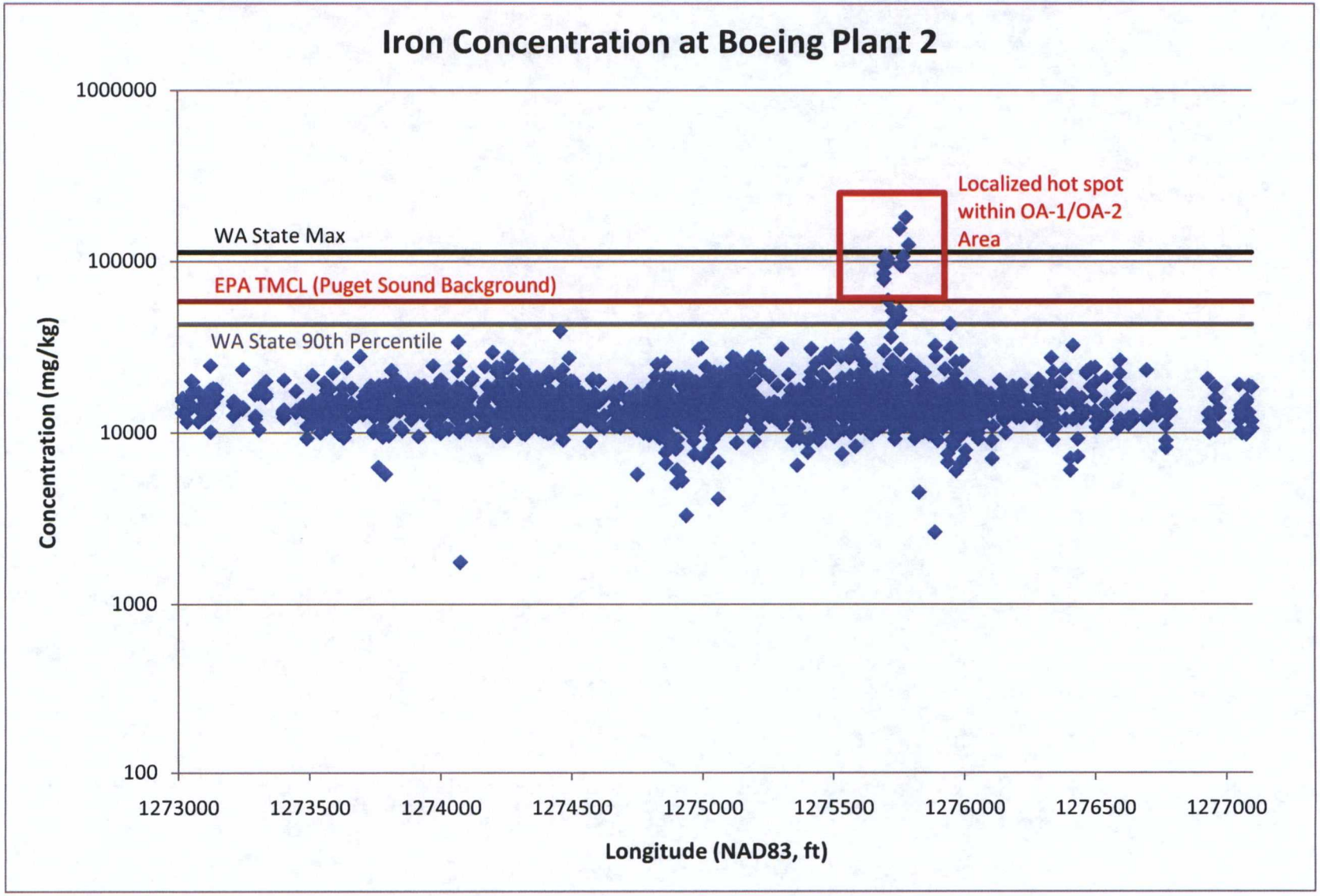


Figure reproduced from: Washington State Department of Ecology. 1994. *Natural Background Soil Metals Concentrations in Washington State, Toxics Cleanup Program (Charles San Juan), Department of Ecology, Publication No. 94-115.* October.

	TMCL Technical Memorandum **Boeing Plant 2**	Figure B.2 Iron Concentration Across Washington State



TMCL Technical Memorandum
Boeing Plant 2

Figure B.3
Iron Concentration at Boeing Plant 2

FIGURE 39: MANGANESE X,Y SCATTER PLOT

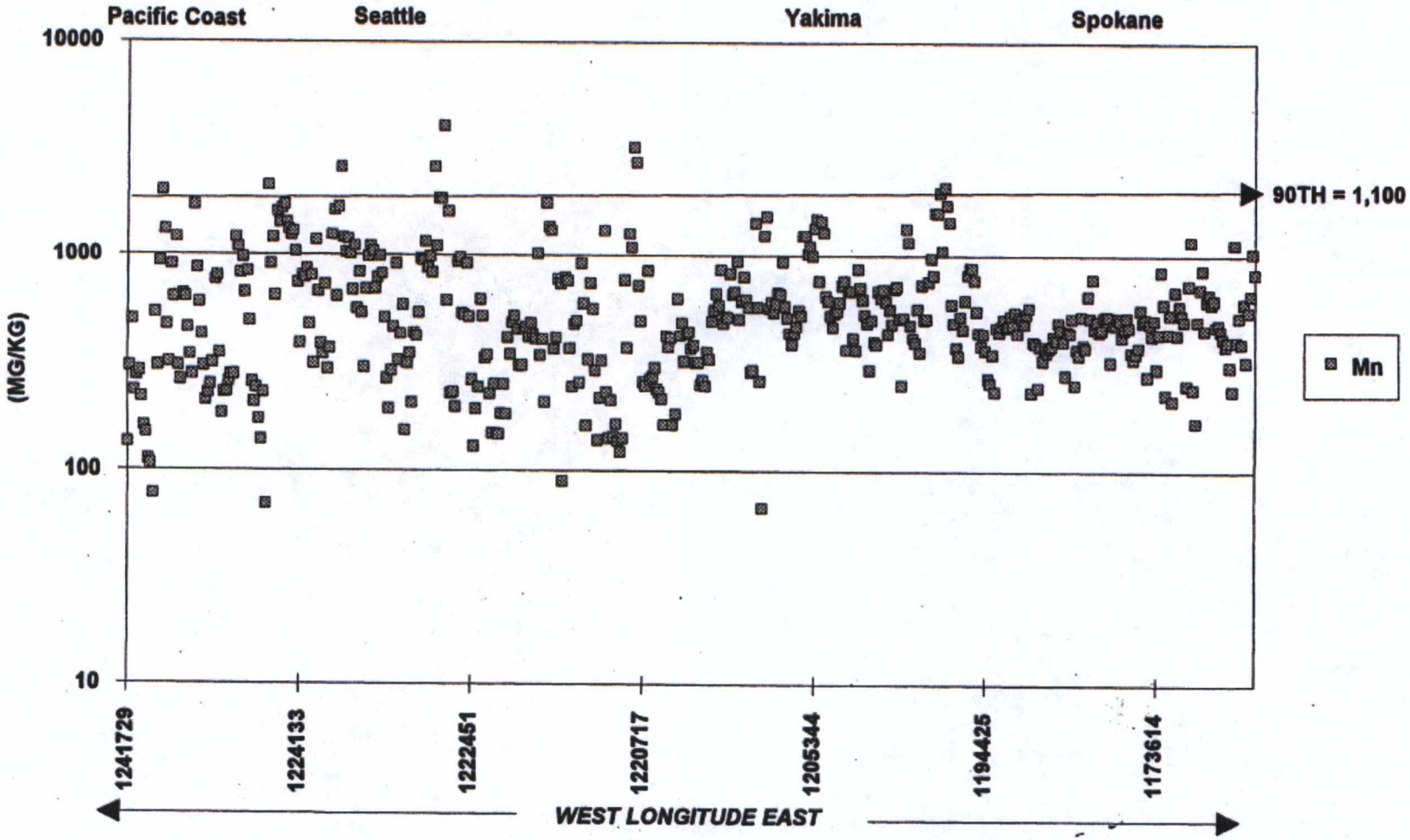
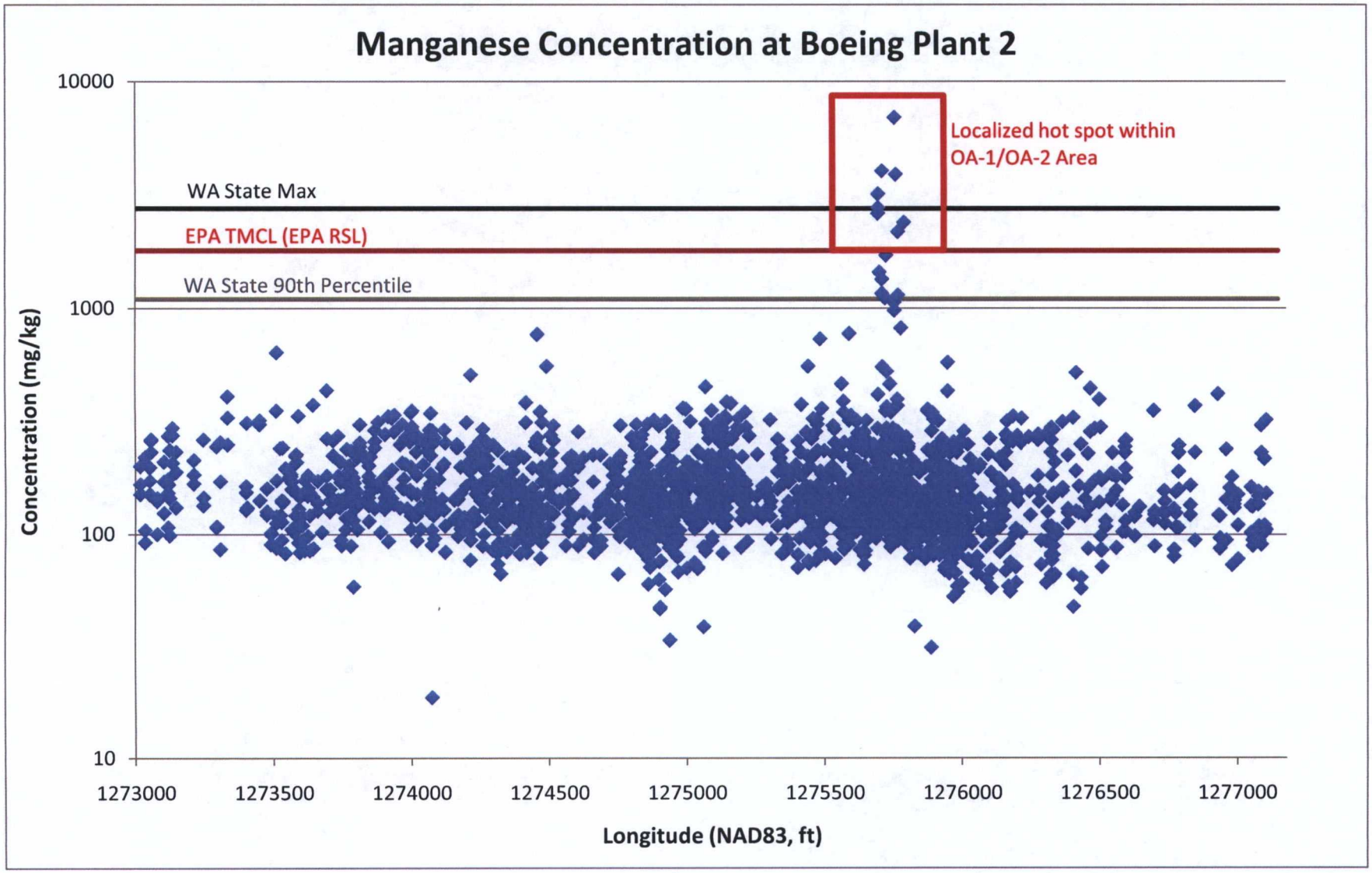
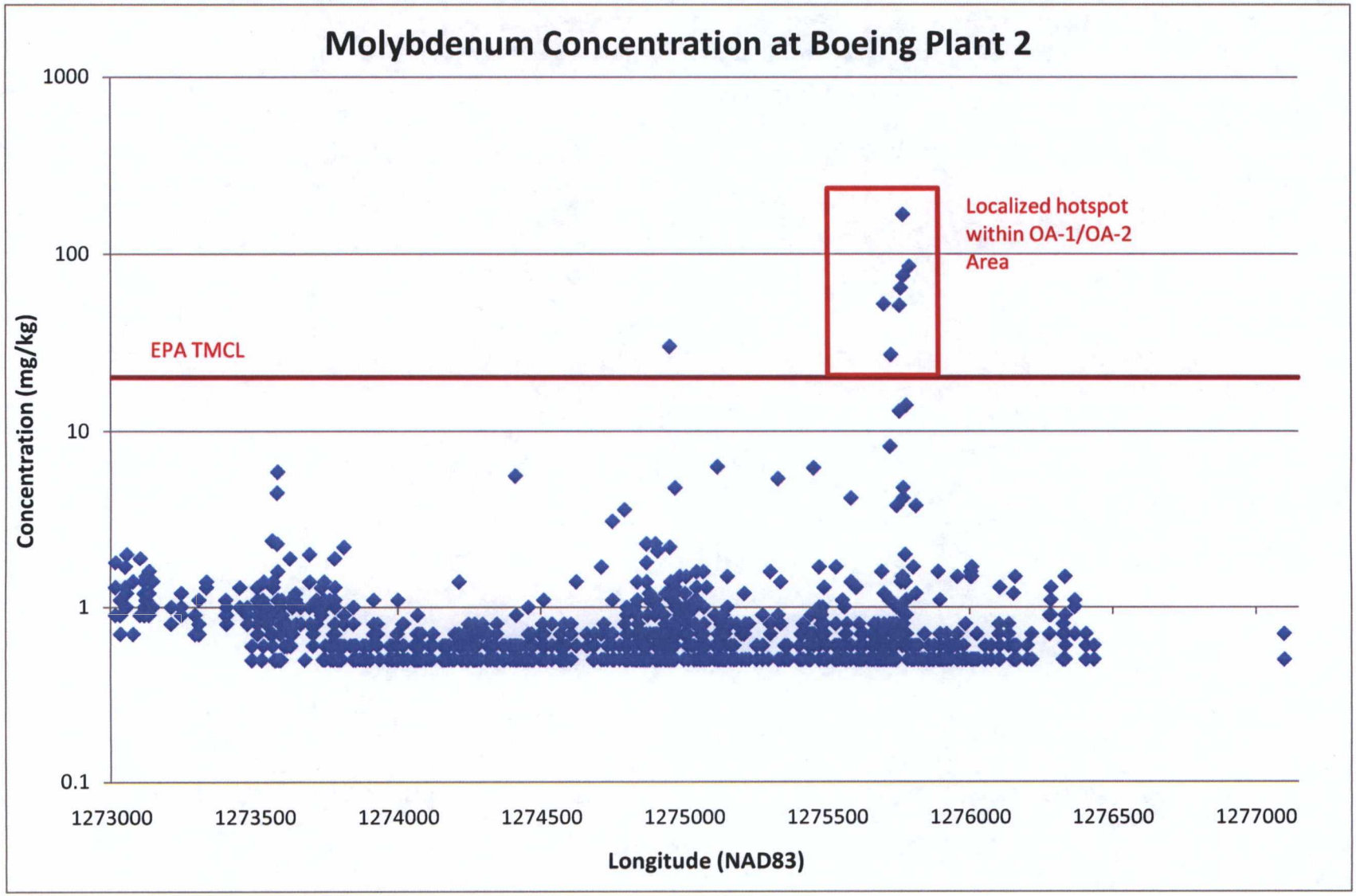


Figure reproduced from: Washington State Department of Ecology. 1994. *Natural Background Soil Metals Concentrations in Washington State, Toxics Cleanup Program (Charles San Juan), Department of Ecology, Publication No. 94-115*. October.

	TMCL Technical Memorandum **Boeing Plant 2**	Figure B.4 Manganese Concentration Across Washington State



	TMCL Technical Memorandum **Boeing Plant 2**	Figure B.5 Manganese Concentration at Boeing Plant 2



	TMCL Technical Memorandum Boeing Plant 2	Figure B.6 Molybdenum Concentration at Boeing Plant 2